HO'OPILI

O'AHU

FINAL
ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2 OF 2
APPENDICES

JULY 2008

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Decision Analysts Hawai'i, Inc.

February 2008

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EXECUTIVE SUMMARY

1. PROPOSED DEVELOPMENT

D.R. Horton—Schuler Homes, LLC (dba D.R. Horton—Schuler Division) proposes to develop Ho'opili ("the Project"), a planned community to be located on 1,555.145 acres in the 'Ewa District, O'ahu. This area includes 1,553.844 acres that is referred to as the "Petition Area," plus another 1.301 acres in the State Urban District. Off-site drinking-water reservoirs and storm-water detention areas will add 45.120 acres, resulting in a total Project Area of 1,600.265 acres. The Project will include about 11,750 single- and multi-family homes; business and commercial space; light-industrial space; parks and open space; public facilities; and associated infrastructure.

The Petition Area—which is surrounded by a combination of existing and planned urban development on three sides and the H-1 Freeway on the fourth side—is designated for residential and related development in the County's 'Ewa Development Plan and is within the Urban Growth Boundary. The Project will require a State Land Use District Boundary Amendment to Urban, and a change in County zoning.

2. AGRICULTURAL CONDITIONS

Existing agricultural leases indicate that about 1,375 acres (88%) of the Petition Area are arable land. Soil ratings indicate that about 1,340 ± 65 acres of the Petition Area have favorable agronomic conditions for crop production. This area has high-quality soils, flat or gently sloping terrain, high solar radiation, low pumping costs for irrigation water, and good access. Because of the sunny conditions, the fields are well-suited for growing crops during the Winter months.

3. LOCATIONAL ADVANTAGES AND DISADVANTAGES FOR CROP PRODUCTION

The Petition Area is well-located for serving the Honolulu consumer market and export markets. This is due to the short trucking distance to the Honolulu markets, the Honolulu International Airport, and Honolulu Harbor.

4. LOCATION AND SURROUNDING LAND USES

The Project is *makai* of the H-1 Freeway, *mauka* of 'Ewa Villages, west of Fort Weaver Road and Old Fort Weaver Road, and east of other planned projects in East Kapolei (Figures 1 and 6). These planned projects include: the University of Hawai'i West O'ahu (UHWO) campus and related residential and commercial development, Department of Hawaiian Home Lands (DHHL) East Kapolei residential projects, DHHL commercial center, and the Kroc Community Center on DHHL land.

Urban development has occurred or will occur to the east, south and west of the Petition Area. To the north on the *mauka* side of the H-1 Freeway are agricultural fields in Kunia and grazing lands in the Kunia foothills.

5. EXISTING AGRICULTURAL OPERATIONS

Currently, four agricultural operations lease or sublease about 1,497 acres (96%) of the Petition Area:

- Aloun Farms, Inc.: about 1,100 acres, of which about 100 acres are subleased to Fat Law's Farm

  In total, Aloun Farms and its affiliate lease about 2,440 acres in 'Ewa, Kunia, and Central O'ahu. Three acres within the Petition Area are used for Aloun's primary operating facilities.

- Fat Law's Farm: about 100 acres subleased from Aloun Farms

  This is the entire acreage for this operation, but the company also markets produce grown elsewhere by other farmers.

- Sugarland Farms, Inc. ("Jefts Farm"): about 197 acres

  In total, the consultant estimates that Jefts Farms owns or leases over 5,000 acres in 'Ewa, Kunia, the North Shore of O'ahu, and Moloka'i.

- Syngenta Seeds, Inc.: about 200 acres

  In total, Syngenta leases and subleases about 740 acres in 'Ewa and Kunia, and about 3,000 acres on Kaua'i.

6. DIRECT ON-SITE AGRICULTURAL IMPACTS

Ho'opili will result in the gradual loss of about 1,497 acres currently being leased for various agricultural operations. In isolation, and allowing for the replacement of Syngenta by another agricultural operation (see Section 8), this gradual loss of agricultural land will result in a related gradual loss of the following: approximately $6 million per year in revenues, average employment of about 80 jobs, and about $1.7 million per year in payroll.

In practice, however, most or all of the agricultural operations on the Ho'opili land are expected to relocate to other lands. In view of these anticipated relocations, mitigating measures are discussed at the end of the Section 10 which addresses cumulative impacts.

7. CUMULATIVE LOSS OF LAND FOR THE AFFECTED AGRICULTURAL OPERATIONS

In addition to the leased and subleased lands that gradually will be lost as the Project is developed over a 20-year period, three of the four agricultural operations in the Petition Area will eventually lose agricultural lands to (1) other private and State urban projects in 'Ewa and Central O'ahu that are within the County's Urban Growth Boundary, and (2) other agricultural operations in Kunia. For the affected agricultural operations, the approximate cumulative reductions in agricultural land will total about 3,600 acres (see Table ES-1). Syngenta's and Jefts Farms' losses of acreage to Monsanto (another agricultural operation) may occur within a few years. The agricultural land lost to urban projects is likely to begin in a few years and continue until as late as 2030.

By 2030, the acreage losses shown in Table ES-1 will leave Aloun Farms with about 160 acres of their current leased land, Fat Law's Farm with none of their current subleased land, and Syngenta with none of their leased acreage on O'ahu although some of their subleased acreage will remain available. Although reduced in size, Jefts Farms will retain over 4,000 acres of their current agricultural land.

8. CHANGES TO AGRICULTURAL OPERATIONS BEFORE HO'OPILI IS DEVELOPED

Monsanto's 2007 land purchase in lower Kunia includes the core of Syngenta's operations on O'ahu. Because of this purchase, the consultant anticipates that Syngenta will relocate from Kunia to some other area within the next few years—with or without Ho'opili, and before Ho'opili construction even begins.

Table ES-1. Cumulative Loss of Land for the Affected Agricultural Operations
(approximate acreage estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Syngenta	TOTAL
Urban Projects					
Ho'opili, 'Ewa	1,000	100	197	200	1,497
State Projects, 'Ewa[1]	850	-	95	-	945
Koa Ridge, Central O'ahu	430	-	-	-	430
Agricultural Uses					
State Ag Park, Kunia	-	-	150	-	150
Monsanto Co., Kunia	-	-	220	360	580
Total	2,280	100	662	560	3,602

1. UHWO, DHHL and other State projects.

Source: Decision Analysts Hawai'i, Inc.

Syngenta could relocate to Kaua'i where they already lease about 3,000 acres, although the North Shore of O'ahu is a possibility. If the company relocates to Kaua'i, the economic activity for Syngenta's O'ahu operation would be transferred to Kaua'i. This would include about a dozen full-time workers, 15 to 20 part-time workers, and about 60 to 90 temporary workers during the peak Winter season.

After Syngenta vacates the 200 acres it now leases in the Petition Area, it is expected that the land will be leased short-term to another agricultural operation until construction of this site is ready to begin.

9. AVAILABILITY OF REPLACEMENT LAND

The impact of the cumulative loss of land on the affected agricultural operations will depend on the amount and quality of available replacement land Statewide and on O'ahu.

a. Statewide

Statewide, a vast amount of land has been released from plantation agriculture: about 251,800 acres between 1968 and 2005, resulting in an average release of over 6,800 acres per year over a 37-year period (see Figure ES-1). The 2006 Del Monte closure in Kunia increased this figure by another 4,400 acres, resulting in a total release of at least 256,200 acres from plantation agriculture between 1968 and 2007. Over the 1968-to-2005 period, the demand for land for diversified crops increased by about 26,300 acres (about 10% of the land released from plantation agriculture).

The acreage released from plantation agriculture has far outpaced the demand for land for diversified crops. The net decrease in diversified crop land amounts to about 229,900 acres. While some of this land has been converted or is scheduled to be converted to urban uses and tree plantations, an estimated 160,000+ acres remain available for diversified crops.

If the Hawai'i Superferry is successful, cultivating crops on the Neighbor Islands for the Honolulu market, and vice versa, may become more economically feasible.

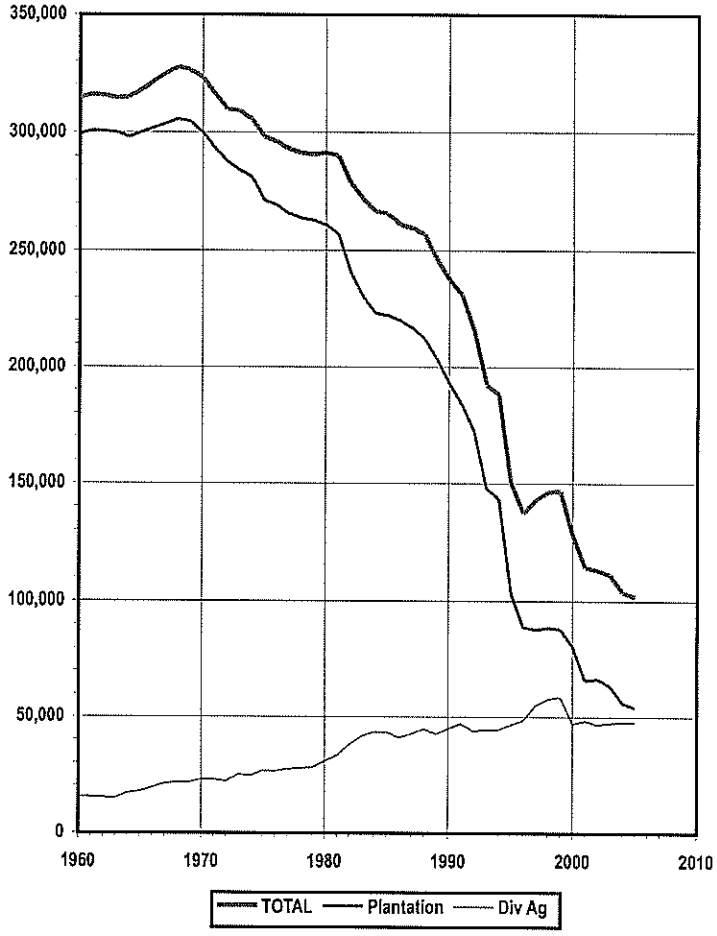
The above information indicates that considerable land is available in Hawai'i to accommodate the relocation of agricultural operations as well as the growth of diversified crop farming.

b. O'ahu

On O'ahu, a similar release of plantation land occurred. In total, about 10,900 acres of former plantation land remain available for other crops, including about 3,150 acres of former pineapple land in Kunia plus about 7,750 acres of former sugarcane and pineapple lands on the North Shore.

However, much of the available 10,900 acres have limitations for growing certain crops. Some limitations reflect permanent agronomic conditions. For example, the higher elevation fields in Kunia and on the North Shore have less solar radiation compared to 'Ewa. Nevertheless, some limitations can be overcome with investment in improvements. For example, on the North Shore, portions of the water delivery systems need major repairs, and the types of crops on fields irrigated with water from Wahiawa Reservoir (Lake Wilson) will be restricted as long as partially-treated wastewater continues to be discharged into the lake.

Figure ES-1 - Statewide Acreage in Crop: 1960 to 2005



10. CUMULATIVE AGRICULTURAL IMPACTS

a. Loss of Land for the Affected Agricultural Operations

As summarized in Table ES-1, the Project will result in a direct loss of about 1,497 acres currently being leased for various agricultural operations. In combination with land lost to other State and private urban projects and to other agricultural uses, the four agricultural operations in the Petition Area will incur a cumulative loss of about 3,600 acres of their leased land. As noted above, it is expected that Syngenta will relocate for reasons unrelated to and before the Ho'opili construction begins.

b. Required Replacement Land

If Syngenta remains on O'ahu, then about 3,600 acres of replacement land will be needed on O'ahu by the four the affected agricultural operations. But, if Syngenta relocates its O'ahu activities to Kaua'i where most of its operations are located, then the O'ahu demand will be reduced to less than 2,900 acres of replacement land.

As summarized in the previous section, sufficient land is available on O'ahu and the Neighbor Islands. Nevertheless, major water-related improvements are required before all available agricultural lands on the North Shore of O'ahu will be suitable for growing diversified crops. Also, the available lands possess different agronomic conditions than those found in 'Ewa and lower Kunia.

c. Anticipated Changes in Agricultural Operations

Until 2030, the agricultural operations located in the Petition Area are likely to adjust to gradual acreage losses by implementing a combination of (1) leasing replacement lands, (2) possibly cultivating remaining lands more intensively, and/or (3) reducing their operations. By 2030, however, Aloun Farms will lose nearly all and Fat Law's Farm will lose all their leased lands, thereby necessitating relocation to Kunia and/or the North Shore.

Assuming that the affected lessees secure replacement lands, and assuming the necessary water improvements are made, then the affected agricultural operations could maintain about the same level of production, sales revenues, employment and payroll. However, major adjustments in their operations will be required since the replacement lands will have different agronomic conditions. Also, the lessees will incur additional expenses to prepare the soils and irrigation systems for their particular crops, and to move their offices, and cooling and packing facilities.

If sufficient replacement land is not available on O'ahu (due to the unlikely possibility that it will be used to grow an energy crop), then one or more of the agricultural operations could turn to a Neighbor Island. Potential feasibility is illustrated by the fact that two of the lessees already have agricultural operations on Neighbor Islands, while many Neighbor Islands growers supply O'ahu markets. However, the affected companies which may move to the Neighbor Islands will incur higher transportation costs, and delivery times will be longer. The costs and delays will be similar to those that Neighbor Island farmers now incur to supply the Honolulu market. In the future, these costs and delays may be somewhat lower because of the Superferry and the planned improvements to interisland barge service. The disadvantages of a Neighbor Island location could be partially offset by lower rents. However, for some perishable crops, the ferry service may not be sufficiently frequent or travel may take too long.

d. Flexibility of Affected Agricultural Operations to Resize

Since the affected diversified crop operations can be flexible with regard to their sizes, it is anticipated that they will survive regardless of the amount of replacement land they lease in the future. More to the point, changes in available agricultural land due to the Project are not likely to threaten the survival of Aloun Farms, Fat Law's Farm, or Jefts Farms.

e. Statewide Impacts

From a Statewide perspective, the cumulative agricultural impact of the Project will be modest regardless of how the affected agricultural operations adjust to losing all, or portions of, their leased acreage. Their lost agricultural production from the Petition Area and from other areas they now lease will be offset largely by (1) maintaining their current levels of operation and production by leasing replacement lands in Kunia and/or the North Shore, and possibly cultivating their remaining lands more intensively; (2) one or more of them relocating all or portions of their operations to a Neighbor Island; (3) other farmers on O'ahu and the Neighbor Islands increasing their production; or (4) some combination of the three.

Thus, it is likely that there will be little or no loss in Statewide agricultural production, revenues, employment or payroll.

f. Urbanization of Agricultural Lands

Reconfigurations of farms such a those described above are common and appropriate when agricultural operations lease land in the path of planned urban expansion. For the affected operations, much of the land they lease is located in areas that the County and, for much of the 'Ewa Plain, the State have designated for eventual expansion of Kapolei. Also, all current tenants entered into lease agreements with this knowledge and, except for Fat Law's Farm, have benefited from rents that are now below market.

For diversified crop farmers who supply nearby markets, locations on the edge of town can be ideal for them because of the lower trucking costs. And until these lands are urbanized, the best "temporary" use of them may be agriculture—a use that may last decades. For example, the affected operations have cultivated their acreage on the 'Ewa Plain for 10 years or more, and some of this land will probably remain available to them for agriculture until as late as 2030.

But when urbanization does occur, the operations will incur the expense and disruption of relocating all their operations or major portions of them to other lands. Since lessees only have temporary rights to the land, the costs of relocating falls on the farmers and are not an obligation of the landowners. If the costs were an obligation of the landowners, they would avoid leasing their land to crop farmers and put their land in a lower value agricultural use such as cattle grazing which has similar land-management and property-tax benefits.

g. Mitigating Measures

The mitigation measures recommended below will contribute to the successful relocation of the four agricultural operations that will be displaced by Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia and Central O'ahu. They are designed to (1) address water issues that limit crop production on the North Shore where most available farm lands on O'ahu are located, and (2) provide sufficient time to make the necessary improvements and arrangements for relocating. Some of the recommendations will also benefit other growers who may relocate to or expand on the North Shore.

The recommended mitigation measures are categorized by those which may be best implemented by government, and those which are within the purview of D.R. Horton:

— Government

- Upgrade the Wahiawa Wastewater Treatment Plant (WWTP) to treat wastewater to the State's R-1 standard, or eliminate discharging wastewater into the Wahiawa Reservoir.

This recommendation to the County is consistent with a 1998 Consent Decree with the U.S. Environmental Projection Agency (EPA). Its purpose is to allow farmers to use water from the Wahiawa Reservoir to irrigate any type of crop using any type of irrigation system.

Until the quality of the reservoir water is improved, most of the available agricultural land on the North Shore cannot be used to grow the types of vegetable crops the farmers grow in 'Ewa and lower Kunia. In turn, one or more agricultural operations that will be displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore until the improvements are made (assuming that relocating to the North Shore is their best option).

- Repair the Wahiawa Irrigation System (WIS)

Repairs to portions of the WIS are needed to address major and minor leaks and to prevent future leaks. Because of the leaks, a number of mid-level and high-level fields on the North Shore can no longer be irrigated in the summer months with water from Wahiawa Reservoir. Until these repairs are made and more fields can be irrigated reliably, one or more agricultural operations being displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore (assuming that relocating to the North Shore is their best option).

Because of the high cost of the repairs, State and Federal funds may be required.

— D.R. Horton

- To the extent possible, coordinate the development of Ho'opili with the affect agricultural operators and with developers of adjacent lands so as to maintain farming in 'Ewa for as long as possible.

The development of Ho'opili and of projects on adjacent State lands could continue until 2030. Until then, farming can continue in 'Ewa, provided that Ho'opili works with the agricultural operators and developers of adjacent land to: (1) maintain access to fields and irrigation water, and (2) phase development to minimize the potential for nuisance issues (discussed in the next section). This will allow more time for others to make the necessary improvements to the WWTP and the WIS.

• Continue to lease agricultural land at below-market rents.

The affected agricultural operators will have to make frequent adjustments to their operations as development proceeds. These adjustments may include contracting their 'Ewa operations, rearranging water systems, building berms to reduce nuisance problems, etc.

Continued below-market rents will allow the affected agricultural operators to retain more funds to help finance the required adjustments.

11. NUISANCE ISSUES

a. Potential for Nuisance Issues

Nuisances arising from agricultural operations can become an issue for both residents and farmers. Residents who live close to and downwind from agricultural operations may complain about occasional noise, dust, chemical spraying, etc. In turn, the farmers may have to change their operations in order to address these complaints.

Regarding the existing homes that are located downwind of the agricultural operations in the Petition Area, they are buffered from nuisance problems by (1) farming activities on State land, (2) fallow fields on State land, and (3) the Kapolei Golf Course.

However, nuisance issues could arise during the 20 or so years while agricultural operations continue in portions of the Petition Area and homes are built and occupied nearby as part of Ho'opili or other projects on adjacent State lands.

Once Ho'opili and adjacent lands are fully developed, nuisance issues arising from agricultural activities will not occur since the lands will no longer be cultivated.

b. Mitigating Measures

To mitigate potential nuisance issues related to agricultural activities near newly built homes, the following mitigation measures are recommended:

— To the extent possible—and subject to transit alignment, water and other infrastructure improvements—phase the development of homes and coordinate agricultural leases to provide wide separations between homes and upwind agricultural activities.

— For each phase of development of Ho'opili and nearby projects, require farmers to provide a buffer of fallow fields and berms upwind of the homes before the homes are occupied.

— As necessary, limit agricultural activities (restricted hours of operation, restricted plowing and use of chemicals on windy days, etc.) so as to avoid or minimize nuisance problems.

— As long as agricultural operations continue in the Petition Area and on adjacent lands, inform home buyers in the area that they will be living near agricultural activities.

12. GROWTH OF DIVERSIFIED CROPS

The Project will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. The impact of this commitment on the growth of diversified crops is addressed below.

a. Potential Acreage Requirements for Diversified Crops

Crops to Replace Imports of Fruits and Vegetables

For low-elevation fruits and vegetables that have a history of profitable production in Hawai'i, potential land requirements in 2010 for 100% import substitution for the Hawai'i and O'ahu markets are estimated at 12,700 acres and 8,600 acres, respectively, plus additional acreage for fallowing land between crop plantings. When allowing for competition from imports, these estimates drop to about half.

Since Hawai'i farmers already supply a portion of the Hawai'i market, land requirements for increased import substitution are a fraction of the above estimates.

Export Crops

The many entrepreneurial agricultural efforts being undertaken on former plantation lands may lead to one or more major new export crops over the next 20+ years. However, the history of agricultural efforts in Hawai'i reveals that developing major new export crops that are successful in overseas markets is difficult and infrequent. For example, over the past 50 years in Hawai'i, farmers have explored numerous possibilities for export crops, but they have developed overseas markets for just one diversified crop that requires more than 10,000 acres (macadamia nuts at 18,300 acres in 2005); one additional crop that requires more than 5,000 acres (coffee at 8,000 acres); and only five additional crops or crop categories that require more than 1,000 acres each.

At 4,220 acres in 2005 and growing at an average rate of 264 additional acres per year, the seed industry is expected to soon become only the third diversified crop that requires more than 5,000 acres. The fourth crop could be nursery and flower products: 3,895 acres and increasing at 235 acres per year.

Feed Crops

If feed crops could be grown in Hawai'i and priced competitively against mainland imports, they could replace some of the grains and hay that are now being imported to the State. Unfortunately, a number of commercial attempts in Hawai'i to grow grains and alfalfa have been unsuccessful.

Biofuel Crops

Crops can be grown to produce biomass to fuel a boiler, or as feedstock to produce fuels. In Hawai'i, the common practice has been to produce biomass as a by-product of some principal crop. However, a company plans to build an ethanol plant at Campbell Industrial Park using conventional technology but, at least initially, using imported molasses as the feedstock. For the longer term, this company is exploring the economics of growing sweet sorghum to supply feedstock to its ethanol plant. Acreage requirements for a new sorghum biofuel plantation on O'ahu would range from about 6,000 acres for viability to 15,000 acres if juice from sorghum were to replace all imported molasses. Also, two companies plan to build biodiesel refineries in Hawai'i: one on O'ahu and one on Maui. Both will use imported palm oil from Malaysia and other countries as their feed stock, but would refine locally produced vegetable oil if available.

However, a number of substantial difficulties must be overcome to develop one or more biofuel plantations. For example, it will be difficult to lease the large amount of land required for economic viability. Most major landowners will be reluctant to lease their land at comparatively low rents for the approximately 30-year period required to capitalize the investment. Also, per-acre returns from biofuel crops are comparatively low. In the long-term, emerging technology that is in the early stages of commercialization holds promise for a cheaper source of feedstock for ethanol. Instead of producing ethanol using sugars from conventional sources, the sugar would come from "cellulosic" sources. This would include green waste for which there would be no land rent and no growing costs, but there could be a disposal fee paid to the processor. In the long term, this less expensive source of feedstock could result in an unprofitable biofuel plantation.

These and other difficulties and risks suggest that the probability of successfully developing and sustaining a biofuel plantation in Hawai'i is low. The more likely scenario is that ethanol will be produced as a by-product of sugar and, over the long-term, it will be produced from green waste.

Recent Crop-Acreage Trends

For all diversified crops (i.e., all crops other than sugarcane and pineapple, including crops to replace imports and crops for export) Statewide land requirements grew as shown in Figure ES-1. As illustrated, growth in acreage has slowed over time, with an average growth of about 160 acres per year from 2000 to 2005. During this period, major export crops grew by an average of about 350 acres per year, while crops grown for the Hawai'i market declined by an average of about 190 acres per year.

b. Adjusted Supply of Land Available for the Growth of Diversified Crops

As discussed above, about 10,900 acres of farm land are available on O'ahu, and over 160,000 acres are available Statewide. Over time, a portion of this available land supply will be leased to the four agricultural operations that will have to relocated as a result of Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia, and Central O'ahu. On O'ahu, this relocation will require about 2,900 to 3,600 acres, depending on whether Syngenta's O'ahu operation remains on O'ahu or relocates to Kaua'i. The adjusted supply of farm land that will remain available for diversified farming will total about 7,300 to 8,000 acres on O'ahu and over 156,000 acres Statewide.

This adjusted supply of available farm land far exceeds the amount of land that will be needed to accommodate the growth of diversified crops, whether demand is based on potential or recent trends. This indicates that the limiting factor to the growth of diversified crops will *not* be the *land supply.* Instead, growth will be limited by the *size of the market* for crops that can be grown *profitably* in Hawai'i.

c. Impact on the Growth of Diversified Crop Farming

The development of Ho'opili—in combination with other development projects in 'Ewa, Central O'ahu and elsewhere—involves the loss of too little good agricultural land to significantly affect the growth of diversified crop farming in Hawai'i. This conclusion is based on the above finding that ample land will remain available for diversified crops, with the available supply far exceeding the likely or potential demand.

However, as discussed previously, water-related improvements are needed to allow full use of some of the available farm lands on the North Shore. These improvements are the responsibility of the landowners and government agencies.

d. Mitigating Measures

In view of the negligible impact of the Project on the growth of diversified agriculture, mitigation measures for the loss of good agricultural land are not recommended beyond the measures addressed in Section 9.h above.

13. OFFSETTING BENEFITS

As previously mentioned, Ho'opili will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. In turn, Ho'opili—in combination with other private and State urban projects and changes in agriculture land use in Kunia—will require the the affected agricultural operations to relocate.

These adverse impacts to agriculture will be offset by the following benefits of the Project:

- About 11,750 homes for Hawai'i residents, along with business and commercial space, light-industrial space, parks and open space, and public facilities.
- For 'Ewa, relatively high housing densities which, in turn, will contribute to slower urbanization of agricultural land than would be the case with lower densities.
- Construction jobs provided by the development activity.
- At full development of the Project, on-site jobs provided by business, commercial, industrial, and home-service activities.
- Tax revenues (excise taxes, personal income taxes, corporate income taxes, property taxes, etc.) generated by the development activity.
- Tax revenues generated by the families and businesses that occupy the Project.
- Improved land and partial funding for schools, parks and other public facilities.

14. CONSISTENCY WITH STATE AND COUNTY POLICIES

a. Availability of Lands for Agriculture

The *Hawaii State Constitution*, the *Hawaii State Plan*, the *State Agriculture Functional Plan*, and the *General Plan of the City and County of Honolulu* call directly or implicitly for preserving the economic viability of plantation agriculture and promoting the growth of diversified crops. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

With regard to plantation agriculture, the Petition Area is no longer part of a sugar plantation since O'ahu Sugar Co. closed in 1995 for reasons unrelated to the Project.

With regard to diversified crops, development of the Petition Area will result in a loss of good farm land, and the farms on this land will have to relocate. However, this loss of agricultural land will not limit the growth of diversified crops since ample agricultural land is available on O'ahu and on other islands. This is due to the enormous supply of farm land that is now available following the contraction of plantation agriculture (Figure ES-1). However, improvements to the WWTP and the WIS will be needed to allow full use of the available farm lands on the North Shore.

b. Conservation of Agricultural Lands

In addition to the above, State policies call for conserving and protecting prime agricultural lands, including protecting agricultural lands from urban development.

However, these policies—which were written before the major contraction of plantation agriculture in the 1990s—assume implicitly that profitable agricultural activities eventually will be available to use all available agricultural lands. This has proven to be a questionable assumption in view of the enormity of the contraction of plantation agriculture, the abundant supply of land that came available for diversified agriculture, and the slow growth in the amount of land being used for diversified crops (see Figure ES-1).

Furthermore, discussions in the Agriculture portion of the *State Functional Plan* recognize that redesignation of lands from Agricultural to Urban should be allowed "... upon a demonstrated change in economic or social conditions, and where the requested redesignation will provide greater benefits to the general public than its retention in ...agriculture;" that is, when an "overriding public interest exists." In this regard, major changes in economic and social conditions have occurred as a result of:

— The on-going development of the City of Kapolei and the surrounding 'Ewa region as the second largest urban center in Hawai'i (see the policy discussion in the following subsection).

— Inadequate expansion in the supply of workforce housing which has contributed to high housing prices on O'ahu.

— The enormous contraction in plantation agriculture which has resulted in the supply of agricultural land far exceeding demand.

Moreover, development in the Petition Area will provide community benefits (about 11,750 homes and many on-site jobs) that far exceed those provided by agriculture (about 80 jobs after Syngenta is replaced by a new farm). In practice, however, development of the Petition Area is likely to have little or no impact on Statewide agricultural employment.

c. County 'Ewa Development Plan

The Petition Area is within the County's designated Urban Growth Boundary of the 'Ewa Development Plan in an area designated for residential development. Thus, the Project is consistent with the 'Ewa Development Plan in terms of future land use.

This Plan is part of a broader long-established County policy, with support from the State, to direct urban growth to 'Ewa, to portions of Central O'ahu, and to the primary urban center. In turn, the policy reduces development pressures on the outlying Districts of Ko'olau Loa, Ko'olau Poko, North Shore, and Wai'anae. The policy was designed to provide needed housing, jobs, and commercial and industrial space in compact areas; preserve agricultural lands and open space in Kunia, the North Shore, and outlying areas; preserve the "country" lifestyle of rural communities; and reduce the cost of providing government infrastructure and services.

Portions of the Project could be inconsistent with the phasing component of the currently approved 'Ewa Development Plan which indicates that urban expansion of the northern and eastern portions of the Petition Area is to occur after 2015. Such phasing in the current 'Ewa Development Plan would create nuisance issues by placing farm areas immediately upwind of the new Ho'opili homes. However, the 'Ewa Development Plan is in the process of being updated which, based on discussions with the County, is expected to reflect the removal of phasing from the Plan.

HO'OPILI:
IMPACT ON AGRICULTURE

1. INTRODUCTION[1,2]

D.R. Horton—Schuler Homes, LLC (dba D.R. Horton—Schuler Division) proposes to develop Ho'opili ("the Project"), a planned community to be located on 1,555.145 acres in the 'Ewa District, O'ahu. This area includes 1,553.844 acres that is referred to as the "Petition Area," plus another 1.301 acres in the State Urban District. Off-site drinking-water reservoirs and storm-water detention areas will add 45.120 acres, resulting in a total Project Area of 1,600.265 acres. The location of the Project, Tax Map Keys (TMKs), and the parcels and their acreages are shown in Figures 1, 2 and 3, respectively.

The Petition Area is designated for residential and related development in the City and County of Honolulu (County) 'Ewa Development Plan (see Figure 4), and is currently zoned "Agricultural." At the State level, the Petition Area is in the State Agricultural District (Figure 5). Thus, the Project will require a State Land Use District Boundary Amendment to Urban, and a change in County zoning. The conceptual land-use plan for the Project is shown in Figure 6.

This report addresses the impacts on agriculture of developing the Project. The material below gives the following information on the Project and its agricultural impacts: its location; a brief Project description; the agricultural conditions of the Petition Area, along with supporting Figures 7, 8 and 9; potential crops; locational advantages and disadvantages for crop production; surrounding land uses; historical agricultural uses; existing farm operations along with supporting Figure 10; for the affected farms, anticipated losses of farm land due to urban development and to other agricultural uses; anticipated changes in farming activity before the development of Ho'opili begins; availability of replacement farm land, along with supporting Figure 11; direct and cumulative impacts of the Project on affected farms; nuisance issues; the impact of the Project on the growth of diversified crop farming; benefits of the Project that will offset adverse agricultural impacts; and consistency of the Project with State and County agricultural policies.

Following the eleven figures at the end of the report, an Appendix provides a summary of State and County goals, objectives, policies and guidelines related to agricultural lands.

2. LOCATION OF THE PROJECT [2]

The Project is *makai* of the H-1 Freeway, *mauka* of 'Ewa Villages, west of Fort Weaver Road and Old Fort Weaver Road, and east of the planned University of Hawai'i West O'ahu (UHWO) campus and planned development by the Department of Hawaiian Home Lands (DHHL) (Figures 1 to 6). As shown in Figures 2 and 3, the Petition Area is identified by the following TMKs:

TMK	Parcel	Acres
9-1-18:04	A	52.289
9-1-18:01	B	447.592
9-1-17:04 (por), 59 & 72	C	1,053.963

3. PROJECT DESCRIPTION[2]

Ho'opili will include about 11,750 single- and multi-family homes; business and commercial space; light-industrial space; parks and open space; public facilities (e.g., schools); and associated infrastructure (e.g., roadways, an electrical system, a telephone system, a cable-TV system, Internet systems, a drinking water system, a non-drinking water system for irrigating landscaped areas, sewers, and drainage).

4. AGRICULTURAL CONDITIONS

a. Soil Types[3]

As shown in Figure 7, the Petition Area consists of 19 soil types plus former reservoir sites. The complete names of the soil types and their slopes are:

- EaB Ewa silty clay loam, 3 to 6 percent slopes
- FL Fill land, mixed
- HLMG Helemano silty clay, 30 to 90 percent slopes
- HxA Honouliuli clay, 0 to 2 percent slopes
- HxB Honouliuli clay, 2 to 6 percent slopes
- Kfb Kaloko clay, noncalcerous variant
- KlaB Kawaihapai stony clay loam, 2 to 6 percent slopes
- KlA Kawaihapai clay loam, 0 to 2 percent slopes
- KlbC Kawaihapai very stony clay loam, 0 to 15 percent slopes

- KmaB Keaau stony clay, 2 to 6 percent slopes
- KyA Kunia silty clay, 0 to 3 percent slopes
- KyB Kunia silty clay, 3 to 8 percent slopes
- KyC Kunia silty clay, 8 to 15 percent slopes
- MuB Molokai silty clay loam, 3 to 7 percent slopes
- MuC Molokai silty clay loam, 7 to 15 percent slopes
- WkA Waialua silty clay, 0 to 3 percent slopes
- W Water (former reservoir)
- WzA Waipahu silty clay, 0 to 2 percent slopes
- WzB Waipahu silty clay, 2 to 6 percent slopes
- WzC Waipahu silty clay, 6 to 12 percent slopes

Table 1 shows the estimated acreage of each soil type according to its quality as rated by the Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service.

As indicated, HxA, KyA and WzA are the predominant soil types, comprising about 63.5% of the Petition Area.

b. Soil Ratings

Three classification systems are commonly used to rate Hawai'i soils: (1) Land Capability Grouping, (2) Agricultural Lands of Importance to the State of Hawai'i, and (3) Overall Productivity Rating.

Land Capability Grouping (NRCS Rating)[3]

The 1972 Land Capability Grouping by the U.S. Department of Agriculture, NRCS rates soils according to eight levels, ranging from the highest classification level I to the lowest VIII.

Table 1 shows that about 1,045.6 acres (67.3%) of the Petition Area have soils that are rated I. Class I soils have few limitations that restrict their use.

About 226.9 acres (14.6%) have soils that are rated IIe. Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices. The subclassification "e" indicates that the soils are subject to erosion.

Table 1. Ho'opili Petition Area: Soil Types and NRCS Ratings

Soil Types	Acres	%	NRCS Ratings[1]
Higher-quality			
HxA	243.9	15.7%	I
KlA	10.9	0.7%	I
KyA	411.6	26.5%	I
WkA	48.2	3.1%	I
WzA	331.0	21.3%	I
EaB	48.2	3.1%	IIe
HxB	14.0	0.9%	IIe
KlaB	4.7	0.3%	IIe
KyB	3.1	0.2%	IIe
MuB	76.1	4.9%	IIe
WzB	80.8	5.2%	IIe
Moderate-quality			
KyC	4.7	0.3%	IIIe
MuC	46.6	3.0%	IIIe
WzC	115.0	7.4%	IIIe
Kfb	15.5	1.0%	IIIw
KmaB	3.1	0.2%	IIIw
Lower-quality			
KlbC	4.7	0.3%	VIs
HLMG	68.4	4.4%	VIIe
FL	7.8	0.5%	n.r.
W (former reservoirs)	15.5	1.0%	n.r.
Total	1,553.8	100.0%	

1. Assuming all soils are irrigated.

Source: U.S. Department of Agriculture, Soil Conservation Service, *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii,* August 1972.

About 166.3 acres (10.7%) have soils rated IIIe. Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

About 18.6 acres (1.2%) have soils rated IIIw. The subclassification "w" indicates that the soils have excess water (i.e., they are poorly drained).

About 4.7 acres (0.3%) have soils rated VIs. Class VI soils have severe limitations that make them generally unsuitable for cultivation and restrict their use largely to pasture. The subclassification "s" indicates that the soils are rocky or stony.

About 68.4 acres (4.4%) have soils rated VIIe. Class VII soils have very severe limitations that make them unsuitable for cultivation and restrict their use largely to pasture.

About 23.3 acres (1.5%) have soils that are not rated because it is fill land or land associated with former reservoirs.

Agricultural Lands of Importance in the State of Hawai'i (ALISH)[4]

ALISH ratings were developed in 1977 by the NRCS, the UH College of Tropical Agriculture and Human Resources, and the State of Hawai'i, Department of Agriculture. This system classifies land into three broad categories: (a) Prime agricultural land which is land that is 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; (b) Unique agricultural land which is non-Prime agricultural land used for the production of specific high-value crops; and (c) Other agricultural land which is non-Prime and non-Unique agricultural land that is important to the production of crops.

About 1,317.1 acres (84.8%) of the Petition Area have soils that are rated Prime; about 155.4 acres (10%) are rated Other; and about 80.8 acres (5.2%) are unclassified (Figure 8).

Overall Productivity Rating (LSB Rating)[5]

In 1972, the University of Hawai'i Land Study Bureau (LSB) developed the Overall Productivity Rating, which classifies soils according to five levels, with A representing the class of highest productivity and E the lowest.

About 517.4 acres (33.3%) of the Petition Area have soils rated A, about 890.3 acres (57.3%) are rated B, about 7.8 acres (0.5%) are rated C, about 17.1

acres (1.1%) are rated D, about 87.0 acres (5.6%) are rated E, and about 34.2 acres (2.2%) are unrated (Figure 9).

Summary Evaluation of Soil Quality

These soil-rating systems suggest that about 1,340 ± 65 acres (86 ± 4%) of the Petition Area are comprised of higher-quality soils (I and II for the NRCS ratings, Prime for ALISH, and A and B for the LSB).

c. Soil Characteristics[3,5]

The better soils in the Petition Area exhibit a number of favorable characteristics: the soils are deep (over 30 inches); they have good machine tillability; they are well-drained; the erosion hazard is none to slight; and the slopes are gentle (see below). However, some of the soils (e.g., HxA) are very sticky and very plastic clay, and others (e.g., KyA) are medium to extremely acidic.

d. Arable Land[1]

Consistent with the above ratings, existing agricultural leases indicate that about 1,375 acres (88%) of the Petition Area are arable land. This assessment is based on the fact that the land classified as arable was once cultivated in sugarcane.

e. Elevations[6]

Elevations range from about 50 feet near the southeast corner of the property to about 220 feet near the 228' Elevation Reservoir (Figure 1).

f. Terrain[2,3]

Most of the Petition Area has flat or gently sloping land, with slopes ranging from 0% to 6%. The exception is Honouliuli Gulch which runs through the northeast corner of the Petition Area and separates Syngenta Seeds from Aloun Farms (Figure10).

g. Climatic Conditions

Like other areas in Hawai'i, the 'Ewa Plain has a mild *semi*tropical climate which is due primarily to three factors: (1) Hawai'i's mid-Pacific location near

the Tropic of Cancer, (2) the surrounding warm ocean waters that vary little in temperature between the Winter and Summer seasons, and (3) the prevailing northeasterly tradewinds that bring air having temperatures that are close to those of the surrounding waters.

Solar Radiation[7]

The 'Ewa Plain is one of the sunniest areas on O'ahu. It is semi-arid, with a relatively warm and dry climate and an average daily insolation ranging from about 470 to 500 calories per square centimeter.

Rainfall[8]

Rainfall in the Petition Area is low: averaging about 25 inches per year. Most of this rain occurs during the Winter rainy season (October through February), while the Summer months (May through September) are hot and dry. Monthly average rainfall is lowest at about 0.5 inch in August and highest at about 3 inches in January.

Temperatures[8]

Average low temperatures range from about 60° Fahrenheit in the Winter to about 69° in the Summer. Average high temperatures range from about 78° in the Winter to 87° in the Summer.

Winds and Storms[8,9]

Wind speeds average about 9.4 miles per hour (mph) in the Winter and about 13.1 mph in the Summer. Tradewinds blow from a northeasterly direction, but they tend to break down during the Fall, giving way to lighter, more variable wind conditions through the Winter and into early Spring. Storms are infrequent, occurring mostly from the south in the Winter months.

h. Irrigation Water[1]

The fields are irrigated with groundwater pumped from wells in the area. The lift is short, so pumping costs are relatively low. None of the fields are irrigated with water from Waiahole Ditch.

i. Road Access[6]

Access to the fields is provided by plantation roads that connect to Farrington Highway, Fort Weaver Road, and Palehua Road.

Palehua Road provides a route for farmers to drive their trucks under the H-1 Freeway between the Petition Area and their operations in Kunia without having to use public roads. Portions of this road, including the segment between the H-1 Freeway and Farrington Highway, will become the North-South Road that will cross the 'Ewa Plain and provide additional access to the H-1 Freeway (Figure 6).

j. Summary

Of the approximately 1,553.8 acres in the Petition Area, soil ratings indicate that about 1,340 ± 65 acres have favorable agronomic conditions for crop production. This area has high-quality soils, flat or gently sloping terrain, high solar radiation, low pumping costs for irrigation water, and good access. Because of the sunny conditions, the fields are well-suited for growing crops during the Winter months. This is consistent with existing agricultural leases which indicate that about 1,375 acres (88%) are arable land.

5. POTENTIAL CROPS[10-14]

Based on the above agronomic conditions, most of the Petition Area is well-suited for low-elevation crops, including but not limited to the following crops which are commercially grown in 'Ewa: apple banana, basil, bell peppers, broccoli, cabbages, canteloupes, chives, choy sum, cucumbers, daikon, green beans, green onions, honeydew, kai choy, leaf lettuces, long beans, pak choy, romaine, seed corn, string beans, sweet corn, sweet potatoes, sweet onion, taro leaves, tomatoes, watermelons, and zucchini,

6. LOCATIONAL ADVANTAGES AND DISADVANTAGES FOR CROP PRODUCTION

The Petition Area is well-located for serving the Honolulu consumer market and export markets. This is due to the short trucking distance to the Honolulu markets, the Honolulu International Airport, and Honolulu Harbor.

In the U.S. mainland market, farmers in Hawai'i must compete against farmers on the mainland and in Mexico, Central and South America, the Caribbean, Australia, New Zealand, Southeast Asia, etc. Most of the competing farm areas have lower production and delivery costs than Hawai'i does. Competing against Mexico is particularly difficult given the North America Free Trade Agreement (NAFTA) and Mexico's proximity to major U.S. markets.

7. SURROUNDING LAND USES[2]

Existing and planned land uses surrounding the Petition Area are shown in Figure 6. By direction, these uses are as follows:

— To the north (*mauka*) are the H-1 Freeway, agricultural fields in Kunia and grazing lands in the Kunia foothills. All of these Kunia lands were once owned by James Campbell Company LLC (JCC). But over the past few years, JCC sold some of them and is in the process of selling the remainder. These lands are expected to remain in agriculture with the exception of land near Schofield Barracks which was purchased by the U.S. Army.

— To the east are Fort Weaver Road, Old Fort Weaver Road, the West Loch Golf Course, and the residential communities of Waipahu, Honouliuli, and West Loch Estates

— To the south (*makai*) are the 'Ewa Villages and other residential communities.

— To the west are agricultural fields on land owned by the State. These lands are in the Urban District and are scheduled to be developed as part of UHWO campus and related residential and commercial development, DHHL East Kapolei residential projects, DHHL commercial center, and the Kroc Community Center on DHHL land (Figure 6).

As indicated, urban development has occurred or will occur to the east, south and west of the Petition Area. Homes to the west will be downwind of the Project.

8. HISTORIC AGRICULTURAL USES[1,15-18]

Following the Mahele of 1848, the Petition Area was part of a 43,250-acre grant which, from 1871 to 1877, was leased for cattle grazing. In 1877, James Campbell purchased most of the property (including the Petition Area) for cattle ranching.

In 1889, Campbell leased most of the 'Ewa Plain to Benjamin Dillingham who, in turn, subleased the land to the 'Ewa Plantation Company to cultivate sugarcane. The 'Ewa Plantation Company grew quickly and continued operating until 1970 when the O'ahu Sugar Company, Ltd. (OSCo) took over operations. Sugarcane cultivation continued on about 1,375 acres of the Petition Area until 1995 when OSCo closed.

Since the mid-1990s, the Petition area has been leased for diversified crop farming (that is, crops other than sugarcane or pineapple).

9. EXISTING AGRICULTURAL OPERATIONS

a. Agricultural Leases[1]

Currently, about 1,497 acres (96%) of the Petition Area are leased to three companies to grow diversified crops. As shown in Figure 10, these companies are:

- Aloun Farms, Inc. (about 1,100 acres)
- Sugarland Farms, Inc. (about 197 acres)
- Syngenta Seeds, Inc. (about 200 acres)

In addition, Fat Law's Farm subleases about 100 acres from Aloun Farms. These four farms are described below.

b. Aloun Farms, Inc.[1,11]

Since 1997, Aloun Farms has leased about 1,097 acres of the Petition Area, of which about 1,003 acres are considered arable. The original lease was with The Estate of James Campbell, now James Campbell Company, LLC (Campbell). The lease expires in 2013, but is subject to withdrawal rights by the landowner. In April 2007, lease rents were about $194 per acre per year for arable land, which is below current market rents for good agricultural land on O'ahu.

Aloun Farms leases an additional 3 acres of arable land for its major facilities, discussed below. The lease expires in 2017 and the landowner does not have withdrawal rights. In April 2007, lease rents were $150 per acre per year.

In addition to the lands in the Petition Area, Aloun Farms and a company affiliated with it (A.M. Enterprises, LLC) lease about 1,440 acres in 'Ewa, Kunia and Central O'ahu. Thus, Aloun Farms (with its affiliate) leases a total of about 2,540 acres. However, about 100 acres of its Ho'opili lands are subleased, resulting in a net of about 2,440 acres available to Aloun Farms. Nearly all of this

land is arable, and most of the fields are of high quality. Having fields in 'Ewa, Kunia and Central O'ahu allows Aloun Farms to maintain year-round production of certain crops by taking advantage of the climatic and seasonal differences between the planting areas.

Averaged over time, about 910 acres (37%) are in crop. They farm their 'Ewa fields less intensively than the average (about 33% of the land in crop), while the Kunia and Central O'ahu fields are farmed more intensively (about 50% of the land in crop).

The 3-acre parcel mentioned above has two buildings on it having a combined footprint of about 22,600 square feet. The buildings are used by Aloun Farms for its cooling plant, packing facilities, and some of its warehouse space. To the east side of this parcel and within the Petition Area, nine buildings having a combined footprint of about 26,900 square feet provide additional operating and storage space.

Aloun Farms with its affiliate is the second largest diversified fruit and vegetable operation in Hawai'i. It is managed by skilled entrepreneurs who have special expertise in Asian vegetables and melons and in Asian markets. In 2006, Aloun Farms provided about 140 full-time-equivalent (FTE) jobs, including about 20 jobs involved with managing the operations. Salaries average about $22,000 per year.

Crops grown by Aloun Farms for the Hawai'i and overseas markets include:[11]

- Vegetables: bean shoot, broccoli, camote leaf (potato leaf), choy sum, daikon (Chinese and Korean), green onion, Japanese cucumber, kabocha squash, kai choy, long beans, long eggplant, pak choy, paria leaf (bitter melon leaf, peppers, radish, romaine and leaf lettuces, saluyot, string beans, sweet corn, sweet onion, won bok (Chinese cabbage), and zucchini.
- Fruits and melons: apple banana, cantaloupe, honeydew, Korean melon, Thai watermelon (small variety seedless red, yellow, seedless yellow), and watermelon.
- Herbs and spices: basil, chives, lemongrass, mint, and parsley (American and Chinese).
- Seed crops: corn and potatoes.

About 30% of the crops are grown in specific locations that take advantage of the distinctive climatic and agronomic conditions found in 'Ewa, but could be grown in areas having similar conditions. For certain crops, a few seasons are

required to determine the best location for the crop, the best variety for the location, the best time to plant, etc.

Table 2 summarizes the consultant's estimates of the 2007 economic activity generated by agricultural operations in the Petition Area, along with the assumed multipliers used in the calculations. As shown for Aloun Farms, the estimates are approximately $3 million per year in revenues, an average employment of 45 jobs, and about $1 million per year in payroll.

c. **Fat Law's Farm, Inc.**[1,11,12]

Fat Law's Farm subleases about 100 acres from Aloun Farms. Their fields are located in the southeast corner of the Aloun lands (see Figure 10), extending south along the lower half of Old Fort Weaver Road and continuing along Fort Weaver Road. The operators began farming at this location on a little over 61 acres in 1996. The lease is month-to-month, and lease rents in April 2007 were about $630 per acre per year for arable land. At any given time, about 60 acres (60%), on average, are in crop and about 40 acres are between crops.

The company farms no other land in Hawai'i. However, they market produce that is farmed by relatives and friends on about 120 to 150 acres. Also, they have leased 150 acres in Hainan, China were they plan to grow tropical fruits (e.g., papaya) and vegetables to be marketed in Hong Kong, mainland China and Japan.

Fat Law's Farm has two on-site structures (about 12,800 square feet under roof) which house their offices, cooling plant, and warehouse space.

Fat Law's Farm is one of Hawai'i's main producers of fresh herbs and vegetables. Its primary crops are basil (Thai, hot and sweet), cucumbers, long beans, malongai leaves, and taro (leaves and stem). Other crops (which the Farm grows itself or markets for other farmers) include betai leaf, bitter melon, chives, curry leaf, la lop, long squash, ngo gai, peppermint, and Thai ginger.

Hawai'i customers include farmers' markets, supermarkets, produce stores, restaurants and wholesalers. The operation also exports Thai basil, sweet basil, taro leaves, chives, curry leaves, and malongai leaves to at least 14 major cities across the United States. They are nicknamed the "King of Basils," due to the fact that they provide more than 60% of the basil exports from Hawaii to the mainland.

In 2006, the U.S. Small Business Administration honored them as Exporter of the Year for Hawai'i and the Western United States. Also, Fat Law's Farm has received many awards for their outreach efforts to help immigrant small-scale farmers. They have provided encouragement, advice on farming practices, marketing help, and other assistance.

Table 2. Economic Activity Generated by Agricultural Operations in the Petition Area: 2007
(approximate estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Syngenta	TOTAL
Agricultural acreage					
Total	1,000[1]	100	197	200	1,497
Arable land	903[2]	100	192	177	1,372
Average land in crop					
Percentage in crop	33.3%	60%	33.3%	25%	
Acres in crop	301	60	64	44	469
Adjustments	___	___	10[3]	8[4]	18
Adjusted acres in crop	301	60	74	52	487
Revenues (average annual)					
Revenue per acre in crop (thousands)	$10	$30	$10	$17	
Total revenues (millions)	$3.0	$1.8	$0.7	$0.9	$6.4
Employment (average)					
Jobs per 100 acres in crop	15	33	10	25	
Total Jobs	45	20	7	13	85
Payroll (average annual)					
Salary per job (thousands)	$22	$22	$25	$25	
Total payroll (millions)	$1.0	$0.4	$0.2	$0.3	$1.9

1. Excludes 100 acres leased to Fat Law's Farm.
2. Excludes 3 acres used for facilities.
3. 30 acres of Syngenta land used by Jefts Farms, with an average of 33% in crop, and assuming no reduction in acreage farmed by Jefts Farms.
4. 30 acres of Jefts Farms land used by Syngenta, with an average of 25% in crop, and assuming no reduction in acreage farmed by Syngenta.

Source: Decision Analysts Hawai'i, Inc.

Fat Law's Farm sells about $3 million of fresh herbs and vegetables annually. Approximately 60% of the sales are derived from its own production, while the remainder comes from selling produce from other farms.

Employment averages about 20 FTE jobs, including six management positions. Workers earn about $6.75 to $7.25 per hour.

For the immediate future, about 5 acres will be converted to organic crops, followed by additional conversions if production proves profitable and demand is sufficient. Growing organic crops will increase revenues since they command higher prices, while the cost of chemicals will be reduced. However, the crops will have to be grown in plastic greenhouses to protect them from insects and wind.

Table 2 summarizes the consultant's estimates of the 2007 economic activity for Fat Law's Farm that takes place in the Petition Area. As shown, the estimates are approximately $1.8 million per year in revenues, an average employment of 20 jobs, and about $400,000 per year in payroll.

d. Sugarland Farms, Inc. ("Jefts Farms")[1,13,14]

Since late 1994, Sugarland Farms has leased about 197 acres in the Petition Area, of which about 192 acres are arable (see Figure 10). The original lease was with Campbell. The lease is year-to-year, and lease rents in April 2007 were about $231 per acre per year for arable land, which is slightly below current market rents for good agricultural land on O'ahu. In addition, Sugarland Farms and Syngenta have an arrangement that allows them to exchange between the two of them 30 acres at no charge. This enables Sugarland Farms to cultivate 30 additional acres in the Petition Area (see Figure 10). Thus, Sugarland Farms cultivates a total of about 227 acres in the Petition Area. The advantage to Syngenta is that it can more easily isolate seed plantings away from its other varieties to avoid cross-pollination.

Sugarland Farms is part of a larger group of family agricultural operations that collectively is referred to in this report as the "Jefts Farms." They include, but are not limited to: Larry Jefts Farms, LLC; Sugarland Farms, Inc.; Sugarland Distribution, Inc.; Waikele Farms, Inc.; and Akea Farms, Inc.

Jefts Farms comprises the largest diversified fruit and vegetable agricultural operation in Hawai'i, with agricultural lands estimated by the consultant at over 5,000 acres. Their fields are located in, but are not limited to, the following areas:

- 'Ewa fields in the Petition Area as noted above.
- Other 'Ewa fields that are sandwiched between the H-1 Freeway and Farrington Highway, and between and to the west of the Sugarland fields shown in Figure 10. These lands are leased from the State.
- Other 'Ewa fields east of Fort Weaver Road and within the Navy's Blast Zone for the West Loch Naval Magazine. Jefts Farms leases these lands from the U.S. Navy.
- Fields in Kunia north of the H-1 Freeway and west of Kunia Road. Jefts Farms leases some of this land from the State and, until recently, the remainder was leased from Campbell. However, most of the Campbell land in lower Kunia was sold to Pioneer Hi-Bred International and the Monsanto Company (Monsanto) for expanded seed-corn operations.
- Fields in Kunia to the north of the H-1 Freeway and east of Kunia Road. Jefts Farms leases most of these lands from Robinson Estate and the remainder from the State.
- Lands at Mokule'ia, O'ahu that are leased from Dole Food Company Hawai'i.
- Lands on Moloka'i.

The heart of Jefts Farms is the Kunia land that it leases from Robinson Estate. Jefts Farms main offices, cooling plant, packing facilities, warehouses, etc., are located in Kunia near the Hawai'i Country Club. These Robinson lands are outside the County's Urban Growth Boundary and, as such, will remain in agriculture for the foreseeable future.

Most of the Jefts Farms fields in Kunia and Central 'Ewa are of high quality. Averaged over time, about one-third of these lands is in crop. By having fields in both Kunia and 'Ewa, Jefts Farms is able to take advantage of the climatic and seasonal differences between the two planting areas to maintain year-round production of certain crops. For example, tomatoes and peppers are planted in Kunia during the Summer months, and in 'Ewa during the Winter months.

Principal crops grown by Jefts Farms include: bell peppers, cabbages, canteloupes, cucumbers, green beans, onions, sweet potatoes, tomatoes, and watermelons. Most of the produce is grown for the Hawai'i market, but some is exported. In addition to its own crops, about 150 acres are subleased each season to Syngenta for its seed-corn operation (see below)—this is in addition to the 30 acres discussed above that Jefts Farms exchanges with Syngenta.

Employment by Jefts Farms is estimated by the consultant to exceed 150 farmhands. Annual salaries range from about $16,600 ($8 per hour) to over $60,000 for about a dozen key managers and technical experts.

Table 2 summarizes the consultant's estimates of the 2007 economic activity generated by farming activity in the Petition Area. As shown, the estimates for Jefts Farms are approximately $700,000 per year in revenues, an average employment of 7 jobs, and about $200,000 per year in payroll. This estimate takes into account the 30 acres of Syngenta land farmed by Jefts Farms.

e. **Syngenta Seed, Inc.**[11,14]

Syngenta is a global agribusiness headquartered in Switzerland with roots going back to 1758. In 2005, company sales amounted to about $8.1 billion which was derived from selling seeds (corn, soybean, other field crops, vegetables, and flowers) and crop-protection products (herbicides, fungicides and insecticides).

In Hawai'i, Syngenta is one of five major seed companies that use conventional breeding practices and genetic engineering to create improved or new parent seed corn—that is, corn seeds that will provide high yields of quality corn from plants that tolerate droughts and resist diseases. Most of the world's commercially grown corn can be traced back to Hawai'i. Syngenta and other companies also conduct research on soybeans, and other seed companies conduct research on sunflowers, soy, wheat and cotton. These seed companies are expanding steadily in Hawai'i: from the 2000/01 to the 2005/06 crop year, the amount of land in seed crops increased from 3,100 acres to 4,220 acres, and the value of the crop increased from about $37.5 million to about $70.4 million. The primary advantage of operating in Hawai'i is the year-round growing conditions which allow faster development of new hybrids and varieties: three crops per year are possible in Hawai'i versus one crop per year on the mainland. Hawai'i also provides a stable political and economic environment relative to other regions having similar agronomic conditions.

Since 1995, Syngenta has leased about 200 acres in the Petition Area, of which about 177 acres are arable (see Figure 10). The original lease was between Campbell and Garst Seed Company. Syngenta took over the lease when it purchased Garst in 2004. The lease expires in 2008, but is subject to withdrawal rights by the landowner. In April 2006, lease rents were about $215 per acre per year for arable land, which is slightly below current market rents for good agricultural land on O'ahu.

On average, about 45 acres of Syngenta's land in the Petition Area are used for parent seed operations (i.e., operations that increase the supply of selected seed varieties). The corn is normally planted in patches with considerable separation from other corn varieties in order to control pollination of the plants. In addition to its own plantings, Syngenta has an arrangement that allows Jefts Farms to use about 30 acres of Syngenta land in the Petition Area for vegetable crops. In exchange, Syngenta has use of a similar amount of land from Jefts Farms.

In total, Syngenta leases or subleases about 740 acres on O'ahu for its seed operations, including:

- The approximately 200 acres mentioned above.
- About 360 acres in Kunia that are under a long-term lease, subject to cancellation clauses. These lands front the west side of Kunia Road below Waiahole Ditch. The fields are used to research corn varieties and, to a lesser extent, soybeans. Also, Syngenta's processing facilities, warehouse, and offices are located there.
- About 30 acres that are made available as part of a land exchange with Jefts Farms. Plantings can occur in 'Ewa or Kunia.
- About 150 acres that are subleased seasonally from Jefts Farms. Plantings occur in 'Ewa and Kunia.

Most of Syngenta's fields in Kunia and 'Ewa are of high quality. In addition to its O'ahu operations, Syngenta has about 3,000 acres on Kaua'i for its seed operations.

On O'ahu, Syngenta provides employment for about a dozen full-time workers, 15 to 20 part-time workers, and about 60 to 90 temporary workers during the peak Winter season. Corresponding figures for the parent-seed portion of their operation—which includes farming the 'Ewa fields—are about two full-time workers, four part-time workers, and 10 to 15 workers in surges. Wages range from $8.75 to $17 per hour.

Table 2 summarizes the consultant's estimates of the 2007 economic activity generated by agricultural operations in the Petition Area. As shown, the estimates for Syngenta are approximately $900,000 per year in revenues, an average employment of 13 jobs, and about $300,000 per year in payroll. This estimate takes into account the 30 acres of Jefts Farms land that is farmed by Syngenta.

f. **Summary of Economic Activity of Agricultural Operations in the Petition Area: 2007**

For all four agricultural operations, the consultant's estimates of the 2007 economic activity they generate in the Petition Area totals approximately $6.4 million per year in revenues (about $4,665 per acre on average), an average employment of about 85 jobs (about 6.2 jobs per 100 acres), and about $1.9 million per year in payroll (see Table 2).

10. CUMULATIVE LOSS OF LAND FOR THE AFFECTED AGRICULTURAL OPERATIONS

In addition to the leased and subleased lands that gradually will be lost as the Project is developed over a 20-year period, three of the four agricultural operations in the Petition Area will eventually lose agricultural lands to (1) other private and State urban projects in 'Ewa and Central O'ahu that are within the County's Urban Growth Boundary, and (2) other agricultural operations in Kunia. The cumulative loss of land for the affected agricultural operations is addressed in this section. The related cumulative impact on them is addressed in Section 13.

a. Overview[1,18,19-23]

For the affected agricultural operations, the approximate cumulative reductions in acreages are summarized in Table 3, and include the following:

— Urban Projects within the County's Urban Growth Boundary

- Ho'opili, Ewa: about 1,497 acres of farm land currently leased or subleased to the four farms in the Petition Area. Some of the land will used by the State Department of Transportation for the North-South Road.
- State projects, 'Ewa: about 945 acres currently farmed by Aloun Farms and Jefts Farms. State projects include (1) the UH West O'ahu campus and related residential and commercial development, and (2) a DHHL residential and commercial development (see Figure 6).
- Koa Ridge, Central Oahu: about 430 acres currently farmed by Aloun Farms. This is a proposed residential community by Castle & Cooke Homes Hawai'i.

— Changes in Agricultural Uses

- State Ag Park, Kunia: about 150 acres currently farmed by Jefts Farms.

Table 3. Cumulative Loss of Land for the Affected Agricultural Operations
(approximate acreage estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Syngenta	TOTAL
Urban Projects					
Ho'opili, 'Ewa	1,000	100	197	200	1,497
State Projects, 'Ewa[1]	850	-	95	-	945
Koa Ridge, Central O'ahu	430	-	-	-	430
Agricultural Uses					
State Ag Park, Kunia	-	-	150	-	150
Monsanto Co., Kunia	-	-	220	360	580
Total	2,280	100	662	560	3,602

1. UHWO, DHHL and other State projects.

Source: Decision Analysts Hawai'i, Inc.

- Monsanto, Kunia: about 580 acres currently farmed by Jefts Farms and Syngenta. Monsanto is a major seed company that purchased land in 2007 in lower Kunia west of Kunia Road.

Altogether, the four agricultural operations in the Petition area are projected to lose about 3,600 acres of their leased land: about 2,870 acres to private and State urban projects located within the County's Urban Growth Boundary, and about 730 acres which will remain in agriculture but will be farmed by other operators. Syngenta's and Jefts Farms' losses of acreage to Monsanto (another agricultural operation) may occur within a few years. The agricultural land lost to urban projects is likely to begin in a few years and continue until as late as 2030.

b. **Aloun Farms**

Aloun Farms is expected to gradually lose about 2,380 acres to urban projects (see Table 3). This will leave Aloun Farms with just 160 acres of its current Kunia farm, assuming that the lease to this land is renewed. This is the only land leased by Aloun Farms that is outside the County's Urban Growth Boundary.

c. **Fat Law's Farm**

As shown in Table 3, Fat Law's Farm eventually will lose all of its 100-acre farm to Ho'opili.

d. **Jefts Farms**

Table 3 shows that Jefts Farms is projected to lose about 660 acres of good farm land: approximately 197 acres to Ho'opili, 95 acres to State urban projects, 150 acres for the State Ag Park in Kunia, and 220 acres to Monsanto's seed operation. Also, Jefts Farms will eventually lose access to Syngenta's 30 acres in 'Ewa since this is within the Petition Area. In addition, Jefts Farms lost about 230 acres of cultivated land in lower Kunia that Campbell sold to Pioneer Hi-Bred International (a seed company) in 2006.

Even with these acreage reductions, Jefts Farms will retain an estimated 4,000+ acres of farm land, and will remain the largest diversified fruit and vegetable farm operation in Hawai'i. On O'ahu, all of Jefts Farms remaining land is located outside the County's Urban Growth Boundary.

e. **Syngenta**

Syngenta is expected to lose about 560 of its 740 acres on O'ahu—this includes 360 acres purchased recently by Monsanto for its seed operations, and 200 acres in the Petition Area (see Table 3).

In addition to the direct acreage losses, Syngenta will no longer have use of the 30 acres on Jefts Farms leased land since Syngenta will no longer have land in 'Ewa to provide to Jefts Farms in exchange (see Section 9.d). Furthermore, inasmuch as Jefts Farm will have less land to sublease, Syngenta could lose access to some of the 150 acres that they sublease from Jefts Farms.

11. CHANGES TO AGRICULTURAL OPERATIONS BEFORE HO'OPILI IS DEVELOPED

a. **Relocation of Syngenta**

Monsanto's 2007 land purchase in lower Kunia includes all of the 360 acres in Kunia that comprise the core of Syngenta's operations on O'ahu. Because of this purchase, the consultant anticipates that Syngenta will relocate from Kunia to some other area. And because of termination clauses in the existing lease, it is likely that this relocation will occur within the next few years—with or without Ho'opili, and before Ho'opili construction even begins.

If Syngenta is to retain its same size after relocating, then they will require about 740 acres of replacement land—the approximate acreage that they now lease and sublease in Kunia and 'Ewa. Syngenta could relocate to Kaua'i where they already lease about 3,000 acres, although the North Shore of O'ahu is also a possibility.

If the company relocates to Kaua'i, then the demand for good farm land on O'ahu will decrease by about 740 acres while the demand on Kaua'i will increase by a similar amount (the acreage could be somewhat less than 740 acres if Syngenta farms their existing lands on Kaua'i more intensively). In this scenario, the economic activity for Syngenta's O'ahu operation would be transferred to Kaua'i. This would include about a dozen full-time workers, 15 to 20 part-time workers, and about 60 to 90 temporary workers during the peak Winter season.

b. **Interim Agriculture on Land Vacated by Syngenta**

After Syngenta vacates the 200 acres it now leases in the Petition Area, it is expected that the land will be leased to a farmer until construction on this site is ready to begin.

Future economic activity associated with diversified crop farming on the land to be vacated by Syngenta is estimated at about $600,000 per year in revenues (based on 177 arable acres with one-third in crop, and revenues of about $10,000 per acre per year); about six jobs (based on ten jobs per 100 acres in crop); and a payroll of about $150,000 per year (based on about $25,000 per job).

c. **Reduction in Jefts Farms Operations**

After Syngenta vacates its 'Ewa fields, Jefts Farms will lose the 30 acres it now farms there as part of its land exchange with Syngenta (unless Jefts Farms leases the entire 200 acres). Thus, the economic activity shown in Table 2 for Jefts Farms will decrease slightly: about $100,000 less in annual revenues, about one less job, and about $25,000 less in annual payroll.

d. **Summary of Economic Activity of Agricultural Operations in the Petition Area: 2010**

Table 4 shows the consultant's resulting estimate of the economic activity generated by farming in the Petition Area by about 2010 after Syngenta is replaced by some other farming operation but before the Ho'opili construction begins. As shown, projected economic activity includes approximately $6 million per year in revenues (about $4,373 per acre on average), an average employment of slightly less than 80 jobs (about 5.6 jobs per 100 acres), and about $1.7 million per year in payroll.

Table 4. Projected Economic Activity Generated by Agricultural Operations in the Petition Area: 2010
(approximate estimates by DAHI)

	Aloun Farms	Fat Law's Farm	Jefts Farms	Interim Farm	TOTAL
Farm acreage					
Total	1,000[1]	100	197	200	1,497
Arable land	903[2]	100	192	177	1,372
Average land in crop					
Percentage in crop	33.3%	60%	33.3%	33.3%	
Acres in crop	301	60	64	59	484
Revenues (average annual)					
Revenue per acre in crop (thousands)	$10	$30	$10	$10	
Total revenues (millions)	$3.0	$1.8	$0.6	$0.6	$6.0
Employment (average)					
Jobs per 100 acres in crop	15	33	10	10	
Total Jobs	45	20	6	6	77
Payroll (average annual)					
Salary per job (thousands)	$22	$22	$25	$25	
Total payroll (millions)	$1.0	$0.4	$0.15	$0.15	$1.7

1. Excludes 100 acres leased to Fat Law's Farm.
2. Excludes 3 acres used for facilities.

Source: Decision Analysts Hawai'i, Inc.

12. AVAILABILITY OF REPLACEMENT LAND

As discussed in Sections 10 and 11, the farms that operate within the Petition Area will lose land to Ho'opili and to other urban projects, and to changes in agricultural uses. The impact of this cumulative loss of land on the affected agricultural operations will depend on the amount and quality of replacement land that will be available to them in the future to offset their land losses. The availability of replacement land Statewide and on O'ahu is reviewed below.

a. Statewide

Statewide, a vast amount of land has been released from plantation agriculture: about 251,800 acres between 1968 and 2005, resulting in an average release of over 6,800 acres per year over a 37-year period (see Figure 11).[10,24] The 2006 Del Monte closure in Kunia increased this figure by another 4,400 acres, resulting in a total release of at least 256,200 acres from plantation agriculture between 1968 and 2007.[25,26] Over the 1968-to-2005 period, the demand for land for diversified crops increased by about 26,300 acres (about 10% of the land released from plantation agriculture).[10]

As the above figures indicate, the acreage released from plantation agriculture has far outpaced the demand for land for diversified crops. The net decrease in diversified crop land amounts to about 229,900 acres. While some of the released land has been converted or is scheduled to be converted to urban uses and tree plantations, an estimated 160,000+ acres remain available for diversified crops.[26] Because of the increased availability of agricultural land, a number of landowners report lower per-acre agricultural land rents on O'ahu and the Neighbor Islands compared to rents charged before the major contraction in plantation agriculture.[27]

If the Hawai'i Superferry is successful, cultivating crops on the Neighbor Islands for the Honolulu market, and vice versa, may become more economically feasible. For a full load carried in a large pick-up truck, the one-way fare will be about 2¢ per pound.[28] However, for some perishable crops, the ferry service may not be sufficiently frequent and/or delivery times may not be sufficiently rapid.

The above information indicates that considerable land is available in Hawai'i to accommodate the relocation of agricultural operations as well as the growth of diversified crop farming (see Sections 13 and 15).

b. O'ahu

On O'ahu, a similar release of plantation land occurred. Between 1968 and 2007, about 51,900 acres were released from plantation agriculture due to the contraction of five plantations and the closures of all but one of them.[10,26] About 32,700 acres were released after 1990. Much of this land remains available for agriculture, and most of it lies outside the County's Urban Growth Boundary.

The Kunia fields are considered to be among the best farm land in the State, based on the high solar radiation, high-quality soils, and the short trucking distance to the large Honolulu market, the airport, and Honolulu Harbor.[29] Except for lands recently released by Del Monte, all of the better Kunia fields have already been leased for diversified crop farming. However, on average, only about one-third of this land is in crop.[30] The large amount of fallowing reflects best management practices when farm land is abundant and land rents are relatively low. Fallowing increases soil fertility and helps control unwanted volunteer plants, weeds, insects and disease. When demand for farm land is strong and rents are high in response to a strong demand for agricultural products, then more intensive farming of the land may be warranted even if this increases farmers' costs for pest control and soil additives.

Of the estimated 4,400 acres of Kunia land recently farmed by Del Monte, about 3,200 acres remain available. The decrease was due to (1) Monsanto's land purchase in lower Kunia for seed crops, and (2) the U.S. Army's land purchase in upper Kunia for expanding Schofield Barracks. These two purchases involve considerable land, including about 640 acres and 580 acres, respectively, of former pineapple fields.[21,31]

Another possible land purchase could impact the future supply of farm land in Kunia. The Army Hawai'i Family Housing LLC (AHFH), a public/private partnership between the U.S. Army and Actus Lend Lease, plans to acquire about 2,520 acres in northern Kunia from Campbell, including about 1,570 acres of former pineapple land.[21,32] AHFH intends to "bank" the land for future needs, which will allow a portion it to be used for military housing if needed in the distant future. If and when AHFH proposes the land for development, the project will be subject to all State and County development approvals and permits, which could prove difficult since the development would be outside the County's existing Urban Growth Boundary. AHFH has indicated that if the land is purchased, it would remain in agriculture for the foreseeable future.

On the North Shore, various crops are being grown, but about 7,750 acres of the former sugarcane and pineapple lands remain fallow or are in a low-value use.[27,33]

In total, about 10,900 acres of former plantation land remain available on O'ahu for other crops, including about 3,150 acres of former pineapple land in Kunia plus the 7,750 acres on the North Shore. However, this excludes any adjustment for the farm land that is already leased for diversified crops but is not farmed intensively, some arable lands in the foothills that are used for grazing, and a portion of the 2,290 acres (about 1,600 acres arable) purchased by Monsanto that might remain available for crops other than seed crops.

Given the large release of land from plantation agriculture on O'ahu, the amount of available farm land that remains on O'ahu is lower than what might be expected. This is explained by: (1) farmers relocating to or expanding on these high-quality and favorably located lands, thereby reducing the amount of land farmed elsewhere on O'ahu and the Neighbor Islands; (2) extensive fallowing of fields that are under lease; (3) growth of seed operations on O'ahu; (4) transferring land in the foothills from farming to grazing because of the lower demand; (5) urbanization in 'Ewa and Central O'ahu; and (6) military use of some land.

Much of the available 10,900 acres have limitations for growing certain crops. Some limitations reflect permanent agronomic and other conditions. For example, the higher elevation fields in Kunia and on the North Shore have less solar radiation compared to 'Ewa: the average daily insolation is about 400 calories per square centimeter at higher elevations compared to as much as 500 calories in 'Ewa.[7] In addition, fields at higher elevations incur higher pumping costs, although rainfall reduces water requirements. Also, North Shore farmers encounter longer trucking distances to Honolulu markets, the airport, and the harbor.

Nevertheless, some limitations can be overcome with investment in improvements. For example, on the North Shore, portions of the water delivery systems need major repairs to address current leaks and to prevent future ones.[27,34] Because of the leaks, a number of mid-level and high-level fields on the North Shore can no longer be irrigated in the summer months. Also, the types of crops on fields irrigated with water from Wahiawa Reservoir (Lake Wilson) will be restricted as long as partially-treated wastewater continues to be discharged into the lake.[35] Water from the lake can be used to irrigate tree crops (e.g., papaya and coffee) and crops such as sugarcane that are processed sufficiently to kill pathogens. However, the water cannot be used to irrigate the wide variety of fresh vegetable crops that are now grown in 'Ewa and Kunia.

Regardless of the above difficulties, the available supply of farm land on O'ahu will be partially absorbed over time as island farmers expand production.

This expansion will reflect the advantages to them of farming fields near the large Honolulu markets, and near the State's primary transportation/distribution centers (i.e., Honolulu Harbor, Honolulu International Airport, and many companies involved in distributing goods inter-island and overseas).

13. DIRECT AND CUMULATIVE IMPACTS ON THE AFFECTED AGRICULTURAL OPERATIONS

a. Loss of Land for the Affected Agricultural Operations

The Project will result in a direct loss of about 1,497 acres currently being leased for various agricultural operations. In combination with land lost to other State and private urban projects and to other agricultural uses, the four agricultural operations in the Petition Area will incur a cumulative loss of about 3,600 acres of their leased land (Section 10 and Table 3). The amount of arable land will be somewhat less. However, as noted above, it is expected that Syngenta will relocate for reasons unrelated to and before the Ho'opili construction begins.

b. Required Replacement Land

If Syngenta remains on O'ahu, then about 3,600 acres of replacement land will be needed on O'ahu by the four the affected agricultural operations. But, if Syngenta relocates its O'ahu activities to Kaua'i where most of its operations are located, then the O'ahu demand will be reduced by 740 acres (see Section 9.3), resulting in a need for less than 2,900 acres of replacement land.

Desired physical characteristics of replacement lands include: large gently-sloping fields, good soils, high solar radiation, and affordable irrigation water of sufficient quality to use on any type of crop.

As summarized in the previous section, sufficient land is available on O'ahu and the Neighbor Islands. Nevertheless, major water-related improvements are required before all available agricultural lands on the North Shore of O'ahu will be suitable for growing diversified crops. Also, the available lands possess different agronomic conditions than those found in 'Ewa and lower Kunia.

c. Direct On-site Agricultural Impacts

In isolation, Ho'opili will result in the gradual on-site loss of all agricultural activity in the Petition Area, along with the related gradual loss of approximately $6 million per year in revenues, an average employment of slightly under 80 jobs and about $1.7 million per year in payroll.

In practice, however, most or all of the agricultural operations on the Ho'opili land are expected to relocate to other lands (see the next subsection).

d. Anticipated Changes in Agricultural Operations

Until 2030, the agricultural operations located in the Petition Area are likely to adjust to gradual acreage losses by implementing a combination of the following:

— Leasing replacement lands

As discussed in the previous section, replacement lands are available in Kunia and on the North Shore, subject to (1) water-related improvements on the North Shore, and (2) adjustments that will have to be made by farmers to their crops and farming practices (see below).

— Cultivating remaining lands more intensively

Some farmers may be able to partially offset their acreage losses by fallowing less and keeping more of their land in crop. However, this may increase their costs for pest control and soil additives.

— Reducing operations

If the above two adjustments are not sufficient to offset future acreage losses, then farmers will have to reduce the sizes of their operations.

By 2030, however, Aloun Farms will lose nearly all and Fat Law's Farm will lose all their leased lands, thereby necessitating relocation to Kunia and/or the North Shore.

Assuming that the affected lessees secure replacement lands, and assuming the necessary water improvements are made, then the affected agricultural operations could maintain about the same level of production, sales revenues, employment and payroll. However, major adjustments in their operations will be required since the replacement lands will have different agronomic conditions (e.g., soils, temperature, solar radiation, and rainfall). Adjustments will include growing varieties that are more suitable to the replacement lands, modifying cultivation practices (which will take a few crop cycles to optimize), and changing the mix of crops if suitable varieties are not available. Also, the lessees will incur additional expenses to prepare the soils and irrigation systems for their particular crops, and to move their offices, and cooling and packing facilities.

If the agricultural operations lease replacement lands in Kunia, their trucking costs will be about the same. If they lease on the North Shore, then they will incur higher costs for hauling produce into Honolulu—costs that would be similar to what North Shore farmers pay, but lower than what Kahuku farmers pay. At the same time, the higher trucking costs could be partially offset by lower land rents on the North Shore as compared to those in Kunia.

If sufficient replacement land is not available on O'ahu due to the unlikely possibility that it will be used to grow an energy crop (explained in Section 15.a), then one or more of the farms could turn to a Neighbor Island. Potential feasibility is illustrated by the fact that two of the lessees already have agricultural operations on Neighbor Islands, while many Neighbor Islands growers supply O'ahu markets. However, the affected companies which may move to the Neighbor Islands will incur higher transportation costs, and delivery times will be longer. The costs and delays will be similar to those that Neighbor Island farmers now incur to supply the Honolulu market. In the future, these costs and delays may be somewhat lower because of the Superferry and the planned improvements to interisland barge service. The disadvantages of a Neighbor Island location could be partially offset by lower rents. However, for some perishable crops, the ferry service may not be sufficiently frequent or travel may take too long.

e. Flexibility of Affected Agricultural Operations to Resize

Diversified crop farms such as those operating in the Petition Area generally can be flexible as to their size: profitability can be achieved with a farm that becomes smaller, stays about the same sizes, or becomes larger (provided the market can absorb additional product). This differs from the typical sugarcane plantation which relies on economies of scale to maintain economic viability.

Because the affected diversified crop operations can be flexible with regard to their sizes, it is anticipated that they will survive regardless of the amount of replacement land they lease in the future. More to the point, changes in available agricultural land due to the Project are not likely to threaten the survival of Aloun Farms, Fat Law's Farm, or Jefts Farms.

f. Statewide Impacts

From a Statewide perspective, the cumulative agricultural impact of the Project will be modest regardless of how the affected agricultural operations adjust to losing all, or portions of, their leased acreage. Their lost agricultural

production from the Petition Area and from other areas they now lease will be offset largely by (1) maintaining their current levels of operation and production by leasing replacement lands in Kunia and/or the North Shore, and possibly cultivating their remaining lands more intensively; (2) one or more of them relocating all or portions of their operations to a Neighbor Island; (3) other farmers on O'ahu and the Neighbor Islands increasing their production; or (4) some combination of the three.

Thus, it is likely that there will be little or no loss in Statewide agricultural production, revenues, employment or payroll.

g. Urbanization of Agricultural Lands

Reconfigurations of farms such a those described above are common and appropriate when agricultural operations lease land in the path of planned urban expansion. For the affected operations, much of the land they lease is located in areas that the County and, for much of the 'Ewa Plain, the State have designated for eventual expansion of Kapolei. Also, all current tenants entered into lease agreements with this knowledge and, except for Fat Law's Farm, have benefited from rents that are now below market.

For diversified crop farmers who supply nearby markets, locations on the edge of town can be ideal for them because of the lower trucking costs. And until these lands are urbanized, the best "temporary" use of them may be agriculture—a use that may last decades. For example, the affected operations have cultivated their acreage on the 'Ewa Plain for 10 years or more, and some of this land will probably remain available to them for agriculture until as late as 2030.

But when urbanization does occur, the operations will incur the expense and disruption of relocating all their operations or major portions of them to other lands. Since lessees only have temporary rights to the land, the costs of relocating falls on the farmers and are not an obligation of the landowners. If the costs were an obligation of the landowners, they would avoid leasing their land to crop farmers and put their land in a lower value agricultural use such as cattle grazing which has similar land-management and property-tax benefits.

h. Mitigating Measures

The mitigation measures recommended below will contribute to the successful relocation of the four agricultural operations that will be displaced by Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia and Central O'ahu. They are designed to (1) address water issues that limit crop

production on the North Shore where most available farm lands on O'ahu are located, and (2) provide sufficient time to make the necessary improvements and arrangements for relocating.

The recommended mitigation measures are categorized by those which may be best implemented by government, and those which are within the purview of D.R. Horton:

— Government

- Upgrade the Wahiawa Wastewater Treatment Plant (WWTP) to treat wastewater to the State's R-1 standard, or eliminate discharging wastewater into the Wahiawa Reservoir.

  This recommendation to the County is consistent with a 1998 Consent Decree with the U.S. Environmental Projection Agency (EPA). Its purpose is to allow farmers to use water from the Wahiawa Reservoir to irrigate any type of crop using any type of irrigation system.

  Until the quality of the reservoir water is improved, most of the available agricultural land on the North Shore cannot be used to grow the types of vegetable crops the farmers grow in 'Ewa and lower Kunia. In turn, one or more agricultural operations that will be displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore until the improvements are made (assuming that relocating to the North Shore is their best option).

- Repair the Wahiawa Irrigation System (WIS)

  Repairs to portions of the WIS are needed to address major and minor leaks and to prevent future leaks. Because of the leaks, a number of mid-level and high-level fields on the North Shore can no longer be irrigated in the summer months with water from Wahiawa Reservoir. Until these repairs are made and more fields can be irrigated reliably, one or more agricultural operations being displaced by Ho'opili and by other projects may not be able to fully relocate to the North Shore (assuming that relocating to the North Shore is their best option).

  Because of the high cost of the repairs, State and Federal funds may be required.

— D.R. Horton

- To the extent possible, coordinate the development of Ho'opili with the affect agricultural operators and with developers of adjacent lands so as to maintain farming in 'Ewa for as long as possible.

  The development of Ho'opili and of projects on adjacent State lands could continue until 2030. Until then, farming can continue in 'Ewa, provided that Ho'opili works with the agricultural operators and developers of adjacent land to: (1) maintain access to fields and irrigation water, and (2) phase development to minimize the potential for nuisance issues (discussed in the next section). This will allow more time for others to make the necessary improvements to the WWTP and the WIS.

- Continue to lease agricultural land at below-market rents.

  The affected agricultural operators will have to make frequent adjustments to their operations as development proceeds. These adjustments may include contracting their 'Ewa operations, rearranging water systems, building berms to reduce nuisance problems, etc.

  Continued below-market rents will allow the affected agricultural operators to retain more funds to help finance the required adjustments.

14. NUISANCE ISSUES

a. Potential for Nuisance Issues

Nuisances arising from agricultural operations can become an issue for both residents and farmers. Residents who live close to and downwind from agricultural operations may complain about occasional noise, dust, chemical spraying, etc. In turn, the farmers may have to change their operations in order to address these complaints.

Regarding the existing homes that are located downwind of the agricultural operations in the Petition Area, they are buffered from nuisance problems by (1) farming activities on State land, (2) fallow fields on State land, and (3) the Kapolei Golf Course.

However, nuisance issues could arise during the 20 or so years while agricultural operations continue in portions of the Petition Area and homes are built

and occupied nearby as part of Ho'opili or other projects on adjacent State lands.

Once Ho'opili and adjacent lands are fully developed, nuisance issues arising from agricultural activities will not occur since the lands will no longer be cultivated.

b. Mitigating Measures

To mitigate potential nuisance issues related to agricultural activities near newly built homes, the following mitigation measures are recommended:

- To the extent possible—and subject to transit alignment, water and other infrastructure improvements—phase the development of homes and coordinate agricultural leases to provide wide separations between homes and upwind agricultural activities.
- For each phase of development of Ho'opili and nearby projects, require farmers to provide a buffer of fallow fields and berms upwind of the homes before the homes are occupied.
- As necessary, limit agricultural activities (restricted hours of operation, restricted plowing and use of chemicals on windy days, etc.) so as to avoid or minimize nuisance problems.
- As long as agricultural operations continue in the Petition Area and on adjacent lands, inform home buyers in the area that they will be living near agricultural activities.

15. GROWTH OF DIVERSIFIED CROPS

The Project will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. The impact of this commitment on the growth of diversified crops is addressed below. The material covers the (1) amount of land required for the growth of diversified crops, (2) the adjusted supply of land available for the growth of diversified crops, (3) impact of the Project on the growth of diversified crop farming, and (4) mitigating measures.

a. Potential Acreage Requirements for Diversified Crops

Crops to Replace Imports of Fruits and Vegetables[36]

For low-elevation fruits and vegetables that have a history of profitable production in Hawai'i, potential land requirements in 2010 for 100% import substitution for the Hawai'i and O'ahu markets are estimated at 12,700 acres and 8,600 acres, respectively, plus additional acreage for fallowing land between crop plantings. When allowing for competition from imports, these estimates drop to about half. These estimates take into account estimated consumption, production trends, seasonal and annual market shares, yields, and the number of crops per year. Also, these figures are for acreage in crop—not harvested acreage as is typically reported in government publications.

For many crops grown in Hawai'i, market shares for Hawai'i growers are limited by the following factors: (1) local varieties are not perfect substitutes for all imports (e.g., premium-priced sweet Maui onions versus inexpensive storage onions); (2) some crops cannot be produced profitably in the Summer due to competition from low-cost imports of fruits and vegetables from California, other states, and Mexico; and (3) over-production must be avoided in order to maintain profitable price levels.

Since Hawai'i farmers already supply a portion of the Hawai'i market, land requirements for increased import substitution are a fraction of the above estimates.

Export Crops[10,37,38]

The potential market for export crops is far larger than the Hawai'i market. In 2005, the U.S. population was 296.41 million, compared to Hawai'i's resident-plus-visitor population of 1.45 million. To take advantage of this large potential, Hawai'i farmers are exploring various export crops on lands released from plantation agriculture. Over the next 20+ years, one or more of these crops may prove to be successful and may grow into a major export crop.

However, the history of agricultural efforts in Hawai'i reveals that the successful development of major new export crops requiring large amounts of land is difficult and infrequent. For example, over the past 50 years in Hawai'i, farmers have explored numerous possibilities for export crops, but they have developed overseas markets for just one diversified crop that requires more than 10,000 acres (macadamia nuts at 18,300 acres in 2005); one additional crop that requires more than 5,000 acres (coffee at 8,000 acres); and only five additional crops or crop categories that require more than 1,000 acres each (papaya at 2,395 acres, bananas at 1,145 acres, tropical specialty fruits at 1,230 acres, flowers/nursery products at 3,895 acres, and seed crops at 4,220 acres). Tropical specialty fruits include longan, lychee, mango, rambutan, star-fruit, etc.

At 4,220 acres in 2005 and growing at an average rate of 264 additional acres per year, the seed industry is expected to soon become only the third diversified crop that requires more than 5,000 acres. The fourth crop could be nursery and flower products: 3,895 acres and increasing at 235 acres per year.

Feed Crops[29]

If feed crops could be grown in Hawai'i and priced competitively against mainland imports, they could replace some of the grains and hay that are now being imported to the State. Unfortunately, a number of commercial attempts in Hawai'i to grow grains and alfalfa have been unsuccessful. The major problems have been (1) pests, particularly birds that eat the grains before they are harvested; (2) humidity that is too high for drying alfalfa properly; and (3) high production costs compared to those of mainland farms.

Biofuel Crops

Crops can be grown to produce biomass to fuel a boiler, or as feedstock to produce fuels. Examples of the latter include sugarcane, corn, or sorghum used to produce ethanol. In turn, the ethanol is used to produce E-10 gasohol (90% gasoline and 10% ethanol). Also, palm oil, soybean, sunflower, kukui nut, avocado, coconut, neem and other crops can be grown to produce biodiesel.[39]

In Hawai'i, the common practice has been to produce biomass as a by-product of some principal crop. For example, at HC&S on Maui and at Gay & Robinson on Kaua'i, the sugarcane by-product bagasse is burned to help fuel their respective power plants. In addition, the biofuel company Maui Ethanol plans to use the sugarcane by-product, molasses, from the two sugarcane plantations as feedstock to produce ethanol.[40,41] Using conventional technology, the sugar in the molasses will be fermented to produce ethanol, followed by distillation to extract the alcohol.

However, O'ahu Ethanol Corporation plans to build an ethanol plant at Campbell Industrial Park using conventional technology but, at least initially, using imported molasses as the feedstock.[40,42] The rated capacity will be 15 million gallons of ethanol per year. For the longer term, this company is exploring the economics of growing sweet sorghum to supply feedstock to its ethanol plant. The sorghum would have to be grown on O'ahu because it would be too expensive to ship the sorghum juice from a Neighbor Island to O'ahu. Sorghum juice is mostly water having a low concentration of sugar compared to molasses. Acreage requirements for a new sorghum biofuel plantation on O'ahu would range from about 6,000 acres for viability to 15,000 acres if juice from sorghum were to replace all imported molasses.[42] This acreage comprises a substantial share, if not all, of the estimated 10,900 acres of crop land that is available on O'ahu as of mid-2007. But it is a small share of the 160,000+ acres of crop land available Statewide (see Section 11.b).

Also, Imperium Renewables Hawai'i LLC is proposing to build by 2009 a biodiesel refinery on State land at Kalaeloa Harbor; it would produce about 100 million gallons of biodiesel annually.[43,44] Similarly, BlueEarth Maui Biodiesel LLC plans to build a similar refinery on Maui that would produce about 120 million gallons annually by 2011. Both will use imported palm oil from Malaysia and other countries as their feed stock, but would refine locally produced vegetable oil if available.

A number of substantial difficulties must be overcome in order to develop one or more biofuel plantations to supply feedstock for ethanol or biodiesel production, including:

— Long-term Leases

In many areas of the State, it will be difficult to lease the large amount of land required for a biofuel plantation at low lease rents for the 30 or so years required to capitalize the investment in a new plantation. Over time, other farmers and other users of land are likely to make higher offers to landowners of lease rents or land purchases. In view of this potential for landowners, the current market value of available farm lands is likely to be higher if landowners do not commit long-term to rents that are low enough to be affordable to a biofuel plantation.

— Capital

Substantial investment capital will be required to cover the cost of improvements and equipment such as: a mill to extract the juice from a biofuel crop; a generating plant to provide power; improvements and upgrades to irrigation systems that are in disrepair; trucks and equipment to harvest and haul harvested plants to the mill, and haul the extracted juice to an ethanol plan or the vegetable oil to a refinery, etc.

— Short-term Profitability

Annual revenues from selling the ethanol plus direct subsidies are estimated by the consultant at about $2,430 per acre (based on an estimated 900 gallons per acre per year of ethanol at about $2.70 per gallon). Even with subsidies, this is low compared to revenues from other crops in Hawai'i. Per-acre returns from biodiesel crops are even less.

Furthermore, the cost of importing molasses or palm oil for feedstock, or importing ethanol may prove to be less expensive

than growing a biofuel crop in Hawai'i. For similar crops (such as feed crops), importing has proven to be less expensive than growing and processing crops locally. Also, the U.S. Department of Agriculture has found sorghum to be an expensive feedstock for producing ethanol—about 3.7 times more expensive than corn and 63% more expensive than molasses.[45]

As ethanol production increases on the mainland and in Hawai'i, there is a risk that the combined Federal and State subsidies for ethanol (over $2 per gallon) could be reduced, thereby compromising the profitability of a biofuel crop.

— Long-term Profitability

Over the long-term, emerging technology holds promise for a cheaper source of feedstock for ethanol than does growing a biofuel crop on a plantation.[46] Instead of producing ethanol using sugars from conventional sources (e.g., molasses, sugarcane, grains, fruits, etc.), the sugar would come from "cellulosic" sources. Using new technology that is in the early stages of commercialization, sugar that is locked in complex carbohydrates of plants is separated into fermentable sugars. Feedstock would include agricultural wastes, yard clippings, discarded paper, wood waste, etc.—i.e., the green waste that is now used for composting. This new technology promises (1) much higher ethanol yields per ton of biomass because the entire plant can be used as feedstock, and (2) lower costs—particularly if there are no growing costs when waste product is used, and if the operator is paid a fee to dispose of municipal and agricultural waste. Eventually, this less expensive source of feedstock could result in unprofitable biofuel plantations. In Hawai'i, this new technology is being explored by ClearFuels Technology Inc.

O'ahu's municipal waste could produce an estimated 160 million gallons of ethanol compared to the current annual consumption of about 400 million gallons of gasoline.

The above difficulties and risks suggest that the probability of successfully developing and sustaining a biofuel plantation in Hawai'i is low. The more likely scenario is that ethanol will be produced as a by-product of sugar and, over the long-term, it will be produced from green waste.

Recent Crop-acreage Trends[10]

For all diversified crops (i.e., all crops other than sugarcane and pineapple, including crops to replace imports and crops for export) Statewide land requirements grew as shown in Figure 11, with the annual growth by selected periods summarized as follows:[1,2]

— 1963 to 1979: about 839 acres per year.

— 1979 to 1983: about 3,450 acres per year.[1]

— 1983 to 2000: about 310 acres per year.[2]

— 2000 to 2005: about 160 acres per year.

As the above illustrates, growth in acreage of diversified crops has slowed over time.

Regarding major export crops and crop categories, acreage increased for four of them from 2000 to 2005: coffee up an average of 20 acres per year; tropical specialty fruits up 54 acres per year, flowers/nursery products up 235 acres per year, and seed crops up 264 acres per year. During this same period, acreage declined for three of the major export crops: macadamia nuts down an average of 20 acres year, papaya down 90 acres per year, and bananas down 113 acres per year. The net change was an average increase of 350 acres per year.

Regarding crops grown for the Hawai'i market, acreage declined by an average of 190 acres per year from 2000 to 2005.

In summary, the major growth in acreage for diversified crops from 2000 to 2005 came from just two crop categories: seed crops and flowers/nursery products.

These trends are consistent with advances in economic development, transportation and overseas trade. In essence, communities increase their standard of living by increasing their economic specialization and their trade with other communities.

1. In Figure 11, the rapid growth in diversified-crop acreage that occurred during the 1979-to-1983 period largely reflects (1) growth in macadamia-nut acreage which continued until about 1986 when tax-shelter advantages were terminated, and (2) a temporary increase in feed-crop acreage that declined after 1983 and offset the acreage gains in macadamia nuts. The growth in feed-crop acreage may reflect the situation addressed in Footnote 2.
2. In Figure 11, the temporary bump in diversified-crop acreage that occurred in the late 1990s reflects the fact that some former sugarcane fields were newly planted with grasses for future cattle grazing. After cattle grazing began in 2000, much of this acreage was recategorized by NASDA from crop land to grazing land.

Factors Limiting the Growth of Diversified Crops[36]

A great many crops can be grown in Hawai'i's year-round subtropical climate, and a number of them can be grown profitably in volumes that require a few hundred acres. However, the modest growth in land requirements for diversified crops reflects the fact that few crops can be grown profitably on a large scale. The primary factors that have limited the growth of diversified agriculture in Hawai'i are given below:

- Hawai'i's subtropical climate is not well-suited to the commercial production of major crops that grow better in the temperate mainland climates.
- For certain crops, special hybrids adapted to Hawai'i's subtropical climate are yet to be developed.
- Crop pests are more prevalent and more expensive to control in Hawai'i than they are on the mainland where the cold winters kill many pests.
- Fruit-fly infestations prevent exports of many crops, or require expensive treatment.
- Most soils in Hawai'i have low nutrient levels and therefore require high expenditures for fertilizer.
- Hawai'i suffers from high farm-labor costs, largely because the agriculture industry must compete against the visitor industry and related industries for its labor.
- Compared to many other farm areas that supply U.S. markets, the cost of shipping agricultural supplies and equipment to Hawai'i is high, as is the cost of exporting produce from Hawai'i to mainland markets. High shipping costs are a result of Hawai'i's remote location and to Federal regulations that require use of American-built ships and U.S. crews between U.S. ports.
- For a number of crops, consumption volumes in Hawai'i are too small to support large, efficient farms (i.e., the volumes are too small to realize economies of scale).
- On-going trends towards food suppliers purchasing produce that is certified as safe and towards buying from a single supplier of many food items favor large farms.
- Hawai'i farmers must compete against highly efficient mainland and foreign farms which, in a number of cases, can deliver produce to Hawai'i more cheaply than it can be produced locally. This is due to economies of scale and, in comparison to Hawai'i, low costs for land, labor, supplies, fertilizer, pest control, equipment, etc.

b. Adjusted Supply of Land Available for the Growth of Diversified Crops

As discussed Section 12, about 10,900 acres of farm land are available on O'ahu, and over 160,000 acres are available Statewide. Over time, a portion of this available land supply will be leased to the four agricultural operations that will have to relocated as a result of Ho'opili in combination with other land-use changes in 'Ewa, lower Kunia, and Central O'ahu. As discussed in Section 13, the relocation will require about 2,900 to 3,600 acres, depending on whether Syngenta's O'ahu operation remains on O'ahu or relocates to Kaua'i. The adjusted supply of farm land that will remain available for diversified farming will total about 7,300 to 8,000 acres on O'ahu and over 156,000 acres Statewide.

This adjusted supply of available farm land far exceeds the amount of land that will be needed to accommodate the growth of diversified crops, whether demand is based on potential or recent trends. This indicates that the limiting factor to the growth of diversified crops will *not* be the *land supply*. Instead, growth will be limited by the *size of the market* for crops that can be grown *profitably* in Hawai'i.

c. Impact on the Growth of Diversified Crop Farming

The development of Ho'opili—in combination with other development projects in 'Ewa, Central O'ahu and elsewhere—involves the loss of too little good agricultural land to significantly affect the growth of diversified crop farming in Hawai'i. This conclusion is based on the above finding that ample land will remain available for diversified crops, with the available supply far exceeding the likely or potential demand.

However, as discussed in Subsections 12.b and 13.h, water-related improvements are needed to allow full use of some of the available farm lands on the North Shore. These improvements are the responsibility of the landowners and government agencies.

d. Mitigating Measures

In view of the negligible impact of the Project on the growth of diversified agriculture, mitigation measures for the loss of good agricultural land are not recommended beyond the measures in Section 13.h.

16. OFFSETTING BENEFITS

As previously mentioned, Ho'opili will commit about 1,554 acres of agricultural land to a non-agricultural use, of which about 1,375 acres are arable. In turn, Ho'opili—in combination with other private and State urban projects and changes in agriculture land use in Kunia—will require the the affected agricultural operations to relocate.

These adverse impacts to agriculture will be offset by the following benefits of the Project:

- About 11,750 homes for Hawai'i residents, along with business and commercial space, light-industrial space, parks and open space, and public facilities.
- For 'Ewa, relatively high housing densities which, in turn, will contribute to slower urbanization of agricultural land than would be the case with lower densities.
- Construction jobs provided by the development activity.
- At full development of the Project, on-site jobs provided by business, commercial, industrial, and home-service activities.
- Tax revenues (excise taxes, personal income taxes, corporate income taxes, property taxes, etc.) generated by the development activity.
- Tax revenues generated by the families and businesses that occupy the Project.
- Improved land and partial funding for schools, parks and other public facilities.

17. CONSISTENCY WITH STATE AND COUNTY POLICIES[47]

a. Availability of Lands for Agriculture

The *Hawaii State Constitution*, the *Hawaii State Plan*, the *State Agriculture Functional Plan*, and the *General Plan of the City and County of Honolulu* call directly or implicitly for preserving the economic viability of plantation agriculture and promoting the growth of diversified crops. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

With regard to plantation agriculture, the Petition Area is no longer part of a sugar plantation since O'ahu Sugar Co. closed in 1995 for reasons unrelated to the Project.

With regard to diversified crops, development of the Petition Area will result in a loss of good farm land, and the farms on this land will have to relocate. However, this loss of agricultural land will not limit the growth of diversified crops since ample agricultural land is available on O'ahu and on other islands. This is due to the enormous supply of farm land that is now available following the contraction of plantation agriculture (see Section 15 and Figure 11). However, improvements to the WWTP and the WIS will be needed to allow full use of the available farm lands on the North Shore.

b. Conservation of Agricultural Lands

In addition to the above, State policies call for conserving and protecting prime agricultural lands, including protecting agricultural lands from urban development.

However, these policies—which were written before the major contraction of plantation agriculture in the 1990s—assume implicitly that profitable agricultural activities eventually will be available to use all available agricultural lands. This has proven to be a questionable assumption in view of the enormity of the contraction of plantation agriculture, the abundant supply of land that came available for diversified agriculture, and the slow growth in the amount of land being used for diversified crops (see Section 15 and Figure 11).

Furthermore, discussions in the Agriculture portion of the *State Functional Plan* recognize that redesignation of lands from Agricultural to Urban should be allowed "... upon a demonstrated change in economic or social conditions, and where the requested redesignation will provide greater benefits to the general public than its retention in ...agriculture;" that is, when an "overriding public interest exists." In this regard, major changes in economic and social conditions have occurred as a result of:

- The on-going development of the City of Kapolei and the surrounding 'Ewa region as the second largest urban center in Hawai'i (see the policy discussion in the following subsection).
- Inadequate expansion in the supply of workforce housing which has contributed to high housing prices on O'ahu.
- The enormous contraction in plantation agriculture which has resulted in the supply of agricultural land far exceeding demand.

Moreover, development in the Petition Area will provide community benefits (about 11,750 homes and many on-site jobs) that far exceed those provided by agriculture (about 80 jobs after Syngenta is replaced by a new farm). In prac-

tice, however, development of the Petition Area is likely to have little or no impact on Statewide agricultural employment.

c. County 'Ewa Development Plan

As shown in Figure 4, the Petition Area is within the County's designated Urban Growth Boundary of the 'Ewa Development Plan in an area designated for residential development. Thus, the Project is consistent with the 'Ewa Development Plan in terms of future land use.

This Plan is part of a broader long-established County policy, with support from the State, to direct urban growth to 'Ewa, to portions of Central O'ahu, and to the primary urban center. In turn, the policy reduces development pressures on the outlying Districts of Ko'olau Loa, Ko'olau Poko, North Shore, and Wai'anae. The policy was designed to provide needed housing, jobs, and commercial and industrial space in compact areas; preserve agricultural lands and open space in Kunia, the North Shore, and outlying areas; preserve the "country" lifestyle of rural communities; and reduce the cost of providing government infrastructure and services.

Portions of the Project could be inconsistent with the phasing component of the currently approved 'Ewa Development Plan which indicates that urban expansion of the northern and eastern portions of the Petition Area is to occur after 2015. This area includes all the fields farmed by Aloun Farms that are between Farrington Highway and the H-1 Freeway, the eastern portion of Aloun lands that are subleased to Fat Law's Farm, and all the lands farmed by Syngenta (see Figure 10). Such phasing in the current 'Ewa Development Plan would create nuisance issues by placing farm areas immediately upwind of the new Ho'opili homes (see Section 14). However, the 'Ewa Development Plan is in the process of being updated which, based on discussions with the County, is expected to reflect the removal of phasing from the Plan.

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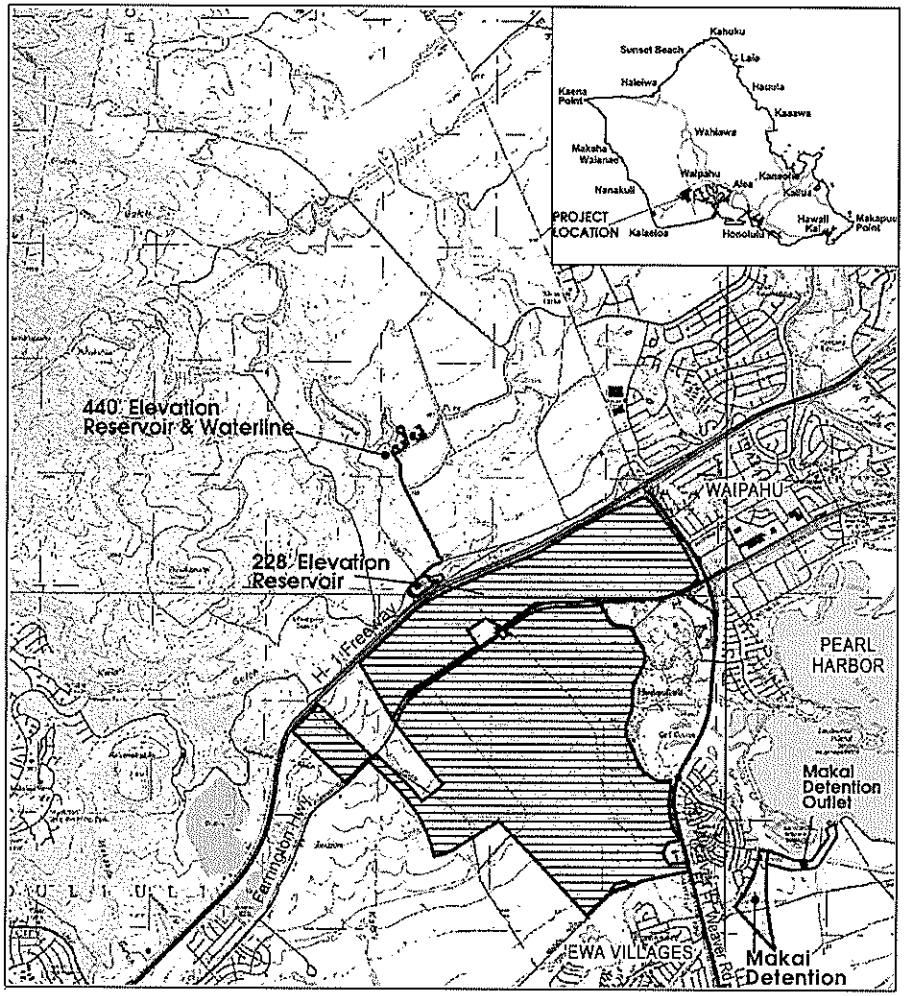
FIGURES



LEGEND

- Project Site Boundary
- Petition Area

Source: US Geological Survey
Disclaimer: This graphic has been prepared for general planning purposes only.

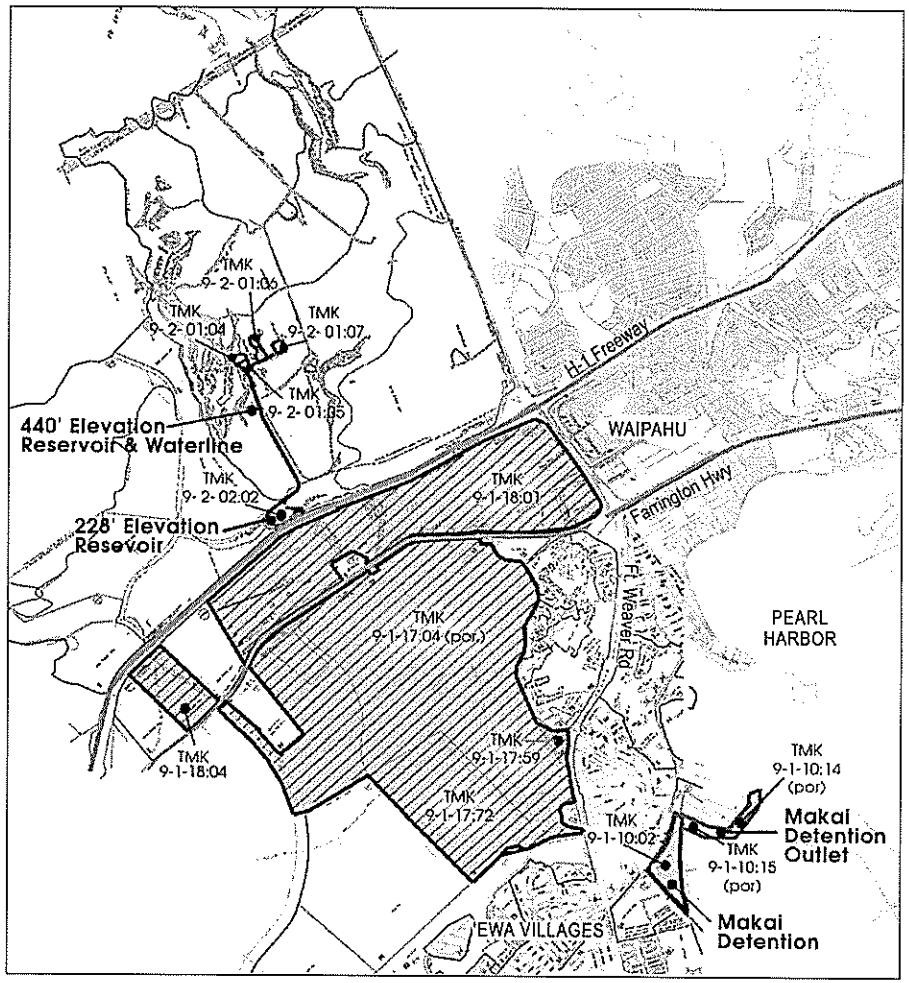
Figure 1: Location Map

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.



LEGEND

- Project Site Boundary
- Petition Area

Source: Tax maps Zone 9, Sec. 1, Plats 10, 17 and 18
Zone 9, Sec. 2, Plat 1 and 2
Disclaimer: This graphic has been prepared for general planning purposes only.

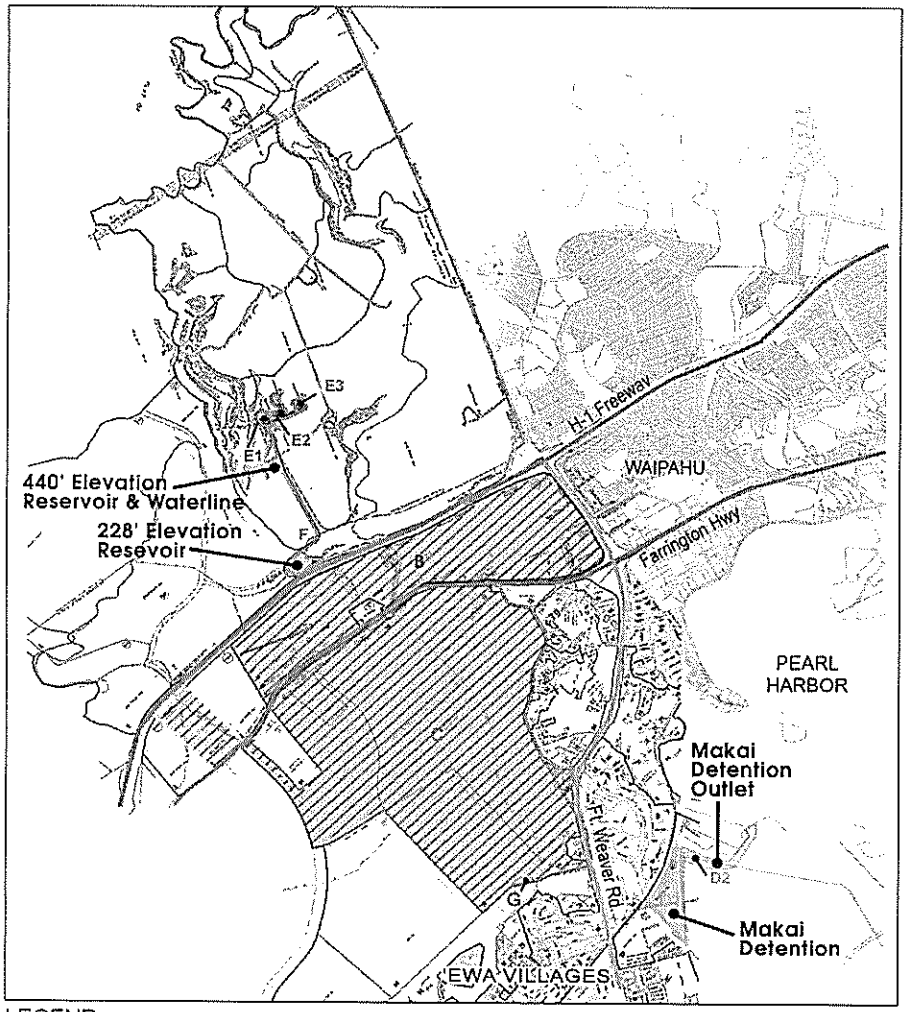
Figure 2: Tax Map Key

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,000 6,000

PBR HAWAII & ASSOCIATES, INC.



LEGEND

Petition Area

- Parcel A: 52.289 Acres
- Parcel B: 447.592 Acres
- Parcel C: 1,053.953 Acres

Non-petition Area

- Parcel D1: 30.825 Acres
- Parcel D2: 4.5 Acres*
- E1 Parcel E1: .635 Acres
- E2 Parcel E2: 1.49 Acres*
- E3 Parcel E3: .359 Acres
- F Parcel F: 7.311 Acres
- G Parcel G: 1.301 Acres

* Approx Acres

Source: Tax Maps Zone 9, Sec. 1, Plats 10, 15,17 & 18 and Zone 9, Sec. 2, Plats 1 and 2
Disclaimer: This graphic has been prepared for general planning purposes only

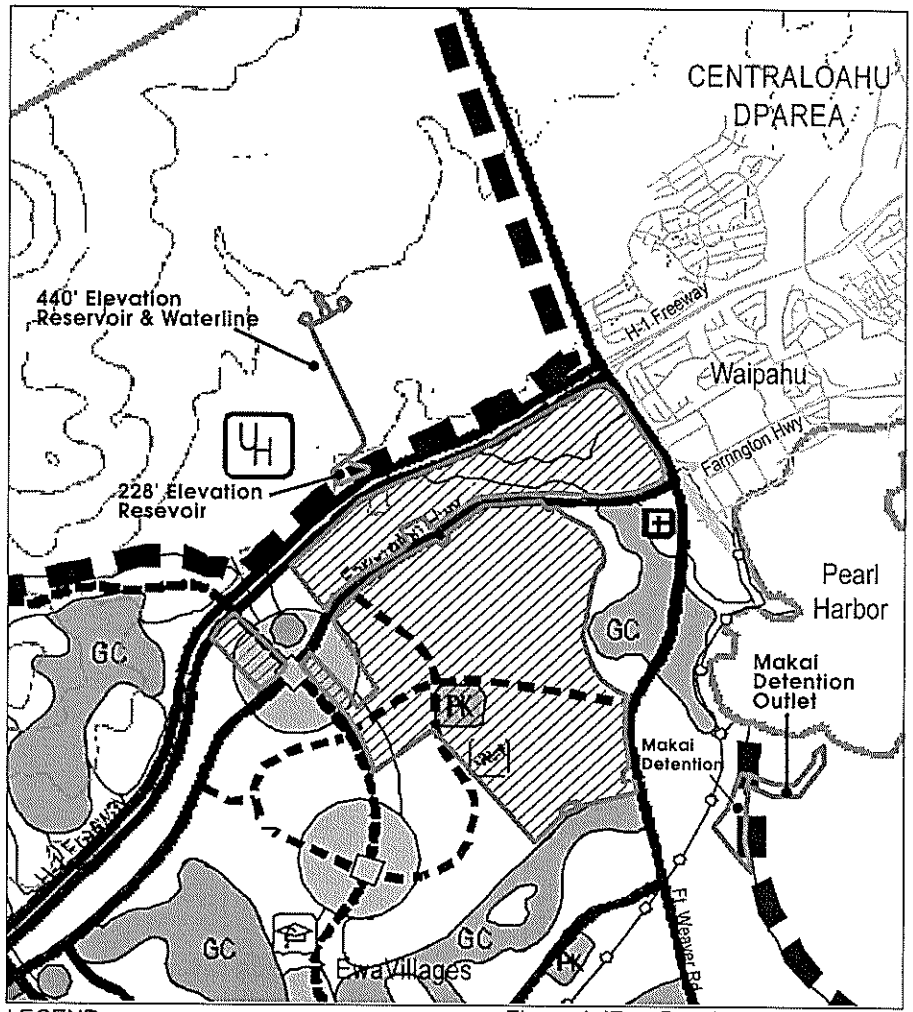
Figure 3: Parcels Map

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,000 6,000

PBR HAWAII & ASSOCIATES, INC



LEGEND

- Project Site Boundary
- Petition Area
- Low & Medium Density Residential
- High Density Residential
- Community Commercial Center
- Agricultural Land Preservation
- PK/GC Parks & Golf Courses
- Transit Nodes/ High Density Residential & Commercial
- Urban Growth Boundary

Source: City & County of Honolulu 'Ewa Development Plan Urban Land Use Map (1997)
Disclaimer: This graphic has been prepared for general planning purposes only

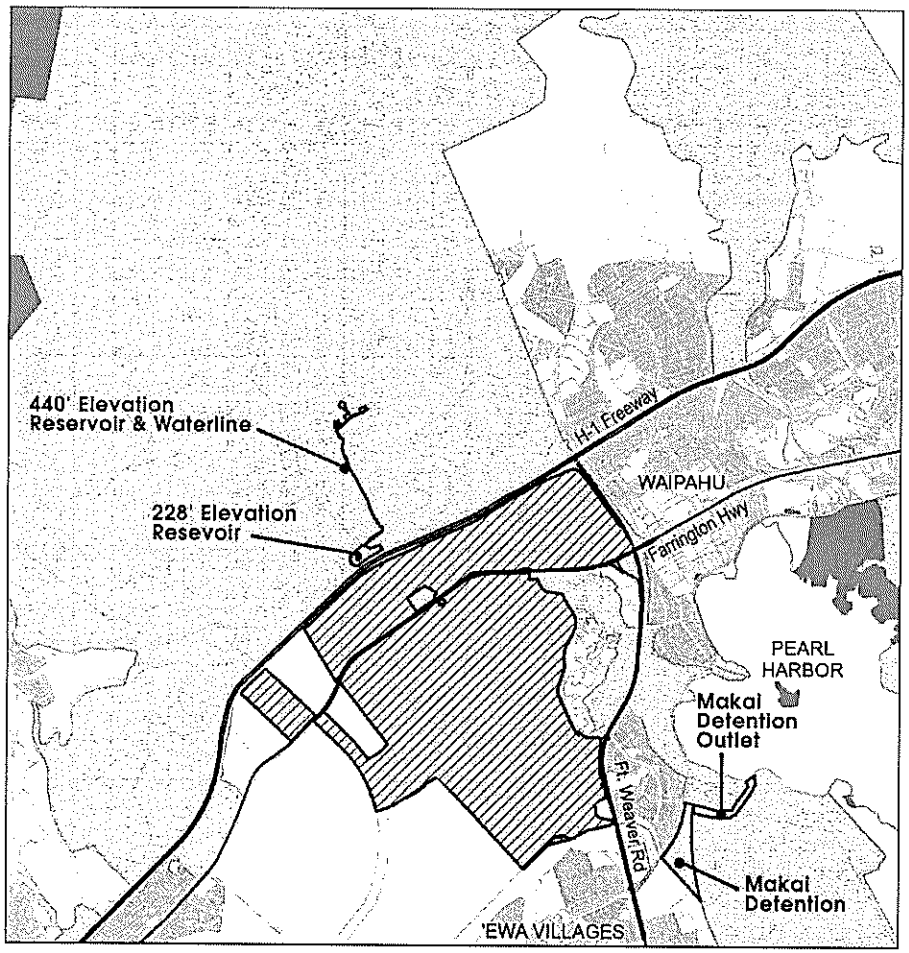
Figure 4: 'Ewa Development Plan Land Use Map

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,000 6,000

PBR HAWAII & ASSOCIATES, INC



LEGEND

- Project Site Boundary
- Petition Area
- Agricultural
- Conservation
- Urban

Source: State Land Use Commission (2004)

Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 5: State Land Use District

HO'OPILI

O'ahu, Hawai'i

NORTH

LINEAR SCALE (FEET)

0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.

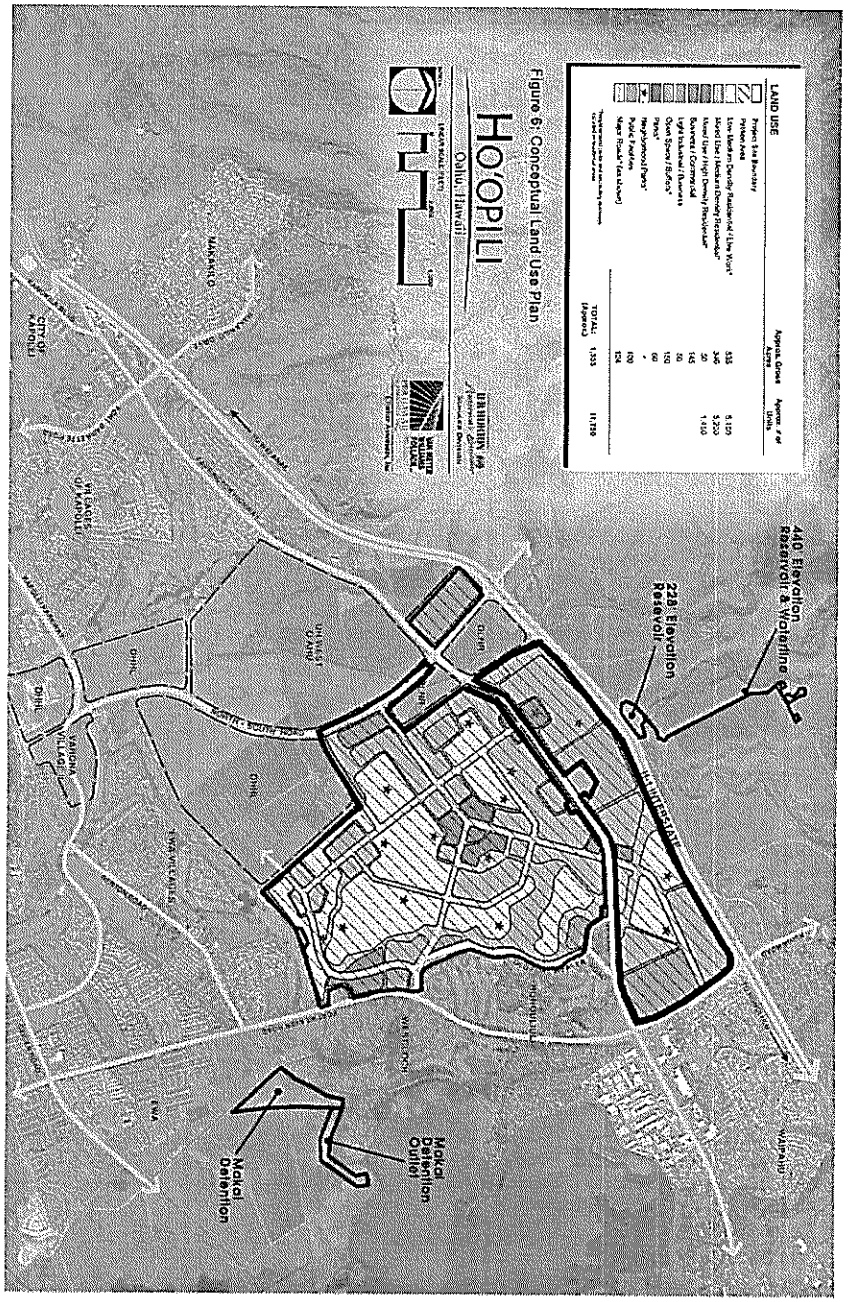


Figure 6: Conceptual Land Use Plan

HO'OPILI

Oahu, Hawaii

Figure 8: Land Study Bureau Land Classification

HO'OPILI

O'ahu, Hawai'i

PBR HAWAII & ASSOCIATES, INC.

Source: Land Study Bureau (1967)

Disclaimer: This graphic has been prepared for general planning purposes only.

Source: U.S. Department of Agriculture Natural Resources Conservation Service (1995)

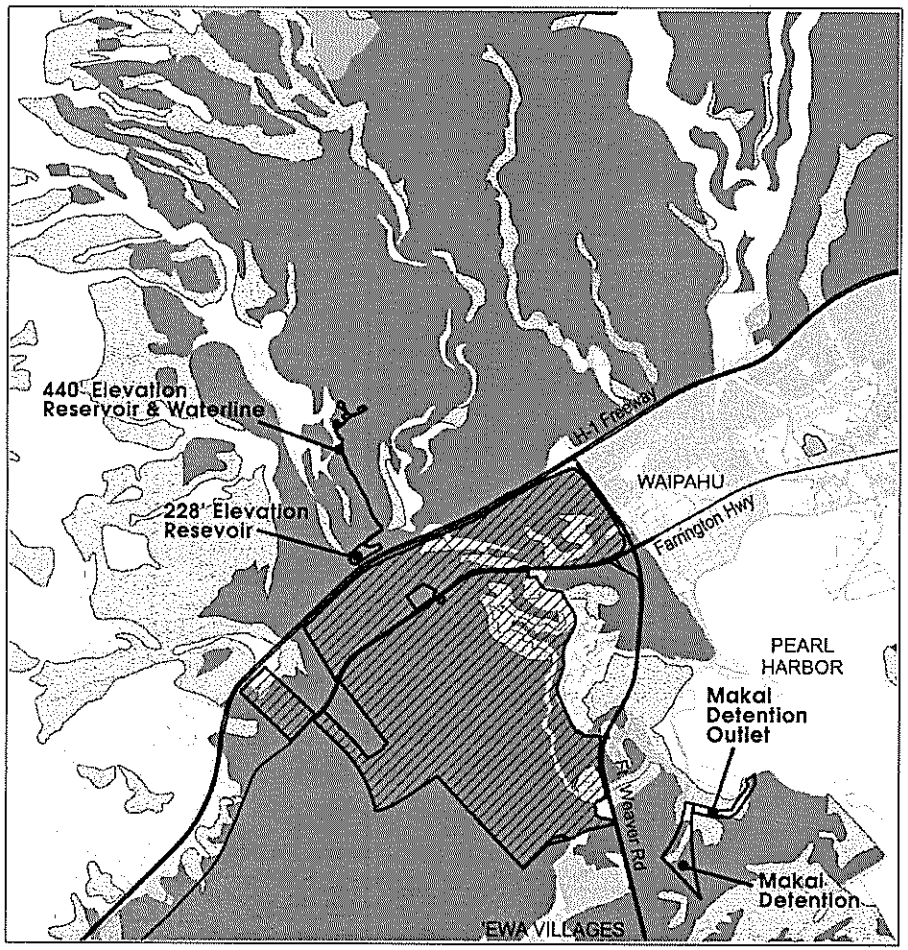
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 7: Natural Resources Conservation Service Soil Survey Map

HO'OPILI

O'ahu, Hawai'i

PBR HAWAII & ASSOCIATES, INC.



LEGEND

- Project Site Boundary
- Petition Area
- Prime Agricultural Lands
- Unique Agricultural Lands
- Other Agricultural Lands
- Unclassified Agricultural Lands

Source: State Dept. of Agriculture (1977).
Disclaimer: This graphic has been prepared for general planning purposes only.

Figure 9: Agricultural Lands of Importance to the State of Hawaii (ALISH)

HO'OPILI

O'ahu, Hawai'i

NORTH LINEAR SCALE (FEET) 0 3,500 7,000

PBR HAWAII & ASSOCIATES, INC.

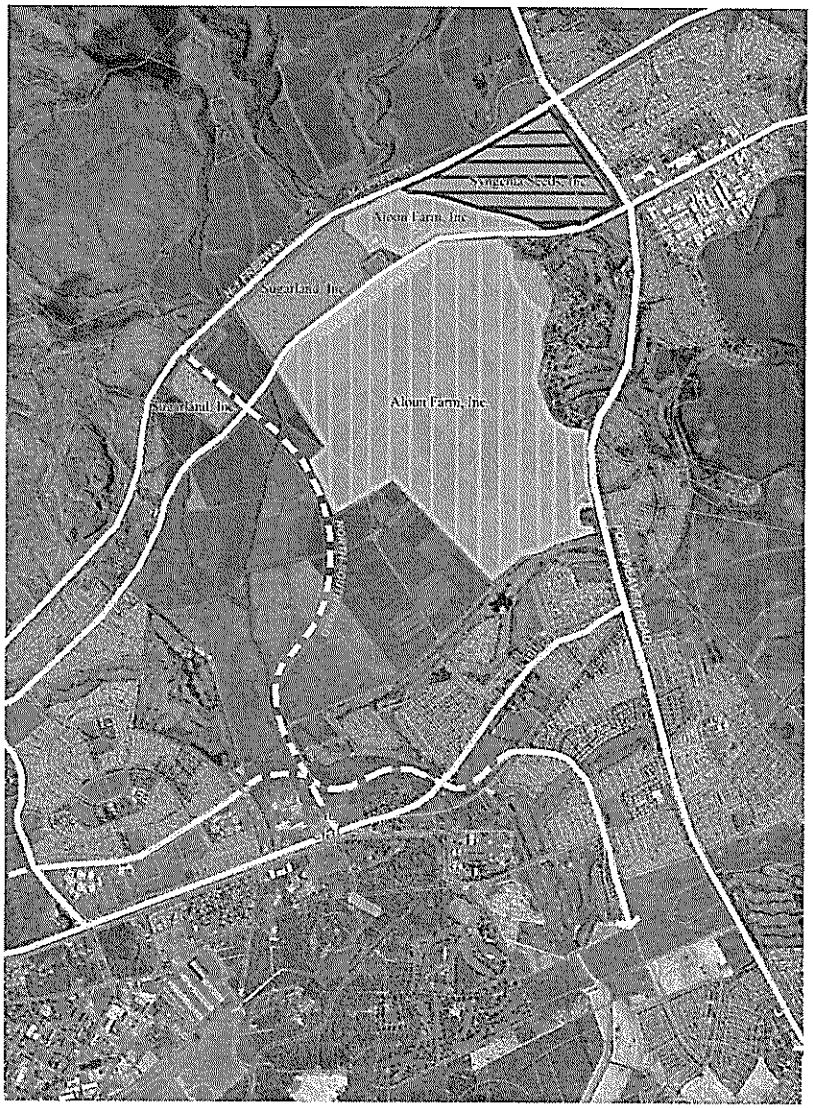
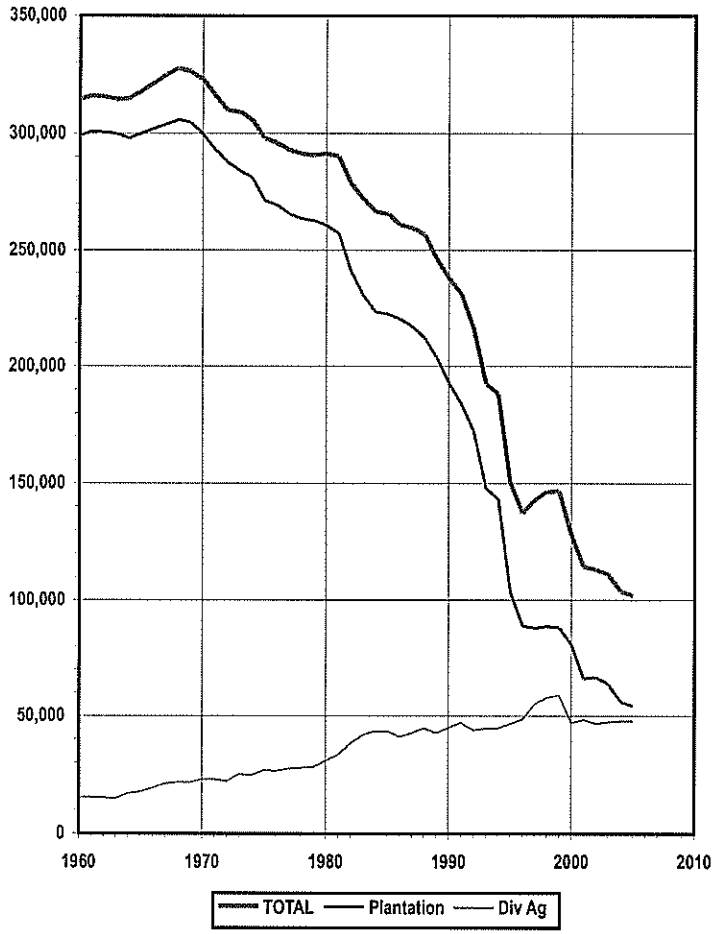


Figure 10: Farm Lease Map

D.R. Horton East Kapolei

Figure 11 - Statewide Acreage in Crop: 1960 to 2005



APPENDIX:
SELECTED STATE AND COUNTY GOALS, OBJECTIVES, POLICIES AND GUIDELINES RELATED TO AGRICULTURAL LANDS

1. HAWAI'I STATE CONSTITUTION (Article XI, Section 3):

   ...to conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally suitable lands...

2. HAWAI'I STATE PLAN (Chapter 226, Hawaii Revised Statutes, as amended):[1,2]

   Section 226-7 Objectives and policies for the economy--agriculture.

   (a) Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives:

   (1) Viability in Hawaii's sugar and pineapple industries.

   (2) Growth and development of diversified agriculture throughout the State.

   (3) An agriculture industry that continues to constitute a dynamic and essential component of Hawaii's strategic, economic, and social well-being.

   (b) To achieve the agricultural objectives, it shall be the policy of the State to:

   (2) Encourage agriculture by making best use of natural resources.

   (10) Assure the availability of agriculturally suitable lands with adequate water to accommodate present and future needs.

   (16) Facilitate the transition of agricultural lands in economically nonfeasible agricultural production to economically viable agricultural uses.

   Section 226-103 Economic priority guidelines.

   (c) Priority guidelines to promote the continued viability of the sugar and pineapple industries:

   (1) Provide adequate agricultural lands to support the economic viability of the sugar and pineapple industries.

(d) Priority guidelines to promote the growth and development of diversified agriculture and aquaculture:

(1) Identify, conserve, and protect agricultural and aquacultural lands of importance and initiate affirmative and comprehensive programs to promote economically productive agricultural and aquacultural uses of such lands.

(10) Support the continuation of land currently in use for diversified agriculture.

Section 226-104 Population growth and land resources priority guidelines.

(b) Priority guidelines for regional growth distribution and land resource utilization:

(2) Make available marginal or non-essential agricultural lands for appropriate urban uses while maintaining agricultural lands of importance in the agricultural district.

Section 226-106 Affordable Housing

Priority guidelines for the provision of affordable housing:

(1) Seek to use marginal or nonessential agricultural land and public land to meet housing needs of low- and moderate-income and gap-group households.

3. AGRICULTURAL STATE FUNCTIONAL PLAN (1991)[3]
(Functional plans are guidelines for implementing the State Plan. They are approved by the Governor, but not adopted by the State Legislature.)

Objective H: Achievement of Productive Agricultural Use of Lands Most Suitable and Needed for Agriculture.

Policy H(2): Conserve and protect important agricultural lands in accordance with the Hawaii State Constitution.

Action H(2)(a): Propose enactment of standards and criteria to identify, conserve, and protect important agricultural lands and lands in agricultural use.

Action H(2)(c): Administer land use district boundary amendments, permitted land uses, infrastructure standards, and other planning and regulatory functions on important agricultural lands and lands in agricultural use, so as to ensure the availability of agriculturally suitable lands and promote diversified agriculture.

4. CITY AND COUNTY OF HONOLULU
GENERAL PLAN, Objectives and Policies (Resolution No. 87-211)[4]

Economic Activity

Objective C. To maintain the viability of agriculture on Oahu.

Policy 1. Assist the agricultural industry to ensure the continuation of agriculture as an important source of income and employment.

Policy 2. Support agricultural diversification in all agricultural areas on Oahu.

Policy 3. Support the development of markets for local products, particularly those with the potential for economic growth.

Policy 4. Provide sufficient agricultural land in Ewa, Central Oahu, and the North Shore to encourage the continuation of sugar and pineapple as viable industries.

Policy 5. Maintain agricultural land along the Windward, North Shore, and Waianae coasts for truck farming, flower growing, aquaculture, livestock production, and other types of diversified agriculture.

Policy 6. Encourage the more intensive use of productive agricultural land.

Policy 7. Encourage the use of more efficient production practices by agriculture, including the efficient use of water.

Policy 8. Encourage the more efficient use of nonpotable water for agricultural use.

5. CITY AND COUNTY OF HONOLULU
'EWA DEVELOPMENT PLAN[5]

3.1. Open Space Preservation and Development

3.1.1 General Policies

Open space will be used to:

- Provide long range protection for diversified agriculture on lands outside the Urban Growth Boundary.

6. REFERENCES

[1] State of Hawaii, Office of State Planning, Office of the Governor. *The Hawaii State Plan, 1991*. Honolulu, Hawaii. 1991.

[2] Act 25, S.B. No. 1158, April 15, 1993.

[3] Hawaii Department of Agriculture. *The Hawaii State Plan: Agriculture, State Functional Plan.* Honolulu, Hawaii. 1991.

[4] City and County of Honolulu, Department of General Planning. *General Plan Objectives and Policies.* Honolulu, Hawaii. 1992.

[5] City and County of Honolulu, Planning Department. *'Ewa Development Plan.* Honolulu, Hawaii. August 1997 (Revised May 2000).

APPENDIX B
Botanical Resources Assessment

BOTANICAL RESOURCES ASSESSMENT FOR THE
HO'OPILI PROJECT
HONOULIULI, OAHU

MAIN PARCELS

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PBR HAWAII &
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August 2006

INTRODUCTION

This report includes the findings of a botanical study conducted within the Honouliuli Region on the island of Oahu, Hawaii. LeGrande Biological Surveys Inc. carried out a botanical field survey of the above location on January18, 19, 23, 24, 30, and 31, and May 6 and 7, 2006, for a total of 8 field days. The primary objectives of the field studies were to:

1) provide a general description of the vegetation on the project site;
2) inventory the flora; and
3) search for threatened and endangered species as well as species of concern.

Federal and State of Hawaii listed species status follows U.S. Fish and Wildlife (USFWS) (1999a and 1999b, 2004) and Federal Register (2002).

GENERAL SITE DESCRIPTION

The area proposed for the Ho'opili Project in Ewa includes three main parcels (covered in this report) and two smaller "Off-Site" areas (separate reports). The main parcels covered in this report include: [A] a rectangular section to the west of Palehua Road, between H-1 Freeway and Farrington Highway (TMK 9-1-18:04);[B] a strip running east-west between H-1 Freeway (to the north) and Farrington Highway (to the south) (TMK 9-1-18:01); and [C] the largest parcel bordered by Farrington Highway to the north, Old Fort Weaver Road to the east, Mango Tree Road to the south, and Palehua Road and the new North-South Road to the west (TMK 9-1-17:04 (por.), 9-1-17:59, and 9-1-17:72). The entire area surveyed (and described in this report) encompasses approximately 1,555 acres

The majority of the surveyed area is either in active cultivation or cleared to bare dirt substrate. The edges of the agricultural fields along with a few small gulches harbor most of the plant diversity. Weedy plant species dominate all areas. The subject property ranges in elevation from near sea level to 250 ft. The Ho'opili parcels have been utilized for agriculture for some time, being planted in sugar cane in the past and now in diversified agriculture. Alteration of native plant habitat has been in place for some time and few of the natural plant elements remain.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. The 2004 Habitat Conservation Plan for *Abutilon menziesii* at Kapolei was reviewed for possible endangered plant locations within the survey area. Information from the Hawaii Biodiverstiy & Mapping Program database was reviewed. Topographic maps were examined to determine terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used. The boundaries of all five parcels were surveyed by foot. Roads through the subject property were driven and most were walked as well to survey for roadside plants. Transects on an average of 80 ft apart were surveyed on foot by 2 botanists for the parcel interiors, except in areas where active cultivation was in progress (i.e. cornfields were surveyed from the outer margins.). Special attention was paid to gulch areas and areas that contained scrub vegetation with native plant elements. Notes were made on plant associations and distribution, disturbances, topography, substrate types, exposure, drainage, etc. Plant identifications were made in the field. Plants that were not positively identified were collected for later determination, and for comparison with the recent taxonomic literature.

DESCRIPTION OF THE VEGETATION

The entire survey area is dominated by non-native plant species and agricultural crops. A total of 137 plant species were observed within the survey area. 133 are alien (introduced) and four are indigenous (native to the Hawaiian Islands and elsewhere). Therefore, 97% of the plant species observed were alien and only 3% native.

An inventory of all the plants observed within the five survey areas is presented in the species list at the end of the report.

TMK 9-1-18:04 [A]

This parcel is located between H-1 and Farrington Highway west of Palehua Road with Hunehune Gulch bordering the parcel to the west. The majority of the parcel is either cleared land or planted in corn. The edges of the parcel, including Palehua Road are dominated by weedy species such as, castor bean (*Ricinus* communis), lion's ear (*Leonotis nepetifolia*), partridge pea (*Chamaecrista nictitans*), and kikania (*Xanthium strumarium* var. *canadense*). A few kiawe (*Prosopis pallida*) and opiuma (*Pithecellobium dulce*) trees are scattered along the top of the gulch. Grass species throughout the parcel include natal redtop, sourgrass (*Digitaria insularis*), and swollen fingergrass (*Digitaria insularis*).

TMK 9-1-18:01 [B]

This parcel is a strip running east-west between H-1 Freeway (to the north) and Farrington Highway (to the south) with Fort Weaver Road bordering to the east. Aloun Farms baseyard is located within this section. The majority of this section consists of gently sloping agricultural fields planted with corn. Edges of fields and along roadsides were generally low-growing weedy shrubs dominated by koa haole, Christmas berry (*Schinus terebinthifolius*), sourbush (*Pluchea carolinensis*), castor bean, and guinea grass.

Honouliuli Gulch runs north-south through this section. The gulch is characterized by koa haole scrub at the northern (upper) sections. Along with koa haole and guinea grass as the dominant species several tall tree species reside in the gulch including kukui (*Aleurites moluccana*), kiawe, pride of India (*Melia azerdarach*), and autograph tree (*Clusia rosea*). Lower down the bottom of the gulch has been cleared for a banana (*Musa sp.*) patch that is currently in cultivation. At the lowest point of the gulch where it crosses Farrington Highway several morning-glory species were observed, koali ai (*Ipomoea cairica*), little bell (*I. Triloba*), and *I. obscura*. Primrose willow (*Ludwigia octovalvis*), love-in-a-mist (*Passiflora foetida*), and comb hyptis (*Hyptis pectinata*) were observed in the drainage.

The Aloun baseyard is planted with various cultivars including citrus (*Citrus sp.*), noni (*Morinda citrifolia*), kalo (*Colocasia esculenta*), yellow Poinciana (*Peltophorum pterocarpum*), sugarcane (*Saccharum officinarum*), and lemon grass (*Cymbopogon citratus*). The electric power substation has a hedge of tropical coral tree (*Erythrina variegata*) planted along the fenceline. Along Farrington Highway the vegetation is dominated by non-native grass species with kiawe, monkeypod (*Samanea saman*) trees and bougainvillea (*Bougainvillea sp.*) scattered along the length of the parcel.

TMK 9-1-17:04, 9-1-17:59, & 9-1-17:72 [C]

This is the largest section of the subject property, bordered by Farrington Highway to the north, Old Fort Weaver Road to the east, Mango Tree Road to the south, and Palehua Road and the new North-South Road to the west. The majority of this portion of the surveyed area is under cultivation or cleared to bare soil. Crops observed grown in this area include corn, melons (*Cucumis sp.*), basil (*Ocimum sp.*) and bananas. At the edges of planted areas and in fallow fields weedy species such as kili oopu (*cyperus rotundus*), wild spider flower (*Cleome gynandra*), and cheeseweed (*Malva parviflora*) were observed. There are several flumes running east-west through the property, they have a greater number of plant species due to the availability of water. The flumes are dominated by koa haole and guinea grass with other non-native plant species scattered within the site including, boerhavia (*Boerhavia coccinea*), Australian saltbush (*Atriplex semibaccata*), heliotrope (*Heliotropium procumbens*), coat buttons (*Tridax procumbens*), and slender mimosa (*Desmanthus pernambucans*). Along the flumes there are some larger woody species such as Christmas berry (*Schinus terebinthifolius*), fleabane (*Pluchea* x *fosbergii*), Chinese banyan (*Ficus microcarpa*), and a few mango (*Mangifera indica*) trees. The only indigenous plant species observed within the site are uncommon and include: ilima (*Sida fallax*) and scattered individuals of popolo (*Solanum americanum*) and uhaloa (*Waltheria indica*).

Between the fairly level agricultural fields and Old Fort Weaver Road, the property changes elevation quite drastically, there is a cliff approximately 20 to 30 feet high running the length of the eastern boundary. The majority of the cliff area is dominated by kiawe forest with an understory of guinea grass. Along the top of the cliff where the cultivated fields do not extend to the edge of the cliff, there are pockets of shrub vegetation that contain a few native plant species such as, ilima, uhaloa, and popolo. At the bottom of the cliff faces there are areas of flat land that extend to Old Fort Weaver Road. These areas are being utilized for various purposes including automobile parking, water pumping stations, baseyards, or farming. The area across from Kahi Mohala

appears to be used for storing and parking large buses and shuttles. Several large trees were observed in this area including earpod tree (*Enterolobium cyclocarpum*), kiawe, African tulip, monkey pod, and Chinese banyan (*Ficus microcarpa*).

The southern section of the parcel between Old Fort Weaver Road and the cliff contain flat areas where there is active farming and equipment buildings. The farm is growing basil, cucumber (*Cucumis sativus*), and horseradish tree (*Moringa oleifera*). Coconut trees (*Cocos nucifera*), papaya (*Carica papaya*), and bamboo (*Bambusa sp.*) are some of the plants observed growing around the farm buildings.

DISCUSSION AND RECOMMENDATIONS

None of the plants which occur on the project site is a threatened or endangered species or a species of concern (U.S. Fish and Wildlife Service, 1999a, 1999b, 2004; Wagner et. al., 1999). HBMP (Hawaii Biodiversity & Mapping Program) supplied historical and present locations of known Threatened and Endangered plant species within the project area for review. The only rare plant mapped near the project area was the kooloaula (*Abutilon menziesii*) population at the southern end of North-South Road. There were no threatened or endangered plants mapped within the Ho'opili project area itself. *A. menziesii* is protected by both the federal Endangered Species Act of 1973, as amended, and Chapter 195D, HRS, as amended. *A. menziesii* is a shrub of the mallow family, growing six to eight feet tall, with coarsely toothed, silvery, heart-shaped leaves that are about one to three inches long. Flowers are medium red to dark red and less than an inch in diameter. It has been sold as an ornamental plant at local nurseries in the past under the name "Red 'ilima." Other extant populations of Kooloaula currently exist on Lāna'i and Maui.

As part of the environmental planning for North-South Road and a portion of Kapolei Parkway, a "Habitat Conservation Plan for *Abutilon menziesii* at Kapolei" was finalized in March 2004. Mitigation measures have already been specified for these populations of *A. menziesii* related to construction of North-South Road. A concerted effort was made in surveying for *Abutilon menziesii* within the survey area. No plants of *A. menziesii* were observed during the survey.

No wetlands were encountered during either the January or May surveys. None of the three essential criteria for defining a federally recognized wetland were present within the study site. Those being hydrophytic vegetation, hydric soils, and wetland hydrology.

A follow up survey for wet season ephemeral plants was conducted in May following the heavy winter and spring rains. All parcels were resurveyed for additional plant species that may have been overlooked or died back during the January survey. No additional species were noted during this follow-up survey.

The proposed development of the surveyed area is not expected to have significant negative impacts on the botanical resources of the site or the general region.

Literature Cited

Evehuis, N.L. and L.G. Eldredge, editors. 1999-2002. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 58-70.

Federal Register. 2002. Department of the Interior, Fish and Wildlife Service, 50 CFR 17. Endangered and Threatened Wildlife and Plants. Review of Species That Are Candidate or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Recycled Petition; Annual Description of Progress on Listing Actions. *Federal Register*, 67 No. 14 (Thursday, June 13, 2002): 40657-40679.

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Wagner, W.L. and D.R. Herbst. 1999. Supplement to the Manual of the flowering plants of Hawaii, pp. 1855-1918. In: Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawaii. Revised Edition. 2 vols. University of Hawaii Press and Bishop Museum Press, Honolulu.

PLANTS SPECIES LIST – Ho`opili, Oahu, Hawaii
MAIN PARCELS

The following checklist is an inventory of all the plant species observed within the three parcels of the survey site for the proposed Ho`opili project. The plant names are arranged alphabetically by family and then by species into two groups: Monocots and Dicots. The taxonomy and nomenclature of the flowering plants (Monocots and Dicots) are in accordance with Wagner *et al.* (1990), Wagner and Herbst (1999) and Staples and Herbst (2005). Recent name changes are those recorded in the Hawaii Biological Survey series (Evehuis and Eldredge, eds, 1999-2002).

For each species, the following name is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:

I= indigenous= native to the Hawaiian Islands and elsewhere.

X=introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact, that is Cook's arrival in the islands in 1778.

HO`OPILI PLANT SPECIES LIST
MAIN PARCELS
AUGUST 2006

SCIENTIFIC NAME	COMMON NAME	STATUS
MONOCOTS		
AGAVACEAE		
Cordyline fruticosa (L.) A.Chev.	Ti, ki	X
ALOEACEAE		
Aloe vera (L.) N.L.Burm.	Aloe	X
ARACEAE		
Colocasia esculenta(L.) Schott	Kalo, taro	X
Dracaena sp. L.	dracaena	X
ARECACEAE		
Areca catechu L.	Betel nut palm	X
Cocos nucifera L.	coconut	X
Phoenix dactylifera L.	Date palm	X
CYPERACEAE		
Cyperus involucratus Roxb.	Ahuawa haole	X
Cyperus rotundus L.	Kili oopu	X
MUSACEAE		
Musa sp. L.	banana	X
POACEAE		
Bambusa sp. Schreber	bamboo	X
Brachiaria mutica (Forssk.) Stapf	California grass	X
Cenchrus ciliaris L.	Buffelgrass	X
Cenchrus echinatus L.	Common sandbur	X
Chloris barbata (L.) Sw.	Swollen fingergrass	X
Coix lachryma-jobi L.	Job's tears, puoheohe	X
Cymbopogon citratus (DC) Stapf	Lemon grass	X
Cynodon dactylon (L.) Pers	manienie	X
Digitaria insularis (L.) Mez ex Ekman	sourgrass	X
Eleusine indica (L.) Gaertn.	wiregrass	X
Eragrostis tenella (L.) P.Beauv. Ex Roem.&Schult.		X
Melinus repens (Willd.) Zizka	Natal redtop	X
Panicum maximum L.	Guinea grass	X
Paspalum dilatatum Poir.	Dallis grass	X

Paspalum urvillei Steud.	Vasey grass	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
Pennisetum purpureum Schumach.	Elephant grass	X
Saccharum officinarum L.	Sugar cane, ko	X
Setaria verticillata (L.) P.Beauv.	Bristly foxtail	X
Sorghum bicolor (L.) Moench	Sorghum	X
Sorghum halapense (L.) Pers.	Johnson grass	X
Zea mays L.	corn	X
DICOTS		
ACANTHACEAE		
Asystasia gangetica (L.) T. Anderson	Chinese violet	X
AIZOACEAE		
Trianthema portulacastrum L.		X
AMARANTHACEAE		
Achyranthes aspera L.		X
Alternanthera pungens Kunth	Khaki weed	X
Amaranthus spinosus L.	Spiny amaranth	X
Amaranthus viridis L.	Slender amaranth	X
ANACARDIACEAE		
Mangifera indica L.	mango	X
Schinus terebinthifolius Raddi	Christmas berry	X
ANNONACEAE		
Annona muricata L.	soursop	X
APOCYNACEAE		
Thevetia peruviana (Pers.) K.Schum.	Be-still tree	X
ARALIACEAE		
Schefflera actinophylla (Endl.) Harms	Octopus tree	X
ASCLEPIADACEAE		
Stapelia gigantea N.E.Br.	Zulu-giant	X
ASTERACEAE		
Bidens alba (L.) DC. var. *radiata* (Sch. Bip.) Ballard ex Melchert	Beggar tick	X
Bidens pilosa L.	Spanish needle	X
Conyza bonariensis (L.) Cronq.	Hairy horseweed	X
Crassocephalum crepidioides (Benth.) S.Moore	crassocephalum	X
Emilia fosbergii Nicolson	Red pualele	X

Lactuca serriola L.	Prickly lettuce	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
Pluchea carolinensis (Jacq.) G. Don	sourbush	X
Pluchea indica (L.) Less.	Indian fleabane	X
Pluchea x *fosbergii* Coopper. & Galang	fleabane	X
Sonchus oleraceus L.	pualele	X
Tridax procumbens (L.)	Coat buttons	X
Verbesina encelioides (Cav.) Benth. & Hook	Golden crown-beard	X
Xanthium strumarium L. var. *canadense* (Miller)	kikania	X
BIGNONIACEAE		
Spathodea campanulata P. Beauv.	African tulip	X
BORAGINACEAE		
Heliotropium curassavicum L.	kipukai	I
Heliotropium procumbens Mill. var. *depressum* (Cham.) Fosberg		X
BUDDLEIACEAE		
Buddleia asiatica Lour.	Dog tail	X
CACTACEAE		
Opuntia ficus-indica (L.) Mill.	panini	X
CAPPARACEAE		
Cleome gynandra L.	Wild spider flower	X
CARICACEAE		
Carica papaya L.	papaya	X
CASUARINACEAE		
Casuarina equisetifolia L.	ironwood	X
CHENOPODIACEAE		
Atriplex semibaccata R.Br.	Australian saltbush	X
Chenopodium murale L.	aheahea	X
CLUSIACEAE		
Clusia rosea Jacq.	Autograph tree	X
CONVOLVULACEAE		
Ipomoea cairica (L.) Sweet	Ivy leaved morning glory, koali ai	X
Ipomoea obscura (L.) Ker Gawl.		X
Ipomoea triloba L.	Little bell	X

Merremia aegyptia (L.) Urb.	Hairy merremia	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
CUCURBITACEAE		
Coccinea grandis (L.) Voigt	Ivy gourd	X
Cucumis dipsaceus ehrenb. Ex Spach	Hedgehog gourd	X
Cucumis melo L.	melon	X
Cucumis sativus L.	cucumber	X
Cucurbita sp. L.	Gourd, pumpkin	X
Momordica charantia L.	Balsam pear	X
EUPHORBIACEAE		
Aleurites moluccana (L.) Willd.	kukui	X
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X
Chamaesyce hypercifolia (L.) Millsp.	graceful spurge	X
Chamaesyce hyssopifolia (L.) Small		X
Euphorbia heterophylla L.	kaliko	X
Ricinus communis L.	Castor bean	X
FABACEAE		
Acacia farnesiana (L.) Willd.	Klu, aroma, kolu	X
Chamaecrista nictitans (L.) Moench	Partridge pea	X
Clitoria ternatea L.	Blue pea	X
Crotalaria incana L.	Fuzzy rattlepod	X
Crotalaria pallida Aiton	Smooth rattlepod	X
Desmanthus pernambucanus (L.) Thell.	Slender or virgate mimosa	X
Desmodium tortuosum (Sw.) DC	Florida beggarweed	X
Enterolobium cyclocarpum (N.Jacquin) Grisebach	Earpod	X
Erythrina variegata L.	Tropical coral tree	X
Indigofera hendecaphylla Jacq.	Creeping indigo	X
Indigofera suffritocosa Mill.	Iniko	X
Leucaena leucocephala (Lam.) de Wit	Koa haole	X
Macroptilium lathyroides (L.) Urb.	Wild bean	X
Peltophorum pterocarpum (A.P. de Candolle) K. Heyne	Yellow poinciana	X
Pithecellobium dulce (Roxb.) Benth.	opiuma	X
Prosopis pallida (Humb. & Bonpl. Ex Willd.) Kunth	Kiawe, algaroba	X
Samanea saman (Jacq.) Merr.	monkeypod	X
LAMIACEAE		
Hyptis pectinata (L.) Poit.	Comb hyptis	X
Leonotis nepetifolia (L.) R.Br.	Lion's ear	X

Ocimum basilicum L.	Sweet basil	X
SCIENTIFIC NAME	**COMMON NAME**	**STATUS**
Ocimum tenuifolium L.	Holy basil	X
MALVACEAE		
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon	X
Abutilon incanum (Link.) Sweet	Hoary abutilon	X
Malva parviflora L.	Cheese weed	X
Malvastrum coromandelianum (L.) Garcke	False mallow	X
Sida ciliaris L.		X
Sida fallax Walp.	'ilima	I
Sida rhombifolia L.		X
Sida spinosa L.	Prickly sida	X
MELIACEAE		
Melia azerdarach L.	Pride of India	X
MORACEAE		
Ficus microcarpa L.f.	Chinese banyan	X
Morus sp. L.	Mulberry	X
MORINGACEAE		
Moringa oleifera Lamark	Horseradish tree	X
MYRTACEAE		
Eucalyptus degulpta Blume	Painted gum	X
Psidium guajva L.	Common guava	X
Syzigium cumini (L.) Skeels	Java plum	X
NYCTAGINACEAE		
Boerhavia coccinea Mill.		X
Bougainvillea sp. A.L. Jussieu	bougainvillea	X
ONAGRACEAE		
Ludwigia octovalvis (Jacq.) Raven	Primrose willow	X
PASSIFLORACEAE		
Passiflora foetida L.	Love-in-a-mist	X
POLYGONACEAE		
Antigonon leptopus Hook&Arnott	Mexican creeper	X
PORTULACACEAE		
Portulaca oleracea L.	pigweed	X

SCIENTIFIC NAME	COMMON NAME	STATUS
RUBIACEAE		
Morinda citrifolia L.	noni	X
RUTACEAE		
Citrus xparadisi MacFadyen	grapefruit	X
Citrus sp. L.	citrus	X
SOLANACEAE		
Datura stramonium L.	Jimson weed	X
Nicandra physalodes (L.) Gaertn.	Apple of Peru	X
Nicotiana glauca R.C. Graham	Tree tobacco	X
Solanum americanum Mill.	Glossy nightshade, popolo	I
Solanum lycopersicum L. var. *cerasiforme* (Dunal) Spooner, G.J. Anderson & R.K. Jansen	Cherry tomato	X
Solanum torvum Sw.		X
STERCULIACEAE		
Waltheria indica L.	`uhaloa	I
VERBENACEAE		
Stachytarpheta jamaicensis (L.) Vahl	Jamaican vervain	X
ZYGOPHYLLACEAE		
Tribulus terrestris L.	Puncture vine	X

Appendix C

Survey of Avian & Mammalian Resources

A Survey of Avian and Mammalian Resources for the Ho'opili Development Project, 'Ewa District, O'ahu, Hawai'i.

-

Main Parcels

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February 11, 2008

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Figures & Tables

Introduction

D. R. Horton – Schuler Division is proposing to develop a residential community on approximately 1,555-acres of land in the 'Ewa District, O'ahu (Figure 1). This report summarizes the findings of the avian and mammalian surveys that were conducted on the subject property to determine the potential effects of the proposed development on biological resources present on the site and within the general project area.

A primary goal of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either Federal or State of Hawaii endangered species statutes. Listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted on July 20, and 21, 2006.

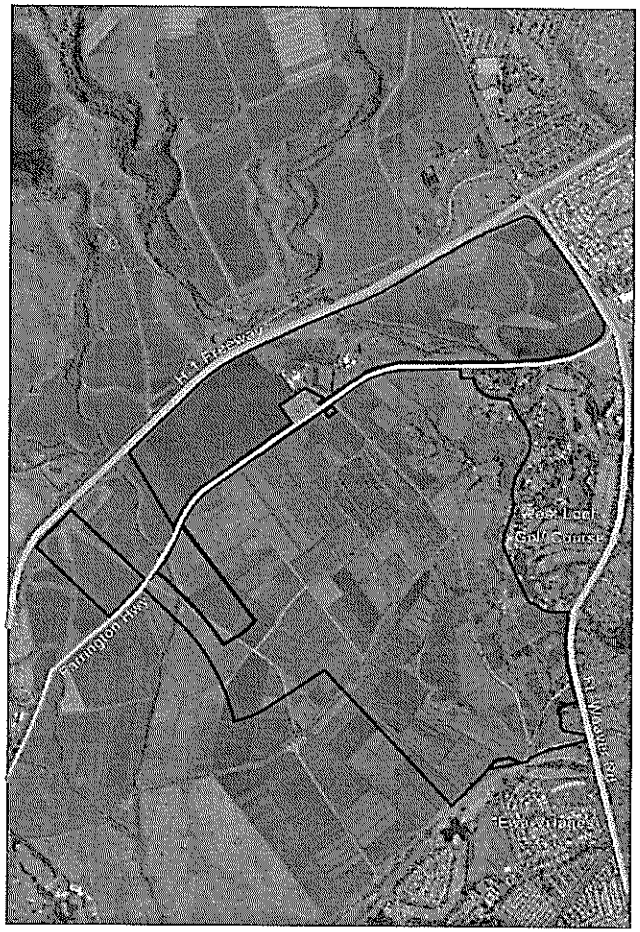
The avian phylogenetic order and nomenclature used in this report follows *The American Ornithologists' Union Checklist of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 11.

General Site Description

The proposed Ho'opili Development includes five main parcels which are identified as (TMK: 9-1-17:04 (por.), 9-1-17:59 and 9-1-17:72, 9-1-18:01 and 9-1-18:04, and two smaller "off-site" parcels, which are covered in two separate reports (David 2008a, 2008b). This reports covers the approximately 1555-acres, which make up the main development area (Figure 1).

The project site is made up primarily of former sugar cane fields, most fallow now, though some are being farmed for various diversified agricultural crops. The site is bound to the north by the H-1 Freeway, to the east by Fort Weaver Road and to the west by additional former sugar cane lands. Farrington Highway transects the side from east to west (Figure 1). The terrain slopes gently from the north-to-south, from an elevation of approximately 200-feet above mean sea level (MSL) at the north corner of the site, adjacent to Fort Weaver Road and H-1 Freeway off ramp, down to approximately 60-feet MSL at the southwestern corner of the site located along Mango Tree Road (Figure 1).



HO'OPILI
Oahu, Hawaii

Much of the site is made up of former sugar cane land, some of which is bare, (Figure 2), and some of which is under active cultivation of various diversified crops, such as corn, and bananas (Figure 3). Areas along roads and between fields are vegetated with a mix of predominantly alien ruderal species typical of disturbed former sugar fields on O'ahu (Figure 2). The vegetation present on the project site is almost completely dominated by alien species. The botanical surveys conducted on the site identified 137-plant species, four of which are considered indigenous, the remainder alien to the Hawaiian Islands (LeGrande 2006).

Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of O'ahu are alien species, and most are ubiquitous. Two hours were spent within the project area on the evenings of August 30 and 31, 2006 and again in the early morning hours of August 31, and September 1, 2006, in an attempt to detect Hawaiian hoary bats. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal signs. A running tally was kept of all vertebrate species observed and heard within the study area.

Mammalian Survey Results

Five mammalian species were detected within the project site. Numerous European house mice (*Mus musculus domesticus*) were seen at several locations during the course of this survey. A total of five domestic dogs (*Canis f. familiaris*) were seen within, or adjacent to the study area. Nine small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations within the site, as were three cats (*Felis catus*). Many more dogs and cats were seen and or heard within existing developments located to the northeast and southeast of the proposed project site. Additionally, tracks, scat and sign of dog, mongoose, cat, and horse (*Equus c. caballus*) were observed in numerous locations within the project site.

The endangered Hawaiian hoary bat was not recorded during the course of this survey. This finding is not surprising given that this species has rarely been documented from the Island of O'ahu (Tomich 1986, USFWS 1998).

Avian Survey Methods

Twenty-seven avian count stations were sited along linear transects within the subject property. Six-minute point counts were made at each of the 27-count stations. Field observations were made using Leitz 10 X 42 binoculars and by listening for avian vocalizations. Counts took place between 06:30 a.m. and 11:00 a.m., the peak of daily bird activity. An additional two hours was spent within the project area on the evenings of August 30 and 31, 2006 and again in the early morning hours of August 31, and September 1, 2006 in an attempt to detect crepuscular and/or nocturnally flying seabirds and owls. Time not spent conducting station counts was used to search the subject property for species and habitats not detected during count sessions.

Figure 2 – Cleared former sugar cane fields and ruderal vegetation along road

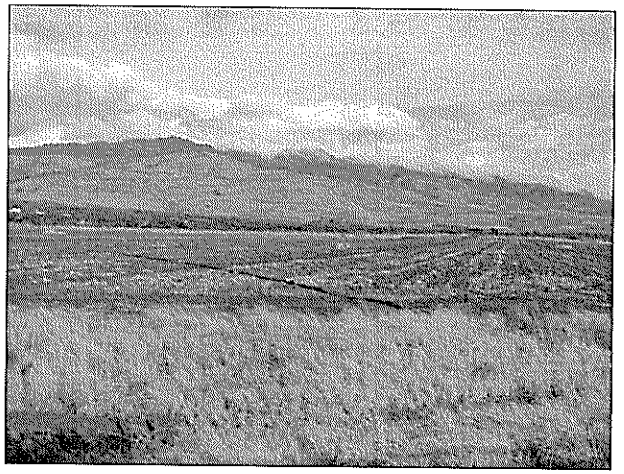
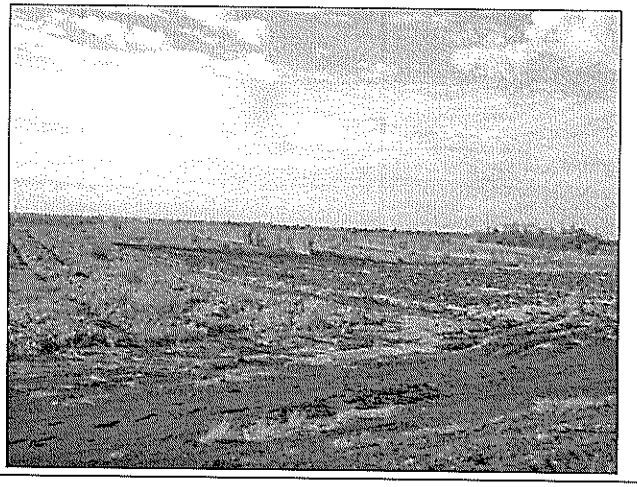


Figure 3 – Cornfields typical of diversified crops to the south of Farrington Hwy.



Avian Survey Results

A total of 831 individual birds, of 24 different avian species, representing 15 separate families were recorded during station counts. These results are summarized in Table 1. Two of the species recorded, Pacific Golden-Plover (*Pluvialis fulva*) and Ruddy Turnstone (*Arenaria interpres*), are indigenous migratory shorebird species. Both species breed in the high Arctic, and spend their winters in Hawai'i and the tropical Pacific. The remaining 22 species detected are considered to be alien to the Hawaiian Islands (Table 1).

Avian diversity and densities were relatively low, not surprising given the depauperate state of the habitat found on most of the site. Four species, Common Waxbill (*Estrilda astrild*), Red-vented Bulbul (*Pycnonotus cafer*), Common Myna (*Acridotheres tristis*), and Spotted Dove (*Streptopelia chinensis*) accounted for slightly less than 43% of the total number of individual birds recorded. Common Waxbills were the most frequently recorded species, accounting for more than 13% of the total number of individual birds recorded during station counts. We recorded an average of 23 birds per station count.

Table 1. Avian Species Detected Ho'opili Project – Main Sites

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.15
Black Francolin	*Francolinus francolinus*	A	0.26
Erckel's Francolin	*Francolinus erckelii*	A	0.56
Ring-necked Pheasant	*Phasianus colchicus*	A	0.19
	CICONIIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	0.74
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.37
	SCOLOPACIDAE - Sandpipers, Phalaropes & Allies		
	Scolopacinae - Sandpipers & Allies		
Ruddy Turnstone	*Arenaria interpres*	IM	0.41

Common Name	*Scientific Name*	*ST*	*RA*
	OLUMBIFORMES		
	OLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	2.81
Zebra Dove	*Geopelia striata*	A	2.15
Morning Dove	*Zenaida macroura*	A	0.15
	PASSERIFORMES		
	ALAUDIDAE - Larks		
Sky Lark	*Alauda arvensis*	A	1.63
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	3.22
	ZOSTEROPIDAE - White-Eyes		
Japanese White-eye	*Zosterops japonicus*	A	2.41
	MIMIDAE - Mockingbirds & Thrushes		
Northern Mockingbird	*Mimus polyglottos*	A	2.89
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	2.89
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	0.70
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.74
	FRINGILLIDAE - Fringilline And Carduline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	1.85
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*		0.67
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
Common Waxbill	*Estrilda astrild*	A	4.11
Red Avadavat	*Amandava amandava*	A	0.78
Nutmeg Mannikin	*Lonchura punctulata*	A	1.41
Chestnut Munia	*Lonchura atricapilla*	A	0.48
Java Sparrow	*Padda oryzivora*	A	1.04

KEY TO TABLE 1

ST Status

A Alien – introduced to the Hawaiian Islands by humans

IM Indigenous Migrant – a native migratory species that winters in Hawai'i but breeds elsewhere

RA Relative Abundance – number of birds detected divided by the number of count stations (27)

Discussion

Mammalian Resources

The findings of the mammalian survey are consistent with the findings of at least one other recent survey conducted on lands immediately adjacent to the subject property (David 2005a), as well as with several others faunal surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

As previously mentioned we did encounter several European house mice within the project site. It is also likely that the other three established *muridae* in Hawaii, roof rats (*Rattus r.rattus*), Norway rats (*Rattus norvegicus*), and possibly Polynesian rats (*Rattus exulans hawiiensis*), use resources present within the project site. These commensal species are all but ubiquitous on the island of O'ahu. All of these introduced rodents are deleterious to remaining native ecosystems and the native floral and faunal species that are dependant on them for their survival.

Avian Resources

The findings of the avian survey are consistent with the findings of at least one other recent avian survey conducted on lands immediately adjacent to the subject property (David 2005a), as well as with several others avian surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Only two of the 24-avian species recorded during the course of this survey are native species. The two species in question, Pacific Golden-Plover, and Ruddy Turnstone are indigenous migratory shorebird species that breed in the high Arctic and spend the winter months in Hawai'i and the tropical Pacific. Both species are readily seen throughout the Hawaiian Islands between late July and the end of April each year. The remaining 22-species detected are considered to be alien to the Hawaiian Islands (Table 1).

Although not detected during this survey, it is likely that the Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandichensis*), or *pueo* use resources within the general project area. This species is regularly seen along the Wai'anae coast from the Lualualei Naval Reservation to Waimānalo Gulch (David 2005c). The O'ahu population of the short-eared Owl is listed as an endangered species under the State of Hawai'i's endangered species program, though; it is not protected under the federal endangered species statutes (DLNR 1998).

From an avian and native mammalian perspective there is nothing unique about the subject property, and none of the study area is important habitat for any listed avian or mammalian species currently known from the Island of O'ahu.

Conclusions

It is not expected that the modification of the project area or the development of the site will have a negative impact on any avian or mammalian species currently listed as endangered, threatened, or any that are currently proposed for listing under either Federal or State of Hawai'i endangered species statutes.

Glossary

Alien - Introduced to Hawai'i by humans
Commensal - Animals that share human food such as rats and mice
Crepuscular – Twilight hours
Depauperate – Lacking in numbers or variety of species
Endangered – Listed and protected under the ESA as an endangered species
Endemic – Native and unique to the Hawaiian Islands
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally
Muridae - Rodents, including rats, mice and voles, one of the most diverse families of mammals.
Nocturnal – Night-time, after dark
'ōpe'ape'a – Hawaiian hoary bat (*Lasiurus cinereus semotus*)
pueo – Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*)
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species

DLNR – Hawaii State Department of Land & Natural resources
TMK – Tax Map Key
USFWS – U.S. Fish & Wildlife Service

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A Survey of Avian and Mammalian Resources for the Ho'opili Development Project, 'Ewa District, O'ahu, Hawai'i.

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Makai Detention Site

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February 11, 2008

Table of Contents

Figures & Tables

Introduction

D. R. Horton – Schuler Division is proposing to use a triangular parcel of land located to the east of Fort Weaver Road as a storm water retention basin for their proposed Ho'opili Development in East Kapolei, 'Ewa District, O'ahu (Figure 1). A portion of the site is currently being used as such by developments to the north and west of the site. This report summarizes the findings of the avian and mammalian surveys that were conducted within this site to determine the potential effects of the proposed development on biological resources present on the site and within the general project area (Figure 1).

A primary goal of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either Federal or State of Hawaii endangered species statutes present on, or close to the proposed project areas. Listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted on August 15, 2006.

The avian phylogenetic order and nomenclature used in this report follows *The American Ornithologists' Union Checklist of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

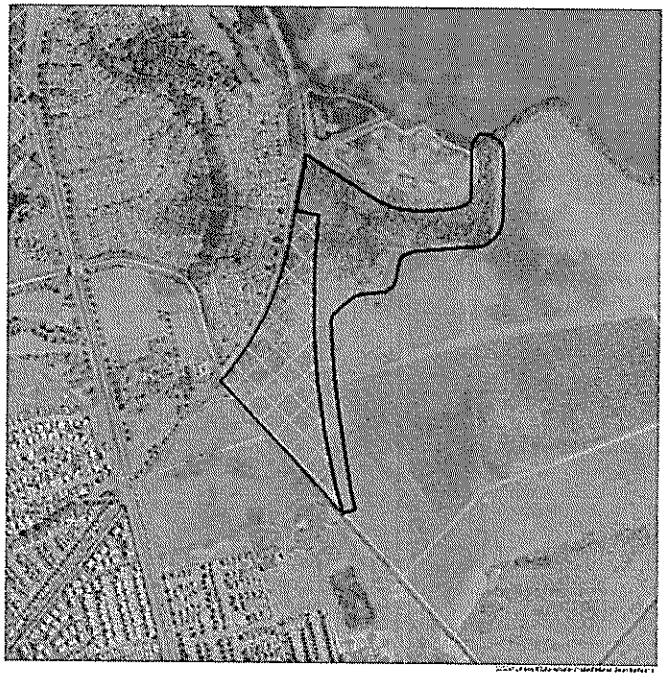
Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 9.

General Site Description

The proposed Ho'opili Development includes five main parcels, which are covered in a separate report, and two smaller "off-site" parcels, which are covered in two separate reports (David 2008a, 20008b). This report covers a proposed storm water detention basin which is to be located to the east of Fort Weaver Road, and south of the Honouliuli Unit of the Pearl Harbor National Wildlife Refuge (Figure 1). The site is transected by the former OR&L railway line. A corridor running from the original detention site to Pearl Harbor was not surveyed, as we were unable to secure access to the area, which is controlled by the U. S. Navy.

The project site is made up of an approximately 2-acre detention basin on the northern third of the site. The southern third of the site is in active cultivation of corn (*Zea mays*) and tomatoes (*Solanum lycopersicum*). The vegetation present on the project site is almost completely dominated by alien species. The botanical surveys conducted on the site identified 73-plant species, three of which are considered indigenous, the remainder being alien to the Hawaiian Islands (LeGrande 2006).

Figure 1 – Ho'opili Makai Detention Site



Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of O'ahu are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed and heard within the study area.

Mammalian Survey Results

Three mammalian species were detected within the project site. Three small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations within the site. Several dogs (*Canis f. familiaris*) were heard barking from within existing developments located to the northwest of the site. Tracks, scat and sign of mongoose cat (*Felis catus*) and dog were encountered in several locations within the site. The endangered Hawaiian hoary bat was not recorded during the course of this survey. This finding is not surprising given that this species has rarely been documented from the Island of O'ahu (Tomich 1986, USFWS 1998).

Avian Survey Methods

Five avian count stations were sited along two linear transects running the length of the site. Stations were sighted approximately 300-meters apart. Six-minute point counts were made at each of the nine-count stations. Field observations were made using Leitz 10 X 42 binoculars and by listening for avian vocalizations. Counts took place between 06:30 a.m. and 11:00 a.m., the peak of daily bird activity. Time not spent conducting station counts was used to search the subject property for species and habitats not detected during count sessions.

Avian Survey Results

A total of 170 individual birds, of 20-different avian species, representing 13-separate families were recorded during station counts. These results are summarized in Table 1. One of the species recorded, Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*), is a resident indigenous breeding species. Two others, Pacific Golden-Plover (*Pluvialis fulva*) and Ruddy Turnstone (*Arenaria interpres*), are indigenous migratory shorebird species. Both of which breed in the high Arctic, and spend their winters in Hawai'i and the tropical Pacific. The remaining 17-species detected are considered to be alien to the Hawaiian Islands (Table 1).

The survey results were in keeping with the habitat present on the site, and it's location on the Island of O'ahu. Three species, Common Waxbill (*Estrilda astrild*), Zebra Dove (*Geopelia striata*), and Spotted Dove (*Streptopelia chinensis*), accounted for more than 45% of the total number of individual birds recorded. Common Waxbills were the most frequently recorded species, accounting for more slightly less that 19% of the total number of individual birds recorded during station counts. We recorded an average of 20 birds per station count.

Table 1. Avian Species Detected Ho'opili Project - Makai Detention Site

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Red Junglefowl	*Gallus gallus*	D	0.80
	CICONIIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	1.40
Black-crowned Night-Heron	*Nycticorax nycticorax hoactli*	IR	0.20
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.80
	SCOLOPACIDAE - Sandpipers, Phalaropes & Allies		
	Scolopacinae - Sandpipers & Allies		
Wandering tattler	*Tringa incana*	IM	0.20
Ruddy Turnstone	*Arenaria interpres*	IM	0.60
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Rock Pigeon	*Columba livia*	A	1.60
Spotted Dove	*Streptopelia chinensis*	A	3.00
Zebra Dove	*Geopelia striata*	A	6.00
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	0.40
	ZOSTEROPIDAE - White-Eyes		
Japanese White-eye	*Zosterops japonicus*	A	2.40
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	1.60
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	1.00
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.40

Common Name	*Scientific Name*	*ST*	*RA*
	FRINGILLIDAE - Fringilline And Cardueline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	1.00
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	A	1.40
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
Common Waxbill	*Estrilda astrild*	A	6.40
Nutmeg Mannikin	*Lonchura punctulata*	A	1.00
Chestnut Munia	*Lonchura atricapilla*	A	1.00
Java Sparrow	*Padda oryzivora*	A	2.80

KEY TO TABLE 1

ST Status

D Domesticated Species – Not currently considered to be established on the Island of O'ahu

A Alien – introduced to the Hawaiian Islands by humans

IM Indigenous Migrant – a native migratory species that winters in Hawai'i but breeds elsewhere

RA Relative Abundance – number of birds detected divided by the number of count stations (5)

Discussion

Mammalian Resources

The findings of the mammalian survey are consistent with the findings of several others faunal surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005a, 2005b, 2007, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Although none of the four established *muridae* were detected during the course of this survey, it is likely that, European house mice (*Mus musculus domesticus*), Hawai'i, roof rats (*Rattus r. rattus*), Norway rats (*Rattus norvegicus*), and possibly Polynesian rats (*Rattus exulans hawaiiensis*), use resources present within the project site. These commensal species are all but ubiquitous on the island of O'ahu. All of these introduced rodents are deleterious to remaining native ecosystems and the native floral and faunal species that are dependant on them for their survival.

Avian Resources

The findings of the avian survey are consistent with the findings of several others avian surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005a, 2005b, 2007, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Three of the 20-avian species recorded during the course of this survey are native species. Black-crowned Night-Herons are an indigenous resident breeding species. They are regularly seen in

and around just about any kind of standing or running water present on O'ahu. The other two native species recorded, Pacific Golden-Plover and Ruddy Turnstone, are indigenous migratory shorebird species that breed in the high Arctic and spend the winter months in Hawai'i and the tropical Pacific. Both species are readily seen throughout the Hawaiian Islands between late July and the end of April each year. The remaining 17-species detected are considered to be alien to the Hawaiian Islands (Table 1).

Four waterbird species that are currently listed as endangered under both the Federal and State of Hawai'i's endangered species statutes, Hawaiian Duck x Mallard hybrids (*Anas wyvilliana x platyrhynchos*), Common Moorhen (*Gallinula chloropus sandvicensis*), Hawaiian Coot (*Fulica alai*), and Black-necked Stilt (*Himantopus mexicanus knudseni*), are present within the general project area, although there currently is no suitable habitat within the project site for them. All four species breed within the Honouliuli unit of the Pearl Harbor National Wildlife Refuge, which is located some 250-meters north of the proposed site. They are also regularly encountered on the golf course located to the northwest of the project site. At such time as the detention basin is enlarged, and when water ponds within it, it is likely that one or more of these species may start to use resources present within the expanded detention basin. According to the projects' civil engineer, Bills Engineering Inc. this is likely to happen very infrequently.

Although not detected during this survey, it is likely that the Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*), or *pueo* use resources within the general project area occasionally. This species is regularly seen along the Wai'anae coast from the Lualualei Naval Reservation to Waimānalo Gulch (David 2005c). I have also seen them within the Honouliuli unit of the Pearl Harbor National Wildlife Refuge upon occasion (David 2007e). The O'ahu population of the short-eared Owl is listed as an endangered species under the State of Hawai'i's endangered species program, though; it is not protected under the federal endangered species statutes (DLNR 1998).

From an avian and native mammalian perspective there is nothing unique about the habitat present within the *makai* detention site. None of the habitat present on the project site is important habitat for any listed avian or mammalian species currently known from the Island of O'ahu.

Conclusions

It is not expected that the modification of the habitat currently found within the proposed makai detention site will result in any deleterious impacts to any avian or mammalian species currently listed as endangered, threatened, or any that are currently proposed for listing under either Federal or State of Hawai'i endangered species statutes.

Glossary

Alien - Introduced to Hawai'i by humans
Commensal - Animals that share human food such as rats and mice
Crepuscular – Twilight hours
Endangered – Listed and protected under the ESA as an endangered species
Endemic – Native and unique to the Hawaiian Islands
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally
makai – Down-slope, towards the ocean
mauka – Upslope, towards the mountains
Muridae - Rodents, including rats, mice and voles, one of the most divers families of mammals.
Nocturnal – Night-time, after dark
'ōpe'ape'a – Hawaiian hoary bat (*Lasiurus cinereus semotus*)
pueo – Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*)
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species

ESA – Endangered Species Act of 1973, as amended
DLNR – Hawaii State Department of Land & Natural resources
USFWS – U.S. Fish & Wildlife Service

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A Survey of Avian and Mammalian Resources for the Ho'opili Development Project, 'Ewa District, O'ahu, Hawai'i.

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New 440 Tank, Transmission Line and New 228 Tank

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February 11, 2008

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Figures & Tables

Introduction

D. R. Horton – Schuler Division is proposing to develop two new potable water tanks (440 and 228) as well as approximately 5600-feet of waterline to service their proposed Ho'opili Development which is to be located *makai* of the water infrastructure in the 'Ewa District, O'ahu (Figure 1). This report summarizes the findings of the avian and mammalian surveys that were conducted along the proposed waterline routes and on the proposed water tank sites, to determine the potential effects of the proposed development on biological resources present on the site and within the general project area (Figure 1).

A primary goal of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either Federal or State of Hawaii endangered species statutes present on, or close to the proposed project areas. Listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted on July 20, and 21, 2006.

The avian phylogenetic order and nomenclature used in this report follows *The American Ornithologists' Union Checklist of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 10.

General Site Description

The proposed Ho'opili Development includes five main parcels, which are covered in a separate report, and two smaller "off-site" parcels, which are covered in two separate reports (David 2008a, 20008b). This reports covers two proposed above ground reservoir sites and associated water transmission line routes, all of which are located *mauka*, or north of the H-1 Freeway (Figure 1 and 2).

The project site is made up primarily of a dirt road, which extends some 4000-feet *mauka* from the H-1 Freeway. The proposed 228 water tank site is located on a previously graded pad, immediately adjacent to an existing Board of Water Supply (BWS) water tank just *mauka* of the H-1 Freeway. The proposed 440 water tank is located adjacent to yet another BWS water tank in a former pineapple field, which was fallow at the time of this survey. The proposed water transmission line will be located parallel to the existing BWS transmission line which currently runs along the dirt road between the two existing tanks (Figure 1).

Figure 1 – New 440 Tank, Transmission Line and New 228 Tank Schematic

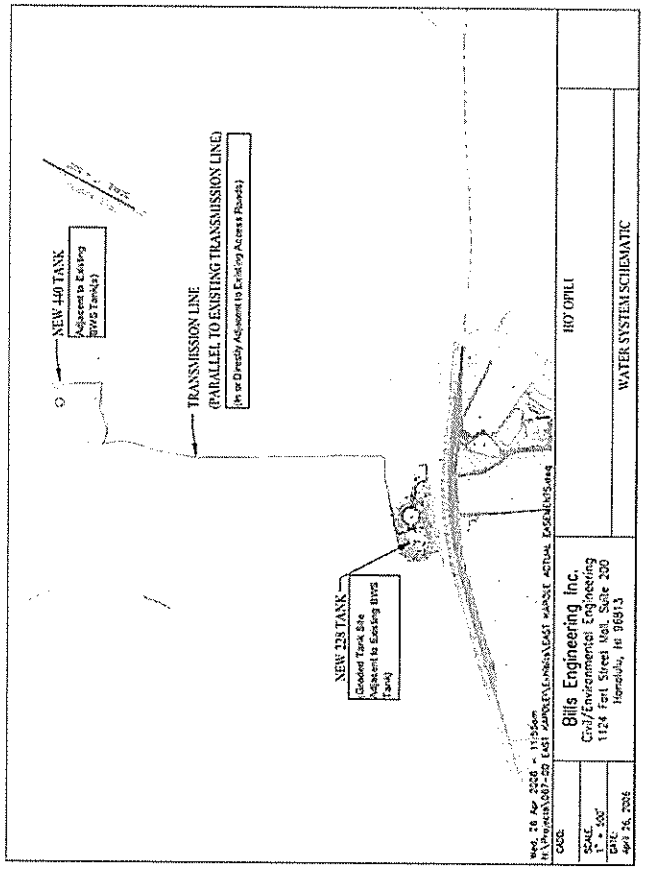

Figure 2
Habitat Present within Transmission Line and 440 Tank Sites

The terrain on the project site slopes from north-to-south, from an elevation of approximately 440-feet above mean sea level (MSL) at the northern terminus of the site, down to approximately 200-feet MSL along the H-1 Freeway (Figure 1).

As can clearly be seen in Figure 2 the habitat present within the general project site is made up of former sugar cane lands, some of which have in recent years been used to grow various diversified agricultural crops. The new 440 tank site is located on a relatively flat parcel of land formerly used to grow pineapple. The entire project site has been heavily disturbed by agricultural activities and the existing water supply infrastructure. The vegetation present on the project site is almost completely dominated by alien species. The botanical surveys conducted on the site identified 56-plant species, two of which are considered indigenous, the remainder alien to the Hawaiian Islands (LeGrande 2006).

Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of O'ahu are alien species, and most are ubiquitous. Two hours were spent within the project area on the evening of July 20, 2006 and again in the early morning hours of July 21, 2006, in an attempt to detect Hawaiian hoary bats. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed and heard within the study area.

Mammalian Survey Results

Three mammalian species were detected within the project site. Several small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations along the dirt road and close to the Hawaiian Electric Companies switching station located at the *mauka* end of the site. We also encountered tracks, scat and sign of dog (*Canis f. familiaris*), cat (*Felis catus*), and mongoose at several locations along the dirt road.

The endangered Hawaiian hoary bat was not recorded during the course of this survey. This finding is not surprising given that this species has rarely been documented from the Island of O'ahu (Tomich 1986, USFWS 1998).

Avian Survey Methods

Seven avian count stations were sited along a linear transect running the length of the dirt road and extending east from the *mauka* water tank site. Stations were sighted approximately 900-feet apart. Six-minute point counts were made at each of the seven-count stations. Field observations were made using Leitz 10 X 42 binoculars and by listening for avian vocalizations. Counts took place between 06:30 a.m. and 11:00 a.m., the peak of daily bird activity. An additional two hours was spent within the project area on the evening of July 20, 2006 and again in the early morning hours of July 21, 2006, in an attempt to detect crepuscular and/or nocturnally flying seabirds and

owls. Time not spent conducting station counts was used to search the subject property for species and habitats not detected during count sessions.

Avian Survey Results

A total of 152 individual birds, of 13 different avian species, representing 11-separate families were recorded during station counts. These results are summarized in Table 1. One of the species recorded, Pacific Golden-Plover (*Pluvialis fulva*), is an indigenous migratory shorebird species. Pacific Golden-Plover breed in the high Arctic, and spend their winters in Hawai'i and the tropical Pacific. The remaining 12 species detected during the course of this survey are considered to be alien to the Hawaiian Islands (Table 1).

Avian diversity and densities were relatively low, not surprising given the depauperate state of the habitat found on most of the site. Three species, Common Waxbill (*Estrilda astrild*), Zebra Dove (*Geopelia striata*), and Japanese White-eye (*Zosteropus japonicus*) accounted for slightly less than 41% of the total number of individual birds recorded. Common Waxbills were the most frequently recorded species, accounting for more than 15% of the total number of individual birds recorded during station counts. We recorded an average of 22 birds per station count.

Discussion

Mammalian Resources

The findings of the mammalian survey are consistent with the findings of at least two other recent surveys conducted on lands immediately adjacent to the subject property (David 2005a, 2007a), as well as with several others faunal surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Although we did not record any of the four muridae species currently considered to be established on O'ahu, it is likely that, European house mouse (*Mus musculus domesticus*) Hawai'i, roof rat (*Rattus r. rattus*), Norway rat (*Rattus norvegicus*), and possibly Polynesian rats (*Rattus exulans hawaiiensis*) use resources present within the project site. These commensal species are all but ubiquitous on the island of O'ahu. All of these introduced rodents are deleterious to remaining native ecosystems and the native floral and faunal species that are dependant on them for their survival.

Avian Resources

The findings of the avian survey are consistent with the findings of at least two other recent avian surveys conducted on lands immediately adjacent to the subject property (David 2005a, 2007a), as well as with several others avian surveys conducted in the general vicinity of the subject property in the recent past (David 2000, 2001, 2005b, 2008a, 2008b, David and Guinther 2000, 2005, 2006, 2007).

Table 1. Avian Species Detected Ho'opili Project; Offsite Reservoirs and Waterline Routes

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.86
	CICONIIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	0.57
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.43
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	1.71
Zebra Dove	*Geopelia striata*	A	2.86
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	2.14
	ZOSTEROPIDAE - White-Eyes		
Japanese White-eye	*Zosterops japonicus*	A	2.71
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	2.29
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	1.00
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.57
	FRINGILLIDAE - Fringilline And Cardueline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	2.43
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
Common Waxbill	*Estrilda astrild*	A	3.29
Red Avadavat	*Amandava amandava*	A	0.86

KEY TO TABLE 1

ST Status
A Alien – introduced to the Hawaiian Islands by humans
IM Indigenous Migrant – a native migratory species that winters in Hawai'i but breeds elsewhere
RA Relative Abundance – number of birds detected divided by the number of count stations (7)

Only one of the 13-avian species recorded during the course of this survey, Pacific Golden-Plover, is a native species. Pacific Golden-Plover are an indigenous migratory shorebird species that breed in the high Arctic and spends the winter months in Hawai'i and the tropical Pacific. This species is readily seen throughout the Hawaiian Islands between late July and the end of April each year. The remaining 12-species detected during the course of this survey are considered to be alien to the Hawaiian Islands (Table 1).

Although not detected during this survey, it is likely that the Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*), or *pueo* use resources within the general project area occasionally. This species is regularly seen along the Wai'anae coast from the Lualualei Naval Reservation to Waimānalo Gulch (David 2005c). The O'ahu population of the short-eared Owl is listed as an endangered species under the State of Hawai'i's endangered species program, although it is not protected under the federal endangered species statutes (DLNR 1998).

From an avian and native mammalian perspective there is nothing unique about the project area or within the reservoir site, and none of the habitat present within the study area is important habitat for any listed avian or mammalian species currently known from the Island of O'ahu.

Conclusions

It is not expected that the modification of the project area will have a deleterious impact on any avian or mammalian species currently listed as endangered, threatened, or any that are currently proposed for listing under either Federal or State of Hawai'i endangered species statutes.

Glossary

Alien - Introduced to Hawai'i by humans
BWS – Board of Water Supply
Commensal - Animals that share human's food such as rats and mice
Crepuscular – Twilight hours
Endangered – Listed and protected under the ESA as an endangered species
Endemic – Native and unique to the Hawaiian Islands
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally
makai – Down-slope, towards the ocean
mauka – Upslope, towards the mountains
Muridae - Rodents, including rats, mice and voles, one of the most diverse families of mammals.
Nocturnal – Night-time, after dark
'ōpe'ape'a – Hawaiian hoary bat (*Lasiurus cinereus semotus*)
pueo – Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*)
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species

BWS – Honolulu Board of Water Supply
ESA – Endangered Species Act of 1973, as amended
DLNR – Hawaii State Department of Land & Natural resources
TMK – Tax Map Key
USFWS – U.S. Fish & Wildlife Service

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APPENDIX D

Archaeological Inventory Survey

An Archaeological Inventory Survey for the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu TMK: (1) 9-1-010:002, 9-1-017:004, 059, 072; 9-1-018:001, 004; 9-2-001:001

Prepared for

D. R. Horton – Schuler Division

Prepared by

Constance O'Hare, B.A.,

D.W. Shideler, M.A.,

and

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai'i, Inc.

Kailua, Hawai'i

(Job Code: HONO 75)

February 2006

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Management Summary

Reference	An Archaeological Inventory Survey For the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu, TMK: (1) 9-1-010:001, 9-1-017:004, 059, 072; 9-1-018:001, 004, 9-2-001:001, by Constance R. O'Hare, David W. Shideler, and Dr. Hallett H. Hammatt
Date	February 2006
Project Number (s)	CSH Job Code: HONO 75
Investigation Permit Number	CSH completed the inventory survey fieldwork under state archaeological permit No. 0508 issued by the State Historic Preservation Division, per Hawai'i Administrative Rules (HAR) Chapter 13-13-282.
Project Location	The main project area comprises TMK:(1) 9-1-017:004, 059, 072; 9-1-018:001, 004. The main project area is generally bound on the north by the H-1 Interstate (I H-1), on the south by Mango Tree Road (a dirt road along the Ewa Villages Golf Course), Pelehua Drive on the west, and Old Fort Weaver Road on the east. There are two non-contiguous parcels, one on the east side of new Fort Weaver Road (TMK 9-1-010:002, and one north of the H-1 Interstate around a reservoir (TMK 9-2-001:001).
Land Jurisdiction	The James Campbell Estate, owner
Agencies	State Historic Preservation Division / Department of Land and Natural Resources (SHPD/DLNR)
Project Description	The landowner plans to develop the area into a mixed residential, commercial, and recreational property.
Project Acreage	2625 acres
Area of Potential Effect (APE)	For the purposes of this study the area of potential effect (APE) and the project area are considered one and the same.
Historic Preservation Regulatory Context	The client, D.R. Horton-Schuler Division proposed development of James Campbell Estate East Kapolei lands constitutes a project requiring compliance with and review under State of Hawai'i historic preservation review legislation (Hawai'i Revised Statutes (HRS) Chapter 6E-42 and Hawai'i Administrative Rules (HAR) 13-284). At the request of D.R. Horton-Schuler Division, CSH completed an archaeological inventory survey investigation, per the requirements of HAR Chapter 13-13-276, of the subject 2625-acre parcel. This archaeological inventory survey report was prepared to support the proposed property's historic preservation review and any other project-related historic preservation consultation
Fieldwork Effort	Constance R. O'Hare, B.A., Owen O'Leary, M.A., Guadalupe Ochoa, B.A., Brad Garrett, M.A., and Jon Tulchin, B.A., under the general direction of Hallett H. Hammatt, Ph.D. conducted surface survey and subsurface testing in the project area. Field work was conducted on November 21, 22, 28, on December 8 and 9, 2005, and January 13, 2006..
Number of Historic Properties Identified	Five sites had been previously identified in a 1990 CSH survey (Hammatt and Shideler 1990). One of these sites (50-80-12-4344) was used to denote Ewa Sugar Plantation scattered infrastructure features. Three features (Features A-C) were recorded for this site during the 1990 survey. During the recent 2005 surface survey, four additional sugar plantation features were recorded. These will be considered additional features (Features D-F) of Site -4344.

Historic Properties Recommended Eligible to the Hawai'i Register of Historic Places (Hawai'i Register)	Sites 50-80-12-4344 (plantation infrastructure), -4345 (railroad berm), -4346 (northern pumping station), -4347 (central pumping station), and -4348 (southern pumping station) have been previously determined during a 1990 survey to be significant under Criteria C and D. Sites -4345 through- 4348 were also recommended for preservation. No further work or preservation was recommended for -4344. All five sites were revisited during the recent 2005 survey; four additional features were added to Site –4344, however, the original three features (Features A-C) have been destroyed since 1990. The significance and recommendations of these five sites remains the same.
Historic Properties Recommended Ineligible to the Hawai'i Register	Four areas of historic habitation (Honouliuli Taro Lands, Kapalani Catholic Church, PipeLine Village, and Drivers/Stable Village) were identified during the 1990 survey of a portion of the project area. No site designations were given, since there were no surface remains found during the survey. During the recent 2005 backhoe testing for the current project, no subsurface remains for these four habitation loci were found in the project area. No site designations are needed.
Mitigation Recommendation	Although no subsurface remains for four habitation loci were found during the recent backhoe testing of the four areas, it is recommended that a program of on-site/on-call monitoring be conducted during any future development of these four specific areas.

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Section 1 Introduction

1.1 Project Background

At the request of D.R. Horton-Schuler Division (828 Fort Street Mall, 4th Floor, Honolulu, HI 96813), Cultural Surveys Hawai'i, Inc. (CSH) has completed this Inventory Survey Report for the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island ([1] 9-1-010:002; 9-1-017:004, 059, 072; 9-1-018:001, 004; 9-2-001:001) (Figures 1 and 2). The main project area is generally bound on the north by the H-1 Interstate (I H-1), on the south by Mango Tree Road (a dirt road along the Ewa Villages Golf Course), Pelehua Drive on the west, and Old Fort Weaver Road on the east. There are two non-contiguous sections, a parcel on the east side of West Loch Estates and a parcel north of the H-1 Interstate, surrounding a reservoir. In all, the project area is approximately 2625 acres. The landowner, the James Campbell estate, plan to develop this area into a mixed residential, commercial, and recreational property (Figure 3).

CSH previously worked on the eastern 546-acres of these lands back in 1990 in association with what was then known as the West Loch Bluffs project (Hammatt and Shideler 1990). In the course of this study, we were able to determine that the eastern lands of the present project area contain more historic resources than one might guess, including such features as:

- A northern pumping station;
- a central pumping station complex;
- a southern pumping station;
- the former site of PipeLine Village;
- the former site of Drivers and Stable Villages;
- the former site of Hawaiian Land Commission Awards and former Hawaiian Homesteads;
- the former site of the Honouliuli "Kapalani" Roman Catholic Church;
- a well preserved portion of the Ewa Plantation Company railroad berm; and,
- the site of the first artesian well in Hawai'i.

Based on the presence of these sites and presumably others, CSH recommended an inventory survey that includes both surface and subsurface investigation. Based on the known data, subsurface testing with a backhoe is needed during the inventory survey. Backhoe testing will focus on locating and evaluating subsurface deposits, such as buried cultural layers, artifacts, and possibly burials that could not be located by surface pedestrian inspection. Backhoe testing will be conducted in four areas, at the site of the nineteenth century Kapalani Church, the area of Hawaiian Land Commission Awards, the location of Drivers/Stable Village, and the location of PipeLine Village, with its associated church.

The archaeological inventory survey and its accompanying report will document all historic properties within the subject parcel. The prepared inventory survey will be in compliance with state standards and will be submitted for review and approval to the State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR).

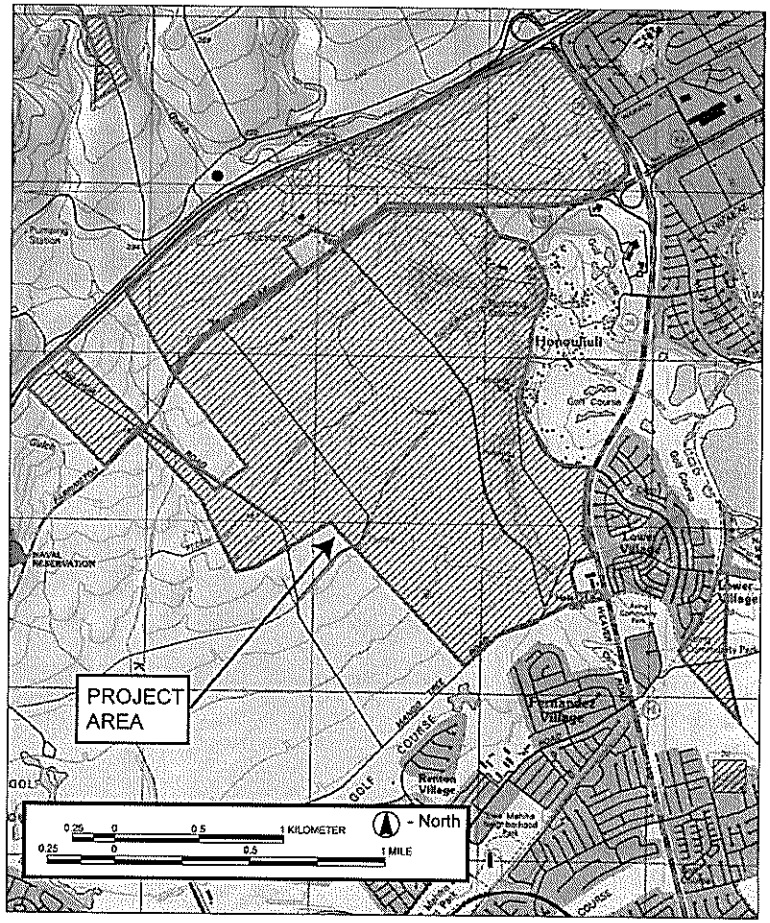
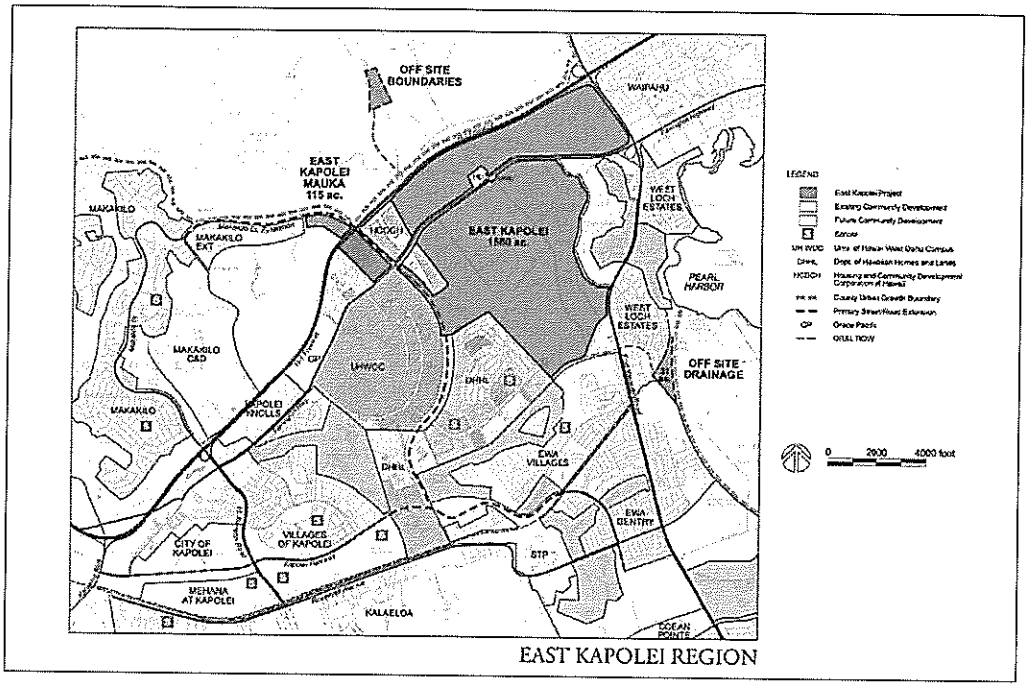


Figure 1. US Geological Survey map (1998), Waipahu and Ewa quadrangles, showing project area (hatched area)



EAST KAPOLEI REGION

Figure 3. Planned Development for the East Kapolei Region

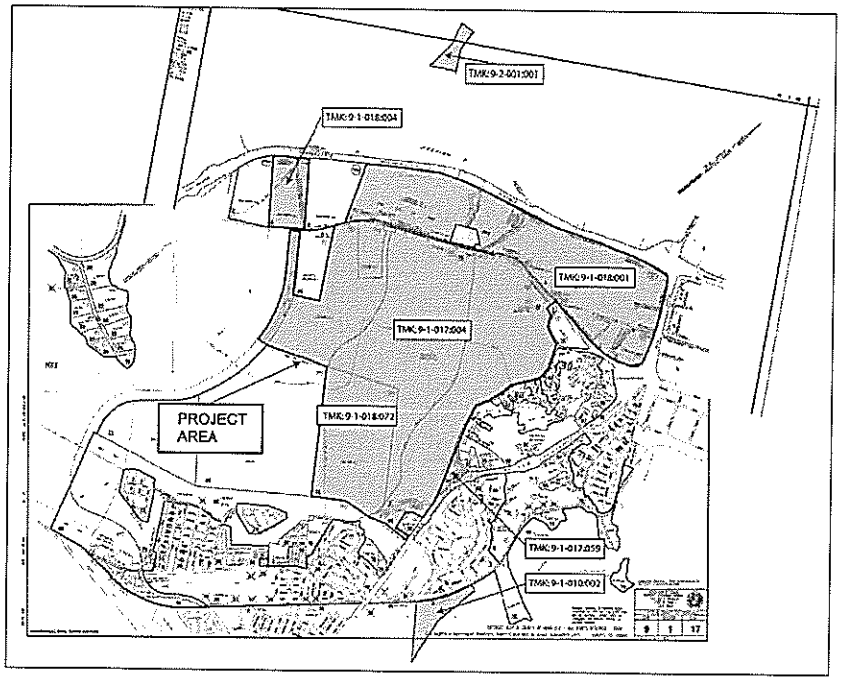


Figure 2. Tax Maps 9-1-010, 9-1-017, 9-1-018, and 9-2-001, showing project area (shaded red)

1.2 Scope of Work

The following archaeological inventory survey scope of work will satisfy the State and County requirements:

1. State rules have recently been established which require consultation with community members as part of the inventory survey process. This consultation requires contacting knowledgeable members of the community and requesting information on historic and cultural issues related to the property.
2. A complete ground survey of the entire project area for the purpose of site inventory. All sites would be located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation will include photographs and scale drawings of selected sites and complexes. All sites will be assigned State site numbers.
3. Subsurface testing to determine if subsurface deposits are located in the project area, and, if so, evaluate their significance. If appropriate samples from these excavations are found, they will be analyzed for chronological and paleoenvironmental information.
4. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research will focus on the specific area with general background on the *ahupua'a* and district and will emphasize settlement patterns.
5. Preparation of a survey report which will include the following:
    a. A topographic map of the survey area showing all archaeological sites and site areas;
    b. Results of consultation with knowledgeable community members about the property and its historical and cultural issues.
    c. Description of all archaeological sites with selected photographs, scale drawings, and discussions of function;
    d. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the archaeological features;
    e. A summary of site categories and their significance in an archaeological and historic context;
    f. Recommendations based on all information generated that will specify what steps should be taken to mitigate impact of development on archaeological resources - such as data recovery (excavation) and preservation of specific areas. These recommendations will be developed in consultation with the client and the State agencies.

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

Part of the SHPD mandated scope of work for an archaeological inventory survey includes specific documentation of located historic properties. If cultural deposits are located, it is required that appropriate data are collected from them. This includes recording their geographic location on project area maps, general written descriptions, sampling, and section drawings, plan views, and photographs as appropriate. For traditional Hawaiian deposits, this can include analysis of recovered artifacts and midden. It often also includes radiocarbon dating of samples from cultural contexts. If historic-era deposits are located then analysis of associated historic artifacts is sometimes required.

1.3 Environmental Setting

1.3.1 Natural Environment

Honouliuli Ahupua'a is the largest traditional land unit on O'ahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupua'a at Pili o Kahe in the west. Honouliuli Ahupua'a includes approximately 19 km (kilometers), or 12 mi (miles) of open coastline from One'ula westward to Pili o Kahe. The *ahupua'a* extends *mauka* (inland) from West Loch nearly to Schofield Barracks in Wahiawā; the western boundary is the Wai'anae Mountain crest running north as far as Pu'u Hāpapa (or to the top of Ka'ala Mountain, according to some).

Topographically, the southern (south of Farrington Highway) project area is most notable for a scarp feature, typically 50 ft (15 m) high, which runs roughly north/south through the southeastern portion of the project area. This scarp is a Pleistocene fossil sea bluff. In the northern section, the land is generally flat, except along Honouliuli Gulch, which runs through the center of this project area section.

Lying in the lee of the Wai'anae mountain range, the project area is one of the driest areas of O'ahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). Temperatures range between 60° to 90° through the year; the highest temperatures are in August and September (Armstrong 1973). Elevation in the project area ranges from 40 ft (feet) AMSL (above mean sea level) to 240 ft, or 12 to 73 m (meters). The project area is located on the 'Ewa Plain, which is a Pleistocene (>38,000 years old) reef platform overlain by alluvium from the southern end of the Wai'anae Mountain Range. This alluvium supported commercial sugar cane cultivation for over a century. Honouliuli Stream extends (roughly northwest to southeast) through the center of the northern section (between I H-1 and Farrington Highway) of the main project area.

In pre-contact Hawai'i the project area would have been mostly lowland dry shrub and grassland, dominated by species such as *wiliwili* (*Erythrina sandwicensis*), *lama* (*Diospyros ferrea*), sandalwood (*Santalum* sp.), *'a'ali'i* (*Dodonea eriocarpa*), scrub *'ōhi'a* (*Metrosideros collina*) and *pili* grass (*Heteropogon contortus*). Today the non-cultivated portions of the project area are dominated by introduced species such as *kiawe* and *koa haole*. Understory plants include *'ilima ku kula* (*Sida cordifola*), cayenne vervain (*Stachytarpheta urticaefolia*), *ko'oko'olau* (*Bidens pilosa*), and morning glory (*Ipomoea indica*) (Moore and Kennedy 2002:3). The vast majority of the project area consists of plowed fields, with crops of pumpkins, squash, cucumbers, bananas, beans, and other vegetable products.

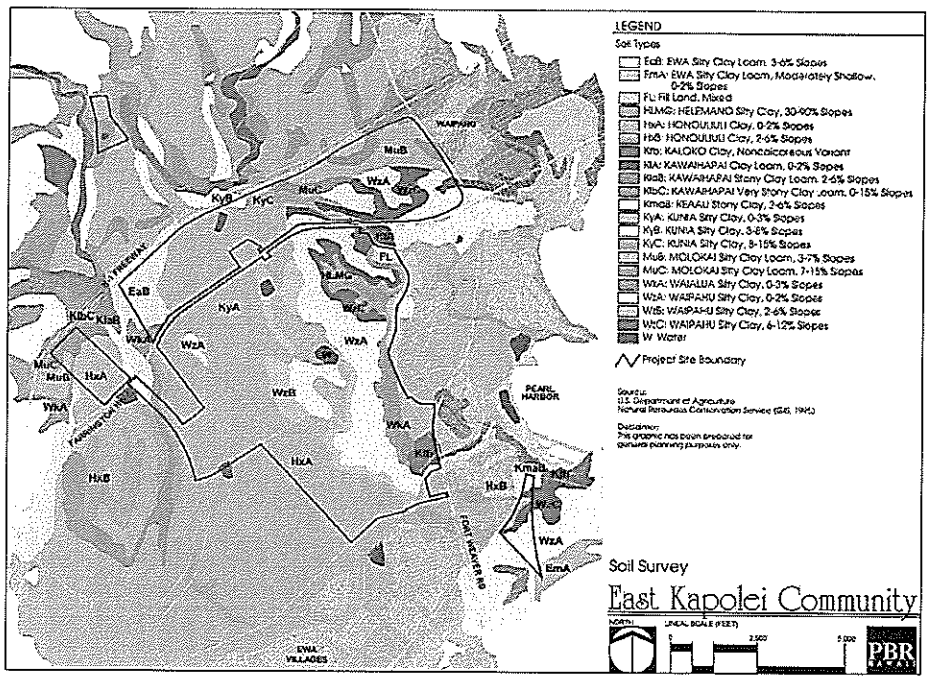


Figure 4. Soil Map of East Kapolei Community Project Area

A total of ten soil series are found in the project area (Figure 4). The Ewa Series consists of well-drained soils in basins and on alluvial fans, developed in alluvium derived from basic igneous rock. They are nearly level to moderately sloping. These soils are used for sugarcane, truck crops, and pasture. The Helemano series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches, which developed in alluvium and colluvium derived from basic igneous rock. They are steep to extremely steep. These soils are used for pasture, woodland, and wildlife habitat. The Honouliuli series consists of well-drained soils on coastal plains; the soils developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. These soils are used for sugarcane, truck crops, orchards, and pasture. The Kaloko Series consists of poorly drained soils on coastal plains. These soils developed in alluvium derived from basic igneous rock; the alluvium has been deposited over marly lagoon deposits. The soils are nearly level. These soils are used for irrigated sugarcane and pasture. The Kawaihapai Series consists of well-drained soils in drainageways and on alluvial fans on the coastal plains. The soils formed in alluvium derived from basic igneous rock in humid uplands. These soils are used for sugarcane, truck crops, and pasture. The Keaau Series consists of poorly drained soils on coastal plains, which developed in alluvium deposited over reef limestone or consolidated coral sand. They are nearly level and gently sloping. These soils are used for sugarcane and pasture. The Kunia Series consists of well-drained soils on upland terraces and fans; the soils developed in old alluvium. They are nearly level to moderately sloping. These soils are used for sugarcane, pineapple, homesites, and military reservations. The Molokai Series consists of well-drained soils on uplands, formed in material weathered from basic igneous rock. They are nearly level to moderately steep. These soils are used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. The Waialua Series consists of moderately well drained soils on alluvial fans; these soils developed in alluvium weathered from basic igneous rock. They are nearly level to steep. These soils are used for sugarcane, truck crops, orchards, and pasture (Foote et al. 1972).

Four sections of the project area were selected for backhoe testing. Honouliuli clay, 0 to 2 percent slopes (HxA) is found adjacent to Old Fort Weaver Road where seven trenches were placed to test for the remains of a nineteenth century Catholic Church (Kapalani Church) and where one trench was placed to test for the remains of a early twentieth century plantation village (Drivers/Stable Village). This soil occurs in the lowlands along the coastal plains. Waialua silty clay, 0 to 3 percent slopes (WkA) is found adjacent (and west) of the HxA soils in the Kapalani Church testing area. This soil is found on smooth coastal plains. Waipahu silty clay, 0 to 2 percent slopes (WzA) is the dominant soil on the top of the scarp. Two areas selected for backhoe testing, the remains of PipeLine Village, and the Honouliuli Taro Lands, had this soil type. This soil is nearly level and occurs on dissected terraces near the ocean. Waipahu silty clay, 2 to 6 percent slopes (WzB) also occurred in the Honouliuli Taro Lands backhoe testing area.

1.3.2 Built Environment

In the post-contact period the project area has been mainly used as pastureland and for sugar cane irrigation and cultivation. Recently (since the 1990 survey of the project) the area has been used for produce farming.

Section 2 Methods

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division, and a review of geology and cultural history documents at Hamilton Library at the University of Hawai'i, the Hawai'i State Archives, the Hawai'i Public Library, and the Archives of the Bishop Museum. Further research included a study of historic photographs at the Archives of the Bishop Museum and a study of historic maps at the Survey Office of the Department of Accounting and General Services. Information on LCAs was accessed through Waihona 'Āina Corporation's Māhele Data Base (www.waihona.com).

2.1 Field Methods

The pedestrian inspection of the main project area was conducted on November 21 and 22, 2005 with four Cultural Surveys Hawai'i staff archaeologists, Constance R. O'Hare, B.A., Owen O'Leary, M.A., Guadalupe Ochoa, B.A., and Brad Garrett, M.A., under the general direction of Hallett H. Hammatt, Ph.D. On January 13, 2006, the two small non-contiguous parcels of the project were surveyed (Figures 5 and 6). At least 75% of the project area has been denuded of all natural vegetation and has been recently plowed and planted with pumpkins, squash, and other vegetables (Figure 7). There are a few areas marked off for other crops, such as bananas and beans. All areas outside plowed fields were surveyed on foot. In the northern section of the project area (north of Farrington Highway) the northwest corner and a larger area to the east of Honouliuli Gulch was surveyed by pedestrian sweeps. Honouliuli Gulch was surveyed by a team of three archaeologists, one sweep moving downstream on one bank and a second sweep moving upstream on the opposite bank (Figure 8). In the southern section, the non-plowed areas surrounding the underground pipelines were surveyed. Sites previously identified during the 1990 CSH survey (Hammatt and Shideler 1990) of the eastern 546-acre parcel were revisited and additional notes were taken on their construction and their current condition.

All significant historic properties encountered were recorded and documented with a brief written field description, a sketch map, and photographs. Each site was also located using GPS survey technology. In total, in addition to the five previously identified sites found during the CSH 1990 survey (Hammatt and Shideler 1990; see Introduction section), four new features, all found along Honouliuli Gulch, were recorded. All features were initially given CSH temporary numbers (CSH 1-4), and were later given feature designations as part of a previously designated site, 50-80-12-4344, a site number used for sugar cane plantation infrastructure features.

Sub-surface testing was conducted in four specific portions of the project area; areas that could potentially contain buried cultural layers or artifacts. This testing was conducted on November 28, and December 8 and 9, 2005 by CSH archaeologists Constance R. O'Hare, B.A., Owen O'Leary, M.A., Guadalupe Ochoa, B.A., Brad Garrett, M.A., and Jon Tulchin, B.A., under the general direction of Hallett H. Hammatt, Ph.D. Subsurface testing consisted of the excavation of 19 backhoe trenches. These trenches were excavated to a total depth of 2.0-3.0 m. A 70 cm (centimeter) wide bucket was used on the backhoe, and one-bucket width trenches were dug. All excavations were closely monitored by CSH personnel. Trenches were placed to test for subsurface deposits in four specific former habitation loci, as well as to provide adequate coverage of these four areas.

Figure 5. Non-contiguous parcel east of Fort Weaver Road (TMK 9-1-001:002), showing koa haole on western half and low grass on eastern half

Figure 6. Non-contiguous parcel north of the H-1 interstate, showing bulldozed reservoir area

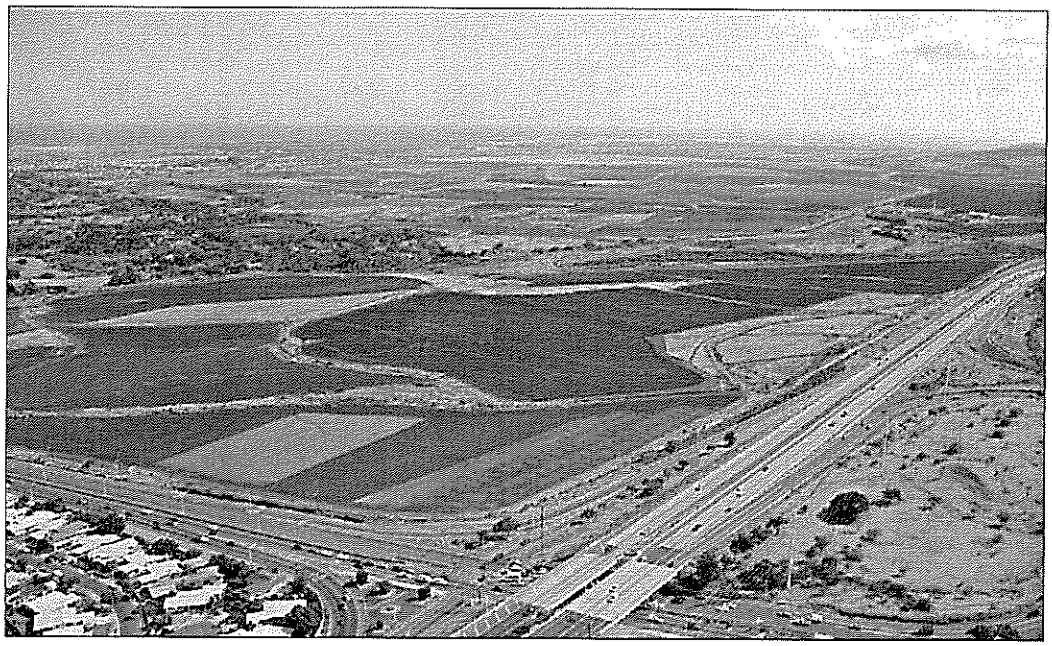


Figure 8. Aerial photograph of northern section of the project area taken near the intersection of H-1 Interstate and Fort Weaver Road; plowed fields in foreground, Honouliuli Gulch in background (shown by the alignment of trees)

Figure 7. 2000 Aerial photograph of main project area (TMK 9-1-017, 9-1-018), showing plowed fields

The stratigraphy of one profile wall was drawn and photographed; sediments were described for each of the 19 trenches. Sediment descriptions include Munsell color, texture, consistence, structure, plasticity, cementation, origin of sediments, descriptions of inclusions, lower boundary distinctiveness and topography, and other general observations. Fieldwork was conducted under state archaeological fieldwork permit No. 0508 issued by SHPD, per Hawai'i Administrative Rules (HAR) Chapter 13-13-282. The field effort, the surface pedestrian survey (2 days with a crew of 3-4 people), and the subsurface testing with a backhoe required 23 person-days to complete.

2.2 Laboratory Methods

Because no archaeological artifacts were discovered, no laboratory work was undertaken.

2.3 Consultation

As partial fulfillment for the Scope of Work (SOW), consultation with organizations and the community are currently being conducted to identify *kūpuna* and other individuals with knowledge of the history of the project area and its surroundings. The results of these interviews will be presented in a companion report for this project, titled "Cultural Impact Assessment for the East Kapolei Project." The on-going consultation with organizations include the Office of Hawaiian Affairs, the O'ahu Island Burial Council, 'Ahahui Siwila Hawai'i O Kapolei Hawaiian Civic Club, 'Ewa Task Force, 'Ewa Neighborhood Board, Hawaii Plantation Village, and Immaculate Conception Church in 'Ewa. A table of informants that will be contacted is presented below:

Table 1.Contact List of Community Members and Organizations for a Cultural Impact Assessment

Name	Affiliation
Aila, William	Hui Malama
Alexander, Jeff	'Ewa Neighborhood Board Member
Bautista, Gary	'Ewa Neighborhood Board Member (Chair)
Cayan, Coochie	O'ahu Island Burial Council
Eaton, Arline	*Kūpuna* at Iroquois Elementary School
Hirata, Richard	President of Hawaii Plantation Village; he was raised at the 'Ewa Plantation
Kane, Shad	Makakilo, Kapolei, Honokai Hale Neighborhood Board Member
Malama, Tesha	Former 'Ewa Neighborhood Board member
Nāmu'o, Clyde	Administrator at Office of Hawaiian Affairs
Oshiro, Richard	Former 'Ewa Plantation employee
Paishon, Frank	Raised in Tenney Village
Ramos, Rodolfo	Chair of 'Ewa Task Force
Sato, Melvin	Raised in Ewa Plantation "C" Village
Serrao, Mary	President of Pu'uloa Outrigger Canoe Club
Soma, Millie	Raised in 'Ewa Plantation Tenney Village
Soma, Kenneth	Former 'Ewa Plantation Employee and resident
Quintal, Leti	Raised in 'Ewa Plantation Secretary for the Immaculate Conception Church

Section 3 Background Research

3.1 Mythological and Traditional Accounts

The traditions of Honouliuli Ahupua'a have been compiled by several authors, in studies by Sterling and Summers (1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), Maly (1992), and Tuggle and Tomonari-Tuggle (1997). Some of the traditional themes associated with this area include connections with Kahiki, the traditional homeland of Hawaiians in central Polynesia. There are several versions of the chief Kaha'i leaving from Kalaeloa for a trip to Kahiki; on his return to the Hawaiian Islands he brought back the first breadfruit (Kamakau 1991a:110) and planted it at Pu'uloa, near Pearl Harbor in 'Ewa (Beckwith 1940:97). Several stories associate places in Honouliuli to the gods Kāne and Kanaloa, with the Hawaiian pig god Kamapua'a and the Hina family, and with the sisters of Pele, the Hawaiian volcano goddess, all of who have strong connections with Kahiki (Kamakau 1991a:111; Pukui et al. 1974:200). The locations of traditional places names for Honouliuli are illustrated in Figure 9.

3.1.1 The Naming of 'Ewa and Honouliuli

Honouliuli is the largest *ahupua'a* in the *moku* (district) of 'Ewa. One translation of the name for this district is given as "unequal" (*Saturday Press* Aug. 11, 1883). Others translate the word as "strayed" and associate it with the legends of the gods, Kāne and Kanaloa.

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of the land they would throw a stone and where the stone fell would be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Waianae range and it landed somewhere, in the Waimanalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

Honouliuli means "dark water," "dark bay," or "blue harbor" and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua'a*. The Hawaiians called Pearl Harbor, Pu'uloa (*lit.* long hill). Another explanation for the names comes from the "Legend of Lepeamoa", the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa (Thrum 1923:164-184). "Her grandfather gave his name, Honouliuli to a land district west of Honolulu . . ." (Thrum 1923:170). Westervelt (1963:209) gives an almost identical account.

It seems likely the boundaries of the western-most *ahupua'a* of 'Ewa were often contested with Wai'anae people. The 'Ewa people could cite divine sanction that the dividing point was between two hills at Pili o Kahe:

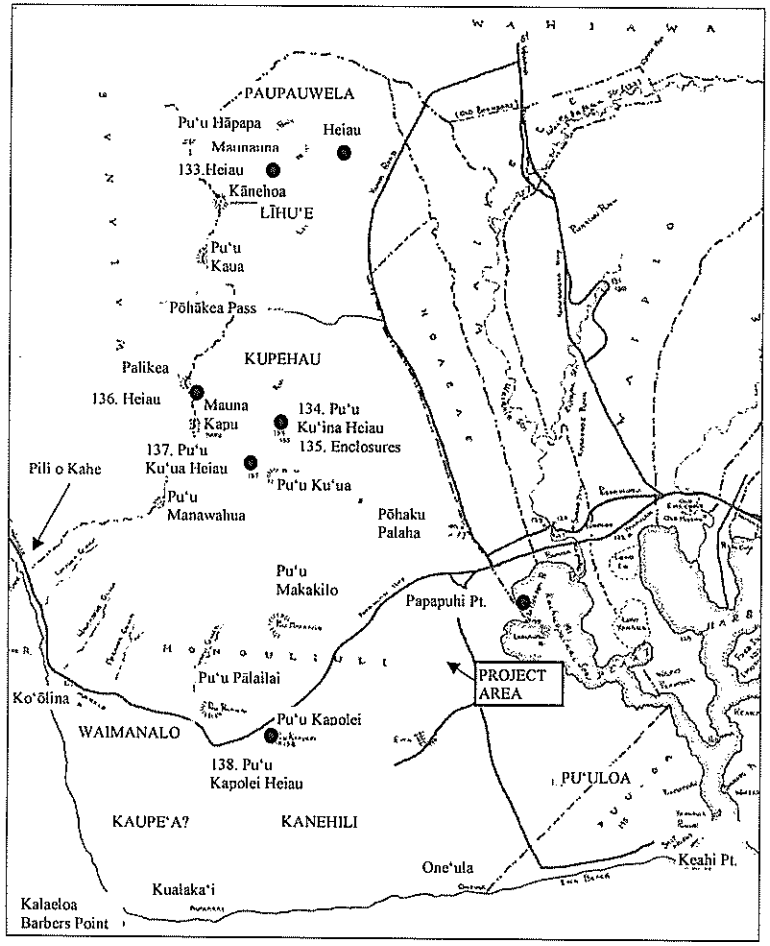


Figure 9. Place Names of Honouliuli (map adapted from Sterling and Summers 1978)

Eventually the stone was found at Pili o Kahe. This is a spot where two small hills of the Wai'anae Range come down parallel on the boundary between Honouliuli and Nānākuli ('Ewa and Wai'anae). The ancient Hawaiians said the hill on the 'Ewa side was the male and the hill on the Wai'anae side was female. The stone was found on the Waianae side hill and the place is known as Pili o Kahe.

> (Pili=cling to, Kahe=flow). The name refers, therefore, to the female or Waianae side hill. And that is where the boundary between the two districts runs [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

3.1.2 Pu'u o Kapolei and the Plains of Kaupa'e

Pu'uokapolei is a prominent hill at the *mauka* edge of the coastal 'Ewa Plains and was the primary landmark for travelers on the trail that ran from Pearl Harbor west to Wai'anae ('Ī'ī 1959:27, 29; Nakuina 1992:54; E.M. Nakuina 1904, in Sterling and Summers 1978:34).

3.1.2.1 Pu'u o Kapolei, Astronomical Marker and Heiau

Pu'u means hill and Kapolei means "beloved Kapo," a reference to the sister of the Hawaiian volcano goddess, Pele. Samuel Kamakau (1976:14) says that ancient Hawaiians used Pu'uokapolei as an astronomical marker to designate the seasons. Samuel Kamakau (1870 *Mo'olelo Hawai'i* Vol. I, Chap. 2, p. 23) relates:

> . . . the people of O'ahu reckoned from the time when the sun set over Pu'uokapolei until it set in the hollow of Mahinaona and called this period Kau [summer], and when it moved south again from Pu'uokapolei and it grew cold and the time came when young sprouts started, the season was called from their germination (*'ōilo*) the season of Ho'oilo [winter, rainy, season].

A *heiau* was once on Pu'uokapolei, but had been destroyed by McAllister's (1933:108) survey of the island in the early 1930s. The hill was used as a point of solar reference or as a place for such observations (Fornander 1919, Vol. VI, Part 2:292). Pu'uokapolei may have been regarded as the gate of the setting sun, just as the eastern gate of Kumukahi in Puna is regarded as the rising sun; both places are associated with the Hawaiian goddess Kapo (Emerson 1915:41). This somewhat contradicts some Hawaiian cosmologies, in which Kū was the god of the rising sun, and Hina, the mother of Kamapua'a was associated with the setting sun. Fornander (Fornander 1919, Vol. VI, Part 2:292) states that Pu'uokapolei may have been a jumping off place (also connected with the setting sun) and associated with the wandering souls who roamed the plains of Kaupe'a and Kāne-hili, *makai* of the hill.

3.1.2.2 Pu'u o Kapolei and the Plains of Kaupe'a and Kāne-hili

Hi'iaka sang this bitter chant addressed to Lohiau and Wahine-oma'o, which uses the association of the Plains of Kaupe'a as a place for the wandering of lost souls:

> *Ku'u aikana i ke awa lau o Pu'uloa,*
> *Mai ke kula o Pe'e-kaua, ke noho oe,*
> *E noho kaua e kui, e lei i ka pua o ke kauno'a,*

I ka pua o ke akuli-kuli, o ka wili-wili;
O ka iho 'na o Kau-pe 'e i Kane-hili,
Ua hili au; akahi no ka hili o ka la pomaika 'i;
E Lohiau ipo, e Wahine-oma 'o,
Hoe 'a mai ka wa 'a i a 'e aku au.

We meet at Ewa's leaf-shaped lagoon, friends;
Let us sit, if you will on this lea
And bedeck us with wreaths of Kauno'a,
Of akuli-kuli and wili-wili,
My soul went astray in this solitude;
It lost the track for once, in spite of luck,
As I came down the road to Kau-pe'a.
No nightmare dream was that which tricked my soul.
This way, dear friends; turn the canoe this way;
Paddle hither and let me embark
[Emerson 1915:162-163].

Several other Honouliuli places are mentioned in this chant, including Pe'e-kaua, which may be a variation of Kau-pe'e or Kaupe'a, and the plains of Kānehili, the last of which again refers to wandering, as the word *hili* means "to go astray" (Emerson 1915:162). In the chant, Hi'iaka is moving downhill from Kaupe'a, probably the plains adjacent to Pu'uokapolei, toward the coast, the plain of Kānehili.

3.1.2.3 The plains of Kaupe'a and Pu'u Kapolei and the Realm of Homeless Souls

There are several places on the 'Ewa coastal plain that are associated with *ao kuewa*, the realm of the homeless souls. Samuel Kamakau (1991b:47-49) explains the Hawaiian beliefs in the afterlife:

> . . . There were three realms (*ao*) for the spirits of the dead. . . There were, first, the realm of the homeless souls, the *ao kuewa*; second, the realm of the ancestral spirits, the *ao 'aumakua*; and third, the ream of Milu, *ke ao o Milu* . . .
>
> The *ao kuewa*, the realm of homeless souls, was also called the *ao 'auwana*, the realm of wandering souls. When a man who had no rightful place in the *'aumakua* realm (*kanaka kuleana 'ole*) died, his soul would wander about and stray amongst the underbrush on the plain of Kama'oma'o on Maui, or in the *wiliwili* grove of Kaupe'a on Oahu. If his soul came to Leilono [in Haława, 'Ewa near Red Hill], there he would find the breadfruit tree of Leiwalo, *ka 'ulu o Leiwalo*. If it was not found by an *'aumakua* soul who knew it (*i ma'a mau iaia*), or one who would help it, the soul would leap upon the decayed branch of the breadfruit tree and fall down into endless night, *the pō pau 'olo o Milu*. Or, a soul that had no rightful place in the *'aumakua* realm, or who had no relative or friend (*makamaka*) there who would watch out for it and welcome it, would slip over the flat lands like a wind, until it came to a leaping place of souls, a *leina a ka 'uhane*. . . . [Kamakau 1991b:47].
>
> On the plain of Kaupe'a beside Pu'uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by 'aumakua souls, and be helped to escape. . . . [Kamakau 1991b:49].

The breadfruit tree Leilono was said to have been located on the 'Ewa-Kona border, above Āliamanu. In another section of his account of the dead, Kamakau calls the plain of wandering souls the "plain at Pu'uokapolei."

> There are many who have died and have returned to say that they had no claim to an 'aumakua [realm] (*kuleana 'ole*). These are the souls, it is said, who only wander upon the plain of Kama'oma'o on Maui or on the plain at Pu'uokapolei on Oahu. Spiders and moths are their food [Kamakau 1991b:29].

This association of Pu'u Kapolei and Kānehili with wandering souls is also illustrated in a lament on the death of Kahahana, the paramount chief of O'ahu, who was killed by his father, Kahekili, after Kahahana became treacherous and killed the high priest Kaopulupulu.

Go carefully lest you fall dead in the sun,	*E newa ai o hea make i ka la,*
The god that dwells on Kapolei hill.	*Akua noho la i Puuokapolei.*
The sun is wailing on account of the women of Kamao,	*E hanehane mai ana ka la i na wahine o Kamao,*
A hiding god, blossoming ohai of the banks,	*Akua pee, pua ohai o ke kaha,*
Contented among the stones-	*I walea wale i ke a-*
Among the breadfruit planted by Kahai.	*I ka ulu kanu a Kahai.*
Thou wast spoken of by the oo-	*Haina oe e ka oo-*
By the bird of Kanehili.	*E ka manu o Kanehili.*

[Fornander 1919, Vol. VI, Part 2:297]

Fornander provides some notes on this lament. The god dwelling at Kapolei is the god Kahahana, stating that this is where his soul has gone. Kamao is one of the names of the door to the underworld. This lament draws an association with wandering souls and the place where the first breadfruit tree was planted by Kahai at Pu'uloa (Fornander 1919, Vol. VI, Part 2:304).

Pukui (1983:180) offers this Hawaiian saying, which places the wandering souls in a *wiliwili* grove at Kaupe'a.

The wiliwili grove of Kaupe'a Ka wiliwili of Kaupe'a.
In 'Ewa, O'ahu. Said to be where homeless ghosts wander among the trees.
[Pukui 1983:#1666].

Beckwith (1940:154) has stressed that "the worst fate that could befall a soul was to be abandoned by its *'aumakua* and left to stray, a wandering spirit (*kuewa*) in some barren and desolate place." These wandering spirits were often malicious, so the places that they wandered were avoided.

3.1.2.4 The Plain of Pukaua

The Hawaiian language newspaper *Ka Loea Kālai'āina*, (January 13, 1900) relates that near Pu'uokapolei, on the plain of Pukaua, on the *mauka* side of the road, there was a large rock. This legend suggests that the plain around Pu'u o Kapolei was called Pukaua. The legend is as follows:

> If a traveler should go by the government road to Waianae, after leaving the village of gold, Honouliuli, he will first come to the plain of Puu-ainako and when that is passed, Ke-one-ae. Then there is a straight climb up to Puu-o-Kapolei and there look seaward from the government road to a small hill, That is Puu-Kapolei. . . . You go down some small inclines, then to a plain. This plain is Pukaua and on the mauka side of the road, you will see a large rock standing on the plain. . . . There were two supernatural old women or rather peculiar women with strange powers and Puukaua belonged to them. While they were down fishing at Kuaiaka'i [near Barbers Point] in the evening, they caught these things, *'a'ama* crabs, *pipipi* shellfish, and whatever they could get with their hands. As they were returning to the plain from the shore and thinking of getting home while it was yet dark, they failed for they met a one-eyed person [bad omen]. It became light as they came near to the plain, so that passing people were distinguishable. They were still below the road and became frightened lest they be seen by men. They began to run - running, leaping, falling, sprawling, rising up and running on, without a thought of the *'a'ama* crabs and seaweeds that dropped on the way, so long as they would reach the upper side of the road. They did not go far for by then it was broad daylight. One woman said to the other, "Let us hide lest people see us," and so they hid. Their bodies turned into stone and that is one of the famous things on this plain to this day, the stone body. This is the end of these strange women. When one visits the plain, it will do no harm to glance on the upper side of the road and see them standing on the plain [*Ka Loea Kālai'āina*, January 13, 1900, translation in Sterling and Summers 1978:39].

In another version of this story, the two women met Hi'iaka as she journeyed toward the 'Ewa coast. The women were *mo'o* (supernatural beings) and were afraid that Hi'iaka would kill them, so they changed into their lizard form. One of the lizards hid in a little space on a stone beside the coastal trail, and the other hid nearby (*Ka Hōkū o Hawai'i*, February 15, 1927, translated in Maly 1997:19). From that time on the stone was known as *pe'e-kāua*, meaning "we two hidden." Hi'iaka greeted the two women but did not harm them, and passed on.

When she reached Pu'u o Kapolei, she also greeted two old women who lived at a *'ohai* grove on the hill. These women were named Pu'uokapolei and Nāwaineokama'oma'o (*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:19). As she continued her travels, she looked to the ocean and saw the canoe carrying Lohi'au.

My man on the many harbored sea of Pu'uloa	*Ku'u kāne i ke awa lau o Pu'uloa*
As seen from the plain of Pe'ekāua	*Mai ke kula o Pe'ekāua ke noho*
Let us dwell upon the 'ōhai covered shore	*E noho kāua i ke kaha o ka 'ōhai*

Where the noni blossoms are twisted together	*I ka wiliwili i ka pua o ka lau noni*
Descending along Kānehili	*O ka ihona i Kānehili la*
I am winding along	*Ua hili ho'i au-e*

[*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:20].

3.1.2.5 Pu'u Kapolei and Kamapua'a

Pu'uokapolei's was the home of Kamapua'a's grandmother, Kamaunuaniho, who was one of the three migrants from Kahiki that were ancestors to the people of O'ahu (Fornander 1919, Vol. V, Part 2:318; Kahiolo 1978:81, 107). Kamapua'a, the Hawaiian pig god, once lived in Kaluanui on the windward side, but escaped to 'Ewa when he was pursued by the chief Olopana.

> Kamapua'a subsequently conquered most of the island of O'ahu, and, installing his grandmother [Kamaunuaniho] as queen, took her to Pu'uokapolei, the lesser of the two hillocks forming the southeastern spur of the Wai'anae Mountain Range, and made her establish her court there. This was to compel the people who were to pay tribute to bring all the necessities of life from a distance, to show his absolute power over all [Nakuina 1904:50-51].

Emma Nakuina goes on to note: "A very short time ago [prior to 1904] the foundations of Kamaunuaniho's house could still be seen at Pu'uokapolei." Another account (*Ka Loea Kālai'āina* January 13, 1900, from Sterling and Summers 1978:34) speaks of Kekeleaiku, the older brother of Kamapua'a, who also lived on Pu'uokapolei.

3.1.2.6 The Strife at Honouliuli; Kūali'i unites Hawai'i nei (Mo'olelo o Kūali'i)

The celebrated chief, Kūali'i, is said to have led an army of twelve thousand (*'ekolu mano*) against the chiefs of Ko'olauloa with an army of twelve hundred (*'ekolu lau*) upon the plains of Keahumoa (Fornander 1917 Vol. IV, Part 2:364-401). Perhaps because the odds were so skewed the battle was called off and the *ali'i* of Ko'olau ceded (*ha'awi a'e*) the districts of Ko'olauloa, Ko'olaupoko, Waialua and Wai'anae to Kūali'i. When the *ali'i* of Kaua'i heard of this victory at Honouliuli they gave Kaua'i to Kūali'i as well and thus he became possessed of all the islands (*a lilo a'e la nā moku a pau ia Kūali'i mai Hawai'i a Ni'ihau*). The strife at Honouliuli was the occasion of the recitation of a song for Kūali'i by a certain Kapa'ahulani (*Ka Pule Ana a Kapa'ahulani*). This *mele* compares the king to certain places and objects in the islands, in this instance to the first breadfruit planted by Kahai at Pu'uloa, and a pig and a woman on Pu'u Kapolei, possibly a reference to Kamapua'a and his grandmother.

Not like these art thou, Ku.	*Aole I like Ku.*
Not like the pig	*Aole I like i ka puaa,*
Discerning the progeny of the god;	*I ka weke lao a ke akua,*
[Or] The breadfruit planted by Kahai.	*Ka ulu kanu a Kahai;*
Truly, have you not known	*Oi ole ka oe i ike,*
The woman with the dyed garment,	*Ka wahine pau mao*
On the top of Puuokapolei?	*I ka luna o Puuokapolei-la?*

[Fornander 1917, Vol. IV, Part 2:392-393].

A later section of this *mele* also refers to Pu'u o Kapolei and makes mention of the famous blue poi of Honouliuli.

O Kawelo! Say, Kawelo!	*O Kawelo-e, e Kawelo-e,*
Kawelokiki, the sharp-pointed hill,	*O Kaweloiki puu oioi,*
Hill of Kapolei.	*Puu of Kapolei-e-*
Blue is the poi which appeases [the hunger] of Honouliuli.	*Uliuli ka poi e piha nei-o Honouliuli;*

[Fornander 1917, Vol. IV, Part 2:400-401].

3.1.3 Pearl Harbor (Pu'uloa) and West Loch (Kaihu o pala'ai)

3.1.3.1 The "Silent Fish" of Pearl Harbor

Pearl Harbor was called Pu'uloa or *ke-awa-lau-o-Pu'uloa*, the many harbored-sea of Pu'uloa (Pukui 1983:#1686) by the Hawaiians. An alternate name was Awawa-lei, or "garland (*lei*) of harbors" (Handy and Handy 1972:469). Pukui (1983:#1126] also uses the name *Awalua* for Pearl Harbor, as in the saying "*Huhui na 'ōpua i Awalau*, The clouds met at Pearl Harbor. Said of the mating of two people." Emerson (1915:167) interprets Awalau as "leaf-shaped lagoon."

John Clark (1977:70) says that its English name came from the name Waimomi, or "water of the pearl," an alternate name for the Pearl River (Pearl Harbor). The harbor was named Pearl Harbor after the pearl oysters of the family Pteriidae (mainly *Pinctada radiata*), which were once abundant on the harbor reefs, but were later decimated by over-harvesting. This oyster was supposedly brought from Kahiki, the Hawaiian ancestral lands, by a *mo'o* (lizard or water spirit) named Kane-kua'ana (Handy and Handy 1972:470).

Kanekua'ana was the *kia'i* (food guardian) for 'Ewa. When food was scarce, the descendants of Kanekua'ana built *waihau heiau* (a *heiau* for *mo'o*) for her and lit fires to plead for her blessings. For 'Ewa, the chief *i'a* (marine food) blessing was the famous *pipi*, or pearl oyster. Samuel Kamakau describes the *pipi* of Honouliuli.

> That was the oyster that came in from deep water to the mussel beds near shore, from the channel entrance of Pu'uloa to the rocks along the edges of the fishponds. They grew right on the *nahawele* mussels and thus was this *i'a* obtained. Not six months after the *hau* branches [that placed a *kapu* on these waters until the *pipi* should come up] were set up, the *pipi* were found in abundance-enough for all 'Ewa-and fat with flesh. Within the oyster was a jewel (*daimana*) called a pearl (*momi*), beautiful as the eyeball of a fish, white and shining; white as the cuttle fish, and shining with the colors of the rainbow-reds and yellow and blues, and some pinkish white, ranging in size from small to large. They were of great bargaining value (*he waiwai kumuku'ai nui*) in the ancient days, but were just "rubbish" (*'opala*) in 'Ewa [Kamakau 1991b:83].

This oyster, the *pipi*, was sometimes called "the silent fish," or *i'a hamau leo o 'Ewa*, 'Ewa's silent sea creature (Handy and Handy 1972:471), since the collectors were supposed to stay quiet while harvesting the shells, as in the sayings:

> The fish of 'Ewa that silences the voice. *Ka ka'a hāmau leo o 'Ewa.*
> The pearl oyster, which has to be gathered in silence [Pukui 1983:#1331].

> 'Ewa is disturbed by the Moa'e wind. *Haumāele 'Ewa i ka Moa'e.*
> Used about something disturbing, like a violet argument. When the people of 'Ewa went to gather the *pipi* (pearl oyster), they did so in silence, for if they spoke, a Moa'e breeze would suddenly blow across the water, rippling it, and the oysters would disappear [Pukui 1983:5#493].

> Hush, lest the wind rise. *E hāmau o makani mai auane'i.*
> Hold your silence or trouble will come to us. When the people went to gather pearl oysters at Pu'uloa, they did so in silence, for they believed that if they spoke, a gust of wind would ripple the water and the oysters would vanish [Pukui 1983:#274].

> The gesturing fish of 'Ewa. *Ka i'a kuhi lima o 'Ewa.*
> The *pipi*, or pearl oyster. Fishermen did not speak when fishing for them but gestured to each other like deaf-mutes [Pukui 1983:#1357].

Sereno Bishop, an early resident of O'ahu, wrote, of his time in the area around 1836, of the pearl oyster, the *pipi*, and another edible clam, identified by Margaret Titcomb (1979:351) as probably *Lioconcha heiroglyphica.*

> The lochs or lagoons of Pearl River were not then as shoal as now. The subsequent occupation of the uplands by cattle denuded the country of herbage, and caused vast quantities of earth to be washed down by storms into the lagoons, shoaling the water for a long distance seaward. No doubt the area of deepwater and anchorage has been greatly diminished. In the thirties, the small oyster was quite abundant, and common on our table. Small pearls were frequently found in them. No doubt the copious inflow of fresh water favored their presence. I think they have become almost entire extinct, drowned out by the mud. There was also at Pearl River a handsome speckled clam, of a delicate flavor which contained milk white pearls of exquisite luster and perfectly spherical. I think the clam is still found in the Ewa Lochs [Bishop 1901:87].

Older Hawaiians believed that the *pipi* disappeared around the time of the smallpox epidemic of 1850-1853, because Kanekua'ana became displeased at the greed of some *konohiki* (overseer).

> The people of the place believe that the lizard was angry because the konohikis imposed kapus [bans], were cross with the women and seized their catch of oysters. So this "fish" was removed to Tahiti and other lands. When it vanished a white, toothed thing grew everywhere in the sea, of Ewa, which the natives of Ewa had named the pahikaua (sword). It is sharp edged and had come from Kauai-helanai, according to this legend [Manu 1885:50].

Pahikaua is the Hawaiian name for the mussel, *Brachidontes crebristriatus* (Mytilidae), which was also a popular clam eaten by the residents of Pearl Harbor.

A clarification of the story of Kanekua'ana and the pearl oysters of Pearl Harbor is given, in which it seems an overseer had set a ban on the *pipi* for several months a year so that they could increase. A poor widow, a relation of the *mo'o*, took some of the *pipi* and hid them in a basket. The *konohiki* found the hidden shells, and took them from her, emptying them back into the sea, which was proper. However, after this he followed the woman home and also demanded that she pay a stiff fine in cash, which she did not have. The *mo'o* thought this was unjust and the next night she took possession of a neighbor who was a medium.

> . . . After the overseer had gone back to Palea the lizard goddess possessed her aged keeper [a woman of Ewa] and said to those in the house, "I am taking the pipi back to Kahiki and they will not return until all the descendants of this man are dead. I go to sleep. Do not awaken my medium until she wakes of her own accord." The command was obeyed and she slept four days and four nights before she awoke. During the time that she slept the pearl oysters vanished from the places where they were found in great numbers, as far as the shore . . . .The few found today are merely nothing . . . [*Ka Loea Kālai'āina*, June 3, 1899, translation in Sterling and Summers 1978:49-50].

3.1.3.2 Kāne and Kanalao and the Fish Ponds of West Loch

According to an account in the Hawaiian newspaper *Ka Loea Kālai'āina* (June 10, 1899), several of the fishponds in the Pu'uloa area were made by the brother gods, Kāne and Kanaloa. A fisherman living in Pu'uloa, named Hanakahi, prayed to unknown gods, until one day two men came to his house. They revealed to him that they were the gods to whom he should pray. Kāne and Kanaloa then built fishponds at Ke'ana-pua'a, but were not satisfied. Then they built the fishpond, Kepo'okala, but were still not satisfied. Finally they made the pond Kapākule, which they stocked with all manner of fish. They gifted all of these fishponds to Hanakahi and his descendants (Handy and Handy 1972:473; *Ka Loea Kālai'āina*, July 8, 1899).

According to Mary Pukui (1943:56-57), who visited Kapākule fishpond when she was young, the pond was built by the legendary little people of Hawai'i, the *menehune*, under the direction of the gods Kāne and Kanaloa. Pukui describes several unique aspects of this pond:

> On the left side of the pond stood the stone called Hina, which represented a goddess of the sea by that by that name. Each time the sea ebbed, the rock became gradually visible, vanishing again under water at high tide. Ku, another stone on the right, was never seen above sea level. This stone represented Ku'ula, Red Ku, a god for fish and fishermen. From one side of the pond a long wall composed of driven stakes of hard wood, ran toward the island [Laulaunui] in the lochs. When the fish swam up the channel and then inside of this wall, they invariably found themselves in the pond. A short distance from the spot where the pond touched the shore was a small koa or altar composed of coral rock. It was here that the first fish caught in the pond was laid as an offering to the gods [Pukui 1943:56].

The fishpond contained many fish, especially the *akule* (scad fish, *Trachurops crumenophthalmus*), thus its name, "the enclosure for *akule* fish" (Pukui 1943:56-57). The pond was destroyed when the channel to Pearl Harbor was dredged in the early twentieth century. The

caretaker of the pond took the stones Kū and Hina to a deep place in the ocean and sunk them so "none would harm or defile them." Cobb (1903:733) says it was used to catch the larger *akule* (goggler), *opelu* (mackeral scad), *weke* (goat fish), *kawakawa* (bonito), and sharks; it was unusual for having walls made of coral. This contradicts much of the legendary material that says that sharks were not killed within Pearl Harbor; however, Kamakau does relate that Kekuamanoha and Kauhiwawaeono, two conspirators against Kamehameha I, lived at Pu'uloa. The chief Kauhiwawaeono was known to murder people and use their bodies as shark bait (Kamakau 1961:182, 232).

Samuel Kamakau adds more information on the pond Kapākule, and a second one called Kepo'okala.

> At Pu'uloa on Oahu were two unusual ponds [fish traps]—Kapakule and Kepoolala. Kapakule was the better one. The rocks of its walls, *kuapa*, could be seen protruding at high tide, but the interlocking stone walls (*pae niho pohaku*) of the other pond were still under water at high tide. . . . It [Kapakule] was said to have been built by the *'e'epa* people [mysterious people] at the command of Kane ma . . .
>
> This is how the fish entered the pond. At high tide many fish would go past the mauka side of the pond, and when they returned they would become frightened by the projecting shadows of the trunks, and would go into the opening. The fish that went along the edge of the sand reached the seaward wall, then turned back toward the middle and entered the *anapuna* (the arched portion of the trap) A man ran out and placed a "cut-off" seine net (*'omuku lau*) in the opening, and the fish shoved and crowded into it. The fish that were caught in the net were dumped out, and those not caught in the net were attacked with sharp sticks and tossed out, or were seized by those who were strong [Kamakau 1976:88].

3.1.3.3 The Story of Kaihuopala'ai Pond, Honouliuli (Ka'ao no Maikohā)

In the Legend of Maikohā (Fornander 1917, Vol. V, Part 2:270-271), a sister of Maikohā, a deified hairy man who became the god of *tapa* makers, named Kaihuopala'ai, journeys to O'ahu:

> Kaihuopala'ai saw a goodly man by the name of Kapapaapuhi who was living at Honouliuli, 'Ewa; she fell in love with him and they were united, so Kaihuopala'ai has remained in 'Ewa to this day. She was changed into that fishpond in which mullet are kept and fattened, and that fish pond is used for that purpose to this day
>
> *'Ike aku la o Kaihuopala'ai i ka maikai o Kapapaapuhi, he kāne e noho ana ma Honouliuli ma 'Ewa. Moe iho la lāua, a noho iho la o Kaihuopala'ai i laila a hiki i kēia lā. 'Oia kēlā loko kai e ho'opuni ia nei i ka 'anae, nona nā i'a he nui loa, a hiki i kēia kākau ana* [Fornander 1919, Vol. V, Part 2:270].

The name of Maikohā's sister, Kaihu o pala'ai, which means "the nose of Pala'ai" (Pukui et al. 1974:68) is also the name the Hawaiians used for the west loch of Pearl Harbor, adjacent to

the current study area. McAllister recorded that other Hawaiians say there never was a fishpond by that name. Beckwith (1918) says that Kaihuopala'ai changed into the fishpond near Kapapapuhi, which means "the eel flats." This is identified on old maps as the point northeast of the current study area (sometimes spelled Kapapa'apuhi) that juts into the loch; early Hawaiian settlement was focused on this area.

There is also a famous *pōhaku*, or rock, associated with the traveling mullet of Pearl Harbor.

> . . . I . . . asked the person sitting on my left, "What place is this?" Answer – "This is Pearl City." It was here that mullets were bred in the ancient times and that flat stone there was called Mullet Rock or Pōhaku Anae. It lies near the beach by Ewa mill [*Ka Nūpepa Kū'oko'a*, Oct. 2, 1908, from Sterling and Summers 1978:53].

3.1.3.4 The Traveling Mullet of Honouliuli (Fish Stories and Superstitions)

The story of Kaihuopala'ai, or Ihuopala'ai, is also associated with the tradition of the *anae-holo*, the traveling mullet of Pearl Harbor (Thrum 1998:270-272):

> The home of the *'anae-holo* is at Honouliuli, Pearl Harbor, at a place called Ihuopala'ai. They make periodical journeys around to the opposite side of the island, starting from Pu'uloa and going to windward, passing successively Kumumanu, Kalihi, Kou, Kālia, Waikīkī, Ka'alāwai, and so on, around to the Ko'olau side, ending at Lā'ie, and then returning by the same course to their starting point [Thrum 1998:271].

In Thrum's account, Ihupala'ai is a male who possesses a Kū'ula or fish god that supplied the large mullet known as "*anae.*" His sister lived in Lā'ie, and there came a time when there were no fish to be had. She sent her husband to visit Ihupala'ai, who was kind enough to send the fish following his brother-in-law on his trip back to Lā'ie.

This story is associated with a proverb or poetical saying identified with Honouliuli:

> The fish fetched by the wind. *Ka I'a hali a ka makani*
> The *'anaeholo*, a fish that travels from Honouliuli, where it breeds, to Kaipāpa'u, on the windward side of O'ahu. It then turns about and returns to its original home. It is driven closer to shore when the wind is strong [Pukui 1983:#1330].

Pukui et al. (1974:68) gives the name of the husband in this story as Lā'ie and the name of the wife as Pala'ai, which ties into the name of the west loch of Pearl Harbor, called Ka-ihu o Pala'ai, "the nose of Pala'ai." Another version has a woman named Awawalei (an alternate version for the name of Pearl Harbor), who had a brother named Laniloa (the point on Lā'ie at which the mullet stops its migration and makes its way back to Pearl Harbor), and another brother (a mullet) who lived with an eel named Papa-puhi, which relates to the name of the fishpond in the tale called Kapapapuhi (*Ka Loea Kālai'āina*, Oct. 21, 1899). On historic maps, Kapapapuhi is a point of land that juts into West Loch and was a focus for habitation, taro cultivation, and fishpond maintenance in the early post-Contact (and probably earlier) period.

3.1.3.5 The Caves of Pu'uloa

'Ewa was famous for the many limestone caves formed in the uplifted coral. Some of these caves, called *ka-lua-ōlohe* were inhabited by the *ōlohe*, a type of people that looked like other humans but had tails like dogs (Beckwith 1940:343). These people were skilled in wrestling and bone-breaking and often hid along narrow passes to rob travelers; they were also reputed to be cannibals. The famous cannibal king, Kaupe, who lived in Līhu'e in upland Honouliuli, was an *ōlohe*.

There was once a cave named Kapuna on Waipi'o peninsula that was associated with a famous riddle. *No Kapuna kane hale noho ia e ke kai*, or "To Kapuna belongs the house, the sea dwells in it."

> This cave is on the Waipio side and a sea passage separates Waipio and Waikele and Waikele and Honouliuli. The passage is obstructed by three small islands, a middle one and Manana and Laulaunui. These small islands in the middle of the passage to Honouliuli and inside and outside of these small islands is the sea of Kaihuopalaai [Hawaiian name for West Loch] where mullet lived till they whitened with age [*Ka Loea Kālai'āina*, Oct. 7, 1899, translation in Sterling and Summers 1978:24].

Another famous cave of the area was Keanapua'a [in Halawa opposite Waipi'o peninsula], which means "the pig's cave," so named because Kamapua'a once slept there (Pukui et al. 1974:103). This cave was one of the places where the high king of O'ahu, Kahahana, hid after he had killed the priest Kaopulupulu, thus angering the high chief of Maui, Kahekili (Kahahana's father).

> Upon the arrival here at Oahu of Kahekili, Kahahana fled, with his wife Kekuapoi, and friend Alapai, and hid in the shrubbery of the hills. They went to Aliomanu, Moanalua, to a place called Kinimakalehua; them moved along to Keanapuaa and Kepookala, at the lochs of Puuloa, and then from there to upper Waipio; thence to Wahiawa, Helemano, and on to Lihue; thence the came to Poohilo, at Honouliuli, where they first showed themselves to the people and submitted themselves to their care.
>
> Through treachery, Kahahana was induced to leave Po'ohilo, Honouliuli and was killed on the plains of Hō'ae'ae [Thrum 1906:213-214].

The place Pō'o Hilo was somewhere on the border between Honouliuli and Hō'ae'ae (north of the current study area). In the "Legend of the Sacred Spear-point" (Kalākaua 1990:209-225) is a reference to the Hawai'i Island chief, Hilo-a-Lakapu. Following his unsuccessful raid against O'ahu "he was slain at Waimano, and his head was placed upon a pole near Honouliuli for the birds to feed upon"(Kalākaua 1990:224). This place was called Pō'o Hilo, which literally means "the head of Hilo."

The caves of Pu'uloa were sometimes used as burial caves. In 1849, Keali'iahonui, son of Kaua'i's last king, Kaumuali'i, died. He had once been married to the chiefess Kekau'ōnohi, who had stayed with him until 1849. She wanted to bury her ex-husband at sea.

> It seems that by Kekauonohi's orders, the coffin containing her late husband's remains was removed to Puuloa, Ewa, with the view of having it afterwards taken out to sea and there sunk. It was temporarily deposited in a cavern in the coral limestone back of Puuloa, which has long been used for a burial place, and has lately been closed up [Alexander 1907:27].

After some initial objections by the niece of Kealaiʻiahonui, the body was removed from the outer coffin, the rest was sunk, and the coffin was later buried somewhere in Puʻuloa.

3.2 Historic Background

3.2.1 Pre-Contact and Early Post-Contact Period

By ca. A.D. 1320, 'Ewa, along with Kona, and Koʻolaupoko were the dominant polities, ruled by the sons of a chief named Māweke (Cordy 2002:21). 'Ewa at this time included the traditional districts of 'Ewa, Waiʻanae, and Waialua (Fornander 1880:48). Around A.D. 1400, the entire island was ruled by King Laʻakona; chiefs within his line, the Māweke-Kumuhonua line, reigned until about A.D. 1520-1540, with their major royal center in Līhuʻe, in 'Ewa. (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line; he was slain by his men at the fortress of Waewae near Līhuʻe (Kamakau 1991a:54-54; Fornander 1880:88). Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūaliʻi achieved control of all of Oʻahu by defeating the Kona chiefs, then the 'Ewa chiefs, and then expanding his control on windward Kauaʻi. Peleiholani, the heir of Kūaliʻi, gained control of Oʻahu ca. 1740, and later conquered parts of Molokaʻi. He was ruler of Oʻahu until his death in ca. 1778 when Kahahana, of the 'Ewa line of chiefs was selected as the ruler of Oʻahu (Cordy 2002:24-41).

After Kamehameha's Oʻahu victory, he gave the *ahupuaʻa* of Honouliuli to Kalanimōkū as part of the *panalāʻau*, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kameʻeleihiwa 1992:58, 112). Kalanimōkū subsequently gave the *ahupuaʻa* to his sister, Wahinepiʻo.

Various Hawaiian legends and early historical accounts indicate that the *ahupuaʻa* (land division) of Honouliuli was once widely inhabited by pre-Contact populations, including the Hawaiian *aliʻi* (chiefly class). This would be attributable for the most part to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the *ahupuaʻa* include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy (1972:429) report:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Koʻolau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous.

In addition, breadfruit, coconuts, *wauke* (paper mulberry; *Broussonetia papyrifera*), bananas, and *olona* (*Touchardia latifolia*) and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *mamaki*. It was also famous for a rare taro called the *kai o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

> He has eaten the Kāī-koi taro of 'Ewa. *Ua 'ai i ke kāī-koi o 'Ewa.*
> Kāī is Oʻahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of 'Ewa, who, like the Kāī taro, is not easily forgotten [Pukui 1983:#2770].

The lochs of Pearl Harbor were ideal for the construction fishponds and fishtraps. Forest resources along the slopes of the Waiʻanae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469-470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP site 50-80-12-4322) is present in Makaʻīwa Gulch at 152 m (500 ft) above mean sea level (Hammatt, Robins, et al. 1990).

John Papa ʻĪʻī describes a network of Leeward Oʻahu trails (Figure 10), which in historic times encircled and crossed the Waiʻanae Range, allowing passage from Lualualei to Honouliuli by three different trails (ʻĪʻī 1959:96-98). The coastal trail skirted Pearl Harbor, passing by Puʻu o Kapolei; this would have been the nearest of three Honouliuli trails to the current project area. Following ʻĪʻī's description, a portion of this trail network would have passed close to the existing Farrington Highway, near the north border of the project area, as seen in an 1825 map (Figure 11) map of the south coast of Oʻahu by Charles Malden of the British ship the *Blonde*.

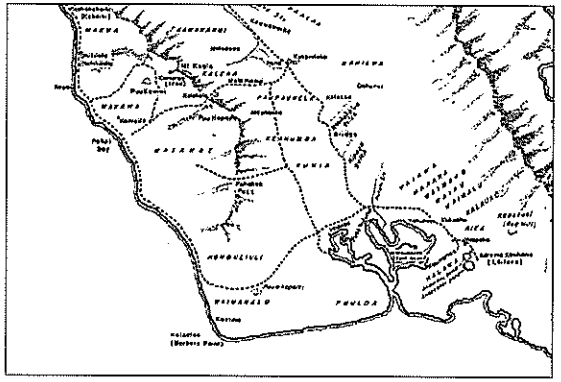


Figure 10. Trails of Leeward Oahu. Map by Paul Rockwood. (ʻĪʻī 1959:96) Mid- to late-1800s

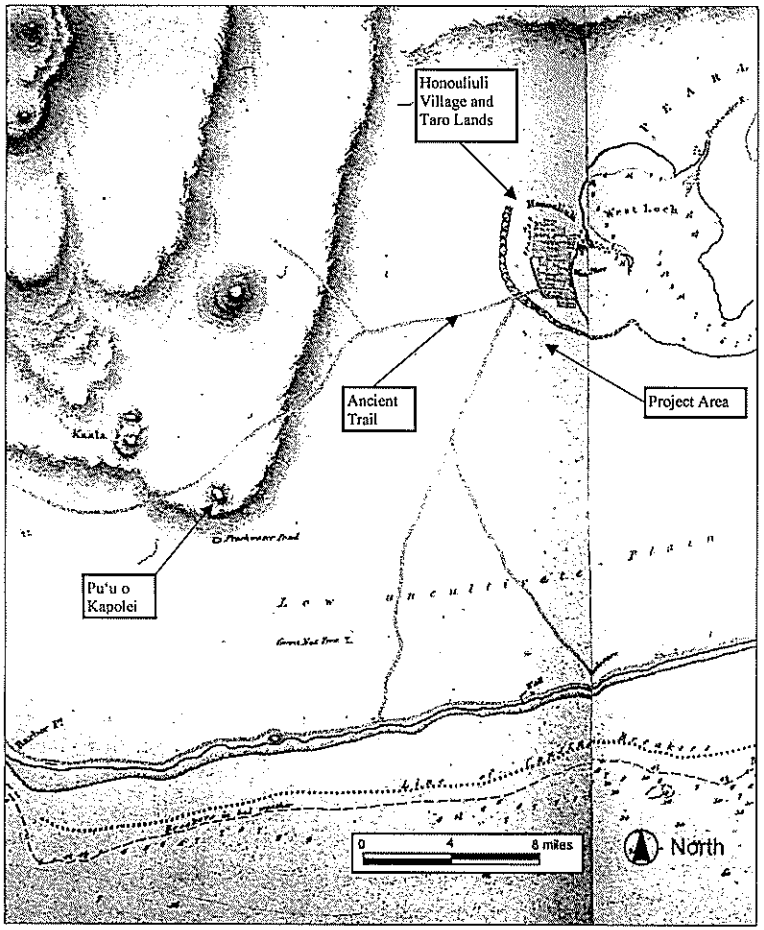


Figure 11. Portion of 1825 Map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde*

The trail is described by 'Ī'ī as:

> The trail went down to the stream and up again, then went above the taro patches of Waiau, up to a *makai* field, to Waimano, to Manana, and to Waiawa; then to the stream of Kukehi and up to two other *maika* fields, Pueohulunui and Haupuu. At Pueohulunui was the place where a trail branched off to go Waialua and down to Honouliuli and on to Waianae. As mentioned before, there were three trails to Waianae, one by way of Pu'u o Kapolei, another by way of Pohakea, and the third by way of Kolekole ['Ī'ī 1959:97].

Early historical accounts of the general region typically refer to the more populated areas of the 'Ewa district, where missions and schools were established and subsistence resources were perceived to be greater. However, the presence of archaeological sites along the barren coral plains and coast of southwest Honouliuli Ahupua'a, indicate that prehistoric and early historic populations also adapted to less inviting areas, despite the environmental hardships.

3.2.2 Observations of Early Explorers and Foreign Residents

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka'i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it . . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen's huts [Vancouver 1798, Vol. I:167].
>
> . . . from the commencement of the high land to the westward of Opooroah [Pu'uloa], was composed of one very barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island . . . [Vancouver 1798, Vol. II:217].
>
> . . . This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced . . . [Vancouver 1798, Vol. III:361-363].

Archibald Campbell, an English seamen who was given some land in Waimano Ahupua'a by King Kamehameha in 1809, described his land around Pearl Harbor:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. . . . We passed by footpaths, winding through an extensive and fertile plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for the taro beds. Where there was not water, the land was under crops of yams and sweet potatoes [Campbell 1967:103-104].

> Pearl and mother of-pearl shells are found here in considerable quantity. Since the king has learned of their value, he has kept the fishing to himself, and employs divers for the purpose [Campbell 1967:114-115].

Subsequent to western contact in the area, the landscape of the 'Ewa plains and Wai'anae slopes was adversely affected by the removal of the sandalwood forest, and the introduction of domesticated animals and new vegetation species. Domesticated animals, including goats, sheep and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. It is unclear when the domesticated animals were brought to O'ahu; however, L.A. Henke reports the existence of a longhorn cattle ranch in Wai'anae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. Within the current project area, the majority of the (non-cultivated) vegetation is comprised of introduced species, mainly grasses.

At contact, the most populous *ahupua'a* on the island was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the population as 1,026. Within four years the population was down to 870 (Schmitt 1973:19, 22). In 1835, there were eight to ten deaths for every birth (Kelly 1991:157-158). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of 'Ewa and Wai'anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of 'Ewa was probably abandoned by the mid-nineteenth century, due to population decline and consolidation of the remaining people in the town of Honouliuli (at Papapuhi Point, northeast of the project area). A detailed discussion of the historic population counts in the 'Ewa District has been presented by Charvet-Pond and Davis (1992).

The first mission station in Ewa was established in 1834 at Kalua'aha near Pearl Harbor. Charles Wilkes, of the U.S. Exploring Expedition visited the missionary enclave at Honouliuli town in 1840.

> At Ewa, Mr. Bishop has a large congregation. The village comprises about fifty houses, and the country around is dotted with them. . . . The natives have made some advance in the arts of civilized life; there is a sugar-mill which, in the season, makes two hundred pounds of sugar a day. . . . In 1840, the church contained nine hundred members, seven hundred and sixty of whom belonged to Ewa, the remainder to Waianae; but the Catholics have now established themselves at both these places, and it is understood are drawing off many from their attendance on Mr. Bishop's church [Wilkes 1970:80-81].

The earliest detailed map of the area (Alexander 1873; Figure 12) shows no habitation closer than the western edge of West Loch in the vicinity of Papapuhi Point. A Monsarrat survey map of 1878 documents substantial settlement at the "Honouliuli Taro Land" in the Papapuhi Point area, and it seems clear that in early historic times, this was the focus of the population of Honouliuli. The amenities of the area - including fishponds, taro *lo'i*, abundant shellfish, and salt pans - would have focused population there in pre-Contact times as well.

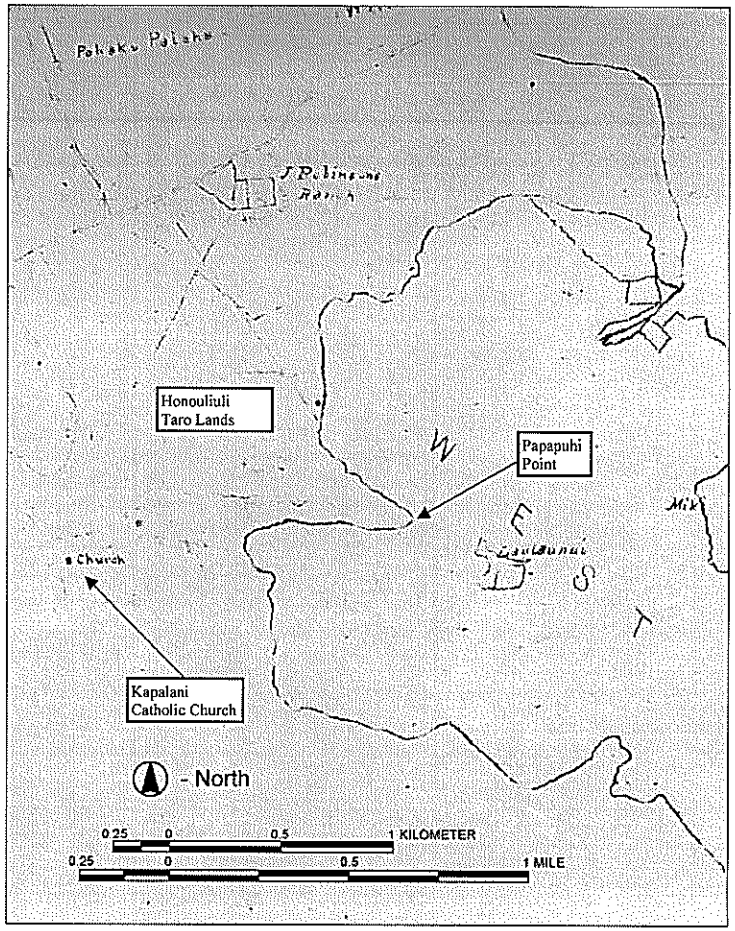


Figure 12. Portion of 1873 W.D. Alexander map of Honouliuli, showing location of Papapuhi Point (habitation symbols are illegible); also note location of Kapalani Catholic Church

3.2.3 Mid-Nineteenth Century and the Māhele

The Organic Acts of 1845 and 1846 initiated the process of the *māhele* - the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848 the crown and the *ali'i* (chiefly class) received their land titles. The common people received their *kuleana* (individual parcels) in 1850.

During the *Māhele* of 1848, 72 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III (Tuggle and Tomonari-Tuggle 1997:34). The 72 *kuleana* awards were almost all made adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields. Kepa Maly (1997, Table 3: 38-42) provides a table recording information on each award, including awardee, *'ili*, and land use of the *'āpana* (lot). A summary of the information on houses, fields, and boundary landmarks noted for each *'ili* is given below in Table 2 and *'ili* locations are shown on Figure 13.

3.2.4 Project Area Māhele Awards

A comparison of project area maps with an 1878 map surveyed by M.D. Monsarrat (Figure 14) clearly show that all or portions of certain land claims belonging to Kelia (LCA 763), Pue (LCA 869), Leleiupa (LCA 1699) and Kua (LCA 5653) lie within the project area. These LCAs were once located on the east side of the main road along Honouliuli town, but now portions lay west of the current alignment of Old Fort Weaver Road. In addition, a portion of the former site of a Catholic church, called Kapalani Catholic Church, also now lies on the west side of the current road alignment, although the church itself was probably covered by the new road itself. This church and associated school house is believed to have been the site of the ministry of a particularly notable person, Kepelino Keauokalani. A brief review of the four known LCAs within the project area follows (see Figure 13 for *'ili* locations):

Kelia's *'Āpana* ('Āp.) 1 (LCA 763)

Kelia's claimed this land situated in the *'ili* of Poohilo and Uani for his houses. His witnesses agreed with his claim, but there was a dispute over whether there were 3 or 4 houses within the parcel. All agreed Kelia has one house there and that his father, Puecu had two. The west or Wai'anae boundary was described variously as the "*pali* of Makaaku," "a ravine" or "a cliff." The claimant received his house lot from his father Puecu and "has accepted it ever since 1836."

Pue *'Āpana* 1 and *'Āpana* 2 (LCA 869)

Pue claimed four parcels in the *'ili* of Maui at Honouliuli, 'Ewa. One parcel was a houselot and had two houses on it, one for himself and one for Puali who was his father-in-law. The western side was bounded by the land of Koi, the *luna* (overseer), who gave Pue's family their land in 1842. The other parcel within the project area was *kula*, pasture land to the east of the houselot.

Leleiupa *'Āpana* 1 and *'Āpana* 2 (LCA 1699)

Leleiupa 'Āpana 1 and 2 were claims for two parcels situated in the *'ili* of Maui. 'Āpana 1 was bordered on the west by the land of Koi, the overseer.

Table 2. Summary of land use and boundary landmarks recorded in Honouliuli LCA awards

'Ili	Land Use and Boundary Landmarks
Hiwalalo	*kou* trees
Ka'aumakua	houselots, *kalo* (taro) patches; *kula* (pasture/dryland agriculture), two fishponds called Mokumeha; landmarks - *kula ālialia* (salt plains), land division wall, Pānāhāhā *loko* (fishpond), Kalahu fishpond, Naholowaa pond, Honouliuli Stream (called stream of Makai'i), or *'aka'akai* (bulrush growth) of Kamo'okahi
Kaihuopala'ai	*mo'i* (arable land in a long strip); on lot bounded by *'auwai* (irrigation ditch) called Panaenui
Ka'ilikahi	houselot and *kalo* patches; landmarks – highway, Kauhipuna cliff, *lapalapa* (*panax*) thickets, meeting house
Kamilomilo	houselot and *kalo* patches
Kamoku	fenced *mo'o kalo*, *lo'i* (irrigated fields) *kalo*, houselot; landmarks – Kauhipuna pali
Kamo'okahi	bulrushes
Kapāpahi	houselots, *kalo* patches; bounded by ponds of Healani
Kapapapūhi	houselots, vineyard, *kula*, pond, trails, hog pens, and salt beds
Ka'ula'ula	*mo'o* next to Kaulaula (cliff) with a houselot and a wall
Loloulu	*kalo* patches, 1/3 of a fishpond (in land of Kahakuli'ili'i), hala grove, pig pens, breadfruit, bulrushes
Maka'u	houselot and *kalo* patches
Maui	*kalo* patches, *kula*, houselots, bounded by *pā'āina a ke Aupini* (land division wall of the government)
Mokumeha	2 fishponds, salt beds (western one called Kohumakahou)
Niuke'e	*kalo* patches, *kula*, potato field, houselots; landmarks - *loko kalo* (taro/ fishpond) of Nihola, Loko'eli pond, Kehewanakawalu pond, Kalokoiki pond, *pali* of Kihewamakawela; Ka'akau *pali*; Ka'akau community, meeting house, prison plot, cattle fences
Polapola	*kalo* patches; houselots, school house, prison plot; some bounded by *pā'āina a ke Aupini*, or high road from the sea, or Catholic Chapel yard
Pō'ohilo	*kula*, *kalo* patches, *loko kalo*, houselots; landmarks - *pā'āina*, Ka'aimanō fishpond, *kula* of Kahakai, *loko kalo* of Kalokoloa, Aimea Pond, Waianu pond, Kahui pond, Ka'aimano fishpond, *pupulu* cave (wet cave?), prison plot, Makaakua pali, Puehuehu Stream, Puehuehu road
Pua'alu'u	*lo'i*, houselot
Pu'uloa	houselots; boundaries include the sea, a *kula* called Waioipu, and the plain of Kaluanohu

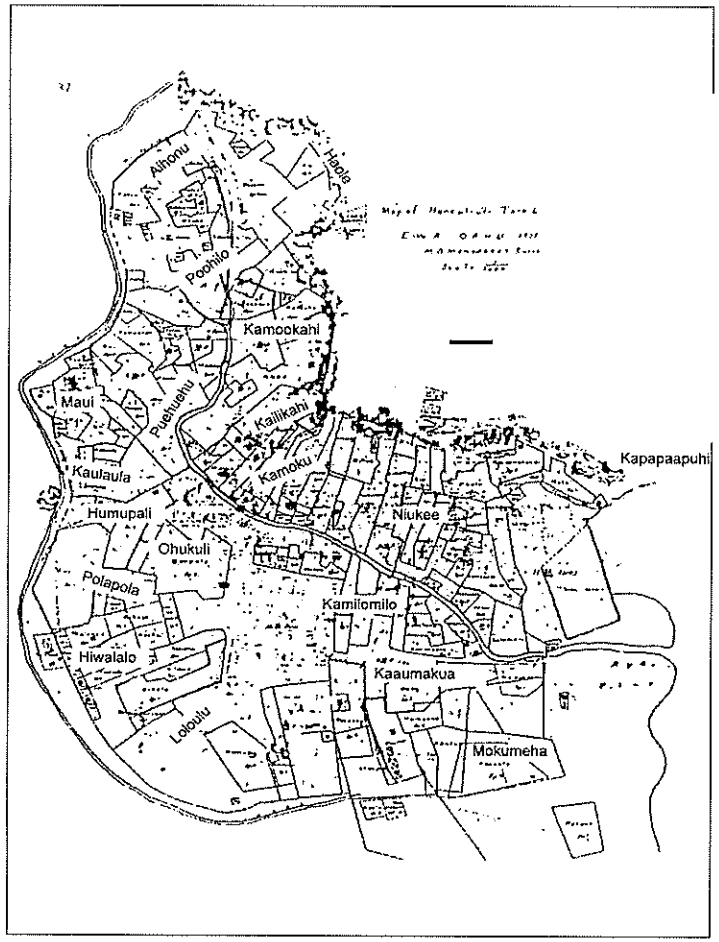


Figure 13. 1878 Map of Honouliuli Taro Lands (LCAs) by M.D. Monsarrat, with inserted *'ili* names

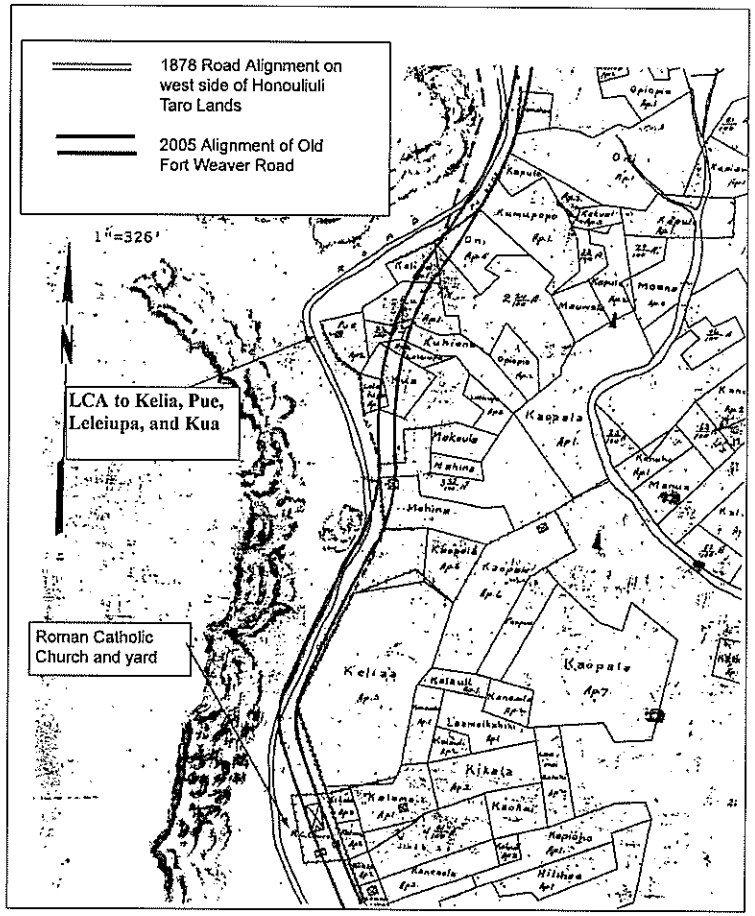


Figure 14. Portion of 1878 Monsarrat map, showing portion of Honouliuli Taro Lands in Relation to current alignment of Old Fort Weaver Road (eastern boundary of the project area)

Kua (LCA 5623)

Kua claimed two taro patches and a *kula* land called Kahui in the '*ili* of Maui. Of note was the sworn testimony of Maakuia on the Land Court Application for Mahina (LCA 749), which stated that the western boundary of Mahina's land was [Kaulaula] Pali, which had a wall on its top.

3.2.5 The Catholic Church

There are two land applications that make reference to a Catholic Church near the town of Honouliuli. Kaohai in April of 1850 (LCA 5670B) claimed a house site in the '*ili* of Polapola "adjoining the Catholic Chapel yard." Hilinae (LCA 1720) in November of 1847 made a houselot claim in the '*ili* of Polapola bounded on the west by the Kapalani Church. Little is known about the Kapalani Roman Catholic Church. It is clearly annotated on Monsarrat's 1878 map (see Figure 14) and is the lone "church" pictured on an 1873 map of the Honouliuli district by Alexander (Figure 15). Even the name is uncertain, as Kapalani probably means "the Frenchmen's" church. Efforts to found a Catholic Mission in Hawai'i were initially met with hostility until the issuing of an edict of toleration in 1839. The establishment of the Catholic Mission in Hawai'i in May of 1849 initiated an active period of building churches and schools. The Kapalani church (and school house) cited in the Land Court Application of Hilinae in November of 1847 must have been constructed within the previous seven years. Father Raymond Delande was pastor of the Leeward District of the church from 1857-1885 and, operating out of Honouliuli, he covered an area extending as far as Makaha and Waialua. "Up to 1877, he had baptized 600 children and adults, all living along the SW coast of Oahu" (Schoofs 1978:110).

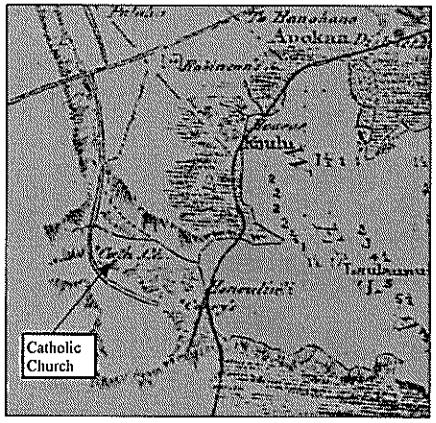


Figure 15. Portion of 1881 Hawai'i Government Survey Map (Alexander) showing location of the Catholic Church

Of particular interest is the association with this church of Kahoali'ikumaieiwakamoku Kepelino (Zepherino) Keauokalani, whose name means "to-be-the-chief-of-the-nine-districts" (Beckwith 1978:4). His father was Namiki, of the lineage of the high priest Pa'ao and his mother, Kahiwa Kaneikopulei, was a daughter of Kamehameha I. They had two children, the son Kepelino, and a daughter named Puahau. Namiki was the "old savage" whose narratives were collected by Jules Remy as "Contributions of a Venerable Savage to the Ancient History of the Hawaiian Islands" during his travels in the islands between 1851 and 1855. In a note on a section concerning the priest Pā'ao, the author talks about Namiki's son, who he met in 1853.

> The old historian Namiki, an intelligent man, and well versed in the secrets of Hawaiian antiquity, has left precious unedited documents, which have fallen into our hands. His son, Kuikauai, a school-master at Kailua, one of the true historico-sacerdotal race, has given us a genealogy of his ancestors which ascends without break to Paao [Remy 1857, in Nordhoff 1974:253].

The family was of Kailua, Kona, Hawai'i and converted to Catholicism very quickly after the arrival of Fathers Walsh and Ernest Herutel of the Catholic Mission to Kona in 1840. His parents sent him to Catholic school in Honolulu in 1845 to become a teacher. Father Ernest writes:

> Father Martial writes me about our little Zepherin, telling me that he has been received as teacher but that because they have no school to give him as yet, he has not received his diploma. Father Desire wants to keep him to send to the High School; but when will you have a High School? Perhaps not so soon. I think therefore that Zepherin would be more useful here as we lack teachers [cited in Beckwith 1978:4].

As noted above, Remy claims that at some point, Kepelino was a school teacher in Kailua; although Remy is believed to have met Kepelino in 1853, his teaching position at Kailua could have dated to an earlier period, possibly around 1845, when Father Ernst suggested that he return to the island of Hawai'i from Honolulu. At some point he attended the Catholic High School at Ahuimanu (established in 1846), where he is said "to have acquired English, French, Latin, and Greek" (Beckwith 1978:5). In 1847, at the age of 17, he was sent briefly with Father Ernest to Tahiti to help establish a Catholic mission. He developed a reputation for his pranks and was sent back to his parents (Beckwith 1978:5).

Controversial letters under the name of Z. Kahoali'i, addressed from the town of Honouliuli on O'ahu, were published in Catholic newspapers from 1860-1869. A letter in the Public Instruction Correspondence filed and dated 11/26/1851, written by a school teacher name Naheona to the Minister of Public Education, state his reasons for the rejection of a teacher "Kepilina" and accuses Kepilina of "dancing and thieving while employed as teacher of Honouliuli School and of general improper conduct." The letter also mentions "Catholic priests in the area who have been among the people for a while who do not recommend retaining Kepilina" (In Silva 1987:A8). It seems quite probable that Kepelino lived at Honouliuli from 1851 into the 1870s and that as a devout Catholic and teacher that he taught at the school house next to Kapalani Church.

Detailed biographic information on Kepelino is not readily available, which is probably due in part to the fact that he was "controversial" for the Catholics and for the government. He went on

to become Queen Emma's secretary (by at least 1874) and was one of the most important documenters about Hawaiian beliefs and traditions. He supported Queen Emma as the heir of King Lunalilo over David Kalākaua, and wrote letters to the king of Italy and the queen of England, asking for warships to support Queen Emma's cause. In 1874, the newly elected King Kālakaua had him tried for high treason and sentenced him to hanging, but the sentence was commuted and he was released from prison in 1876; he died in 1878 (Day 1984:77).

"The Honouliuli church . . . had by the 1880s outlived its usefulness and become dilapidated. It was therefore abandoned and replaced by a simple structure close, too close to the mill" [at 'Ewa Village, south of the project area] (Schoofs 1978:111). However, "in 1891 Honouliuli was still important enough to acquire its own Catholic cemetery" (Schoofs 1978:110). Whether this cemetery or any other Catholic cemetery was on the grounds of the Kapalani Church in unknown. In the late 1920s, Bishop Alencastre exchanged land at Honouliuli with Campbell Estate for land at 'Ewa Village to establish a new church.

3.2.6 Honouliuli Māhele Awards to *Ali'i*

In 1855 the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke'ahikuni Kekau'ōnohi (Royal Patent #6971 in 1877; Parcel #1069 in the Land Court office), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O'ahu (Indices of Awards 1929; Kame'eleihiwa 1992). Kekau'ōnohi was also awarded the *ahupua'a* of Pu'uloa, but she sold this land in 1849 to Isaac Montgomery, a British lawyer.

Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahalai'a, who was governor of Kaua'i (Hammatt and Shideler 1990:19-20:20). Subsequently, Kekau'ōnohi ran away with Queen Ka'ahumanu's stepson, Keli'iahonui, and then became the wife of Chief Levi Ha'alelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. A lawsuit (Civil Court Case No. 348) was brought by Ha'alelea in 1858, to reclaim the fishing rights of the Pu'uloa fisheries from Isaac Montgomery, and the court ruled in Ha'alaea's favor. In 1863, the owners of the *kuleana* lands deeded their lands back to Ha'alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha'alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney (Yoklavich et al 1995:16).

3.2.7 Early Ranching in on the 'Ewa Plain

John Coney rented the land to James Dowsett and John Meek in 1871, who used the land for cattle grazing. In 1877, the land, except for the *'ili* of Pu'uloa, was sold to James Campbell. He drove off 32,237 head of stock belonging to Dowsett and Meek and to James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). He let the land rest for one year and then began to restock the ranch, so that he had a head of 5,500 head after a few years (Dillingham 1885, cited in Frierson 1972:14)

In 1880-81, the Honouliuli ranch was described as:

> . . . Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. . . . There are valuable fisheries attached to this estate . . . . [Bowser 1880:489].
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. . . . Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts [Bowser 1880:495].

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Co. 1923:6-7). In 1879, Campbell brought in a well-driller from California to search the 'Ewa plains for water, and the well, drilled to a depth of 240 feet near Campbell's home in 'Ewa, resulted in ". . . a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d., cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource. A Hawai'i Visitor Bureau, marker, located in the southwestern portion of the project area, bears the inscription "Site of First Artesian Well in the Hawaiian Islands drilled by James Ashley for James Campbell owner of Honouliuli Ranch brought in on Sept. 22, 1879." Kuykendall (1967:III, 67) states that this well was "near Campbell's ranch house" but Campbell's ranch house, which is shown on Monsarrat's 1878 map, was located outside the project area.

3.2.8 History of the Ewa Sugar Plantation

3.2.8.1 General History of the Plantation

In 1886, Campbell and B. F. Dillingham put together the "Great Land Colonization Scheme," which was an attempt to sell Honouliuli land to homesteaders (Thrum 1886:74). This homestead idea failed, but with the water problem solved by the drilling of artesian wells, Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Wai'anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:100). This railroad line eventually ran across the center of the 'Ewa Plain at the lower boundary of the sugar fields.

To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly-formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company (Figure 16). Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch - established by Dillingham was - the "fattening" area for the other ranches (Frierson 1972:15).

Figure 16. 1902 map showing relationship of Ewa Plantation and the Oahu Sugar Co. plantation; also note location of sisal growing area

Ewa Plantation Company (Figure 17) was incorporated in 1890 for sugar cane cultivation. The first crop, 2,849 tons of sugar, was harvested in 1892 at the Ewa Plantation. Ewa was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967:69). As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964). It is uncertain if there was also a deliberate effort to induce erosion on the scarp (called Evans Bluff by the Campbell Estate), near the eastern boundary of the project area, but it would have been easy to do and probably very effective. By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific*, Dec. 1902:19-22, cited in Kelly 1985:171).

Just north of 'Ewa Plantation was the equally sprawling O'ahu Sugar Company which "covered some 20 square miles . . . ranging in elevation from 10 feet at the Waipio Peninsula . . . to 700 feet at the Waiahole Ditch" (Condé and Best 1973:313) (see Figure 16). The Oahu Sugar

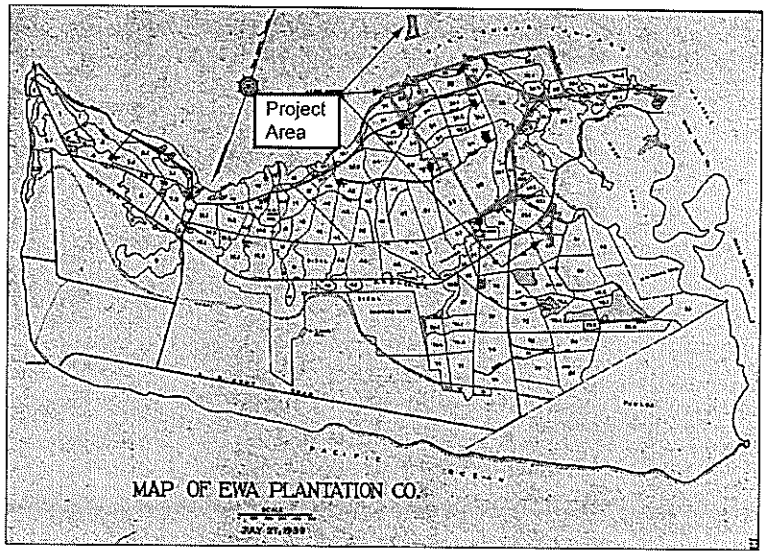


Figure 17. 1939 map of the Ewa Plantation Co. lands, showing project area

Company was incorporated in 1897. Prior to commercial sugar cultivation, the lands occupied by the Oahu Sugar Company were described as being "of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project" (Condé and Best 1973:313). The Oahu Sugar Company took control of the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugar cane production in the combined plantation area (Dorrance and Morgan 2000:45, 50).

3.2.8.2 History of PipeLine Village

During the twentieth century, the Ewa Plantation would continue to grow and, by the 1930s, would encompass much of the eastern half of Honouliuli Ahupua'a. This growth impelled the creation of plantation villages to house the growing immigrant labor force working the fields. In the decade of the 1890s, the plantation built 72 houses, cottages or dwellings; in the first decade of this century, 536; in the second decade, 132; in the 1920s, 285; in the 1930s, 168; and, in the 1940s, only 35. Censuses of the Ewa Plantation population record 4,967 persons in 1928, 4,477 in 1929, and 4,100 in 1932. After the outbreak of World War II, which siphoned off much of the plantation's manpower, along with the changeover to almost complete reliance on mechanical harvesting in 1938, there was little need for the large multi-racial (Japanese, Chinese, Okinawan, Korean, Portuguese, Spanish, Hawaiian, Filipino, European) labor force that had characterized most of the early history of the plantation.

It is to be noted that in the history of construction, buildings were moved, demolished, and replaced all the time. As early as 1899, the plantation moved "the lower camp of thirty houses [believed to be duplexes built in 1890] to a position on the bluffs nearby . . . principally for sanitary reasons" (Ewa Plantation Company Annual Report for 1890).

The original location of these thirty houses is unknown. They probably were not in the area later known as "Lower Camp" and may have been in the Honouliuli Taro lands. It is also unknown where they moved to "on the bluffs," but it seems probable that they were moved to what became the west central portion of PipeLine Village near the present water pumping station in that vicinity. A 1908/1913 U.S. Army Fire Control map shows 47 houses in the area of PipeLine Village (Figure 18).

PipeLine Village was a major plantation community that lay in the central southern portion of the present project area and is shown in detail in a 1928 USGS map (Figure 19), which documents the location of about 160 houses, a church and a school. This was probably the great extent of PipeLine Village. An entry in the 1931 Annual Report of Ewa Plantation Company records that "The PipeLine Village of 162 cottages built in 1906" was dismantled and that "other cottages near [near the factory, south of the project area] were erected using the reclaimed lumber from the PipeLine Villages. Photos (Bishop Museum Visual Collection) dated 1906 (Figure 20) show what appears to be brand new single family residences at PipeLine Village, but the Annual Report for 1906 documents the construction of only 47 houses and many of there were probably not built in PipeLine Village. Photos dated 1907 (Figure 21) show houses at PipeLine village with very well established garden and tall banana, papaya, and many mango trees, suggesting that they are significantly older. Another photo dated January 1910 (Figure 22) shows a line of ten new cottages with the caption "Pipe Line Village (Family houses built

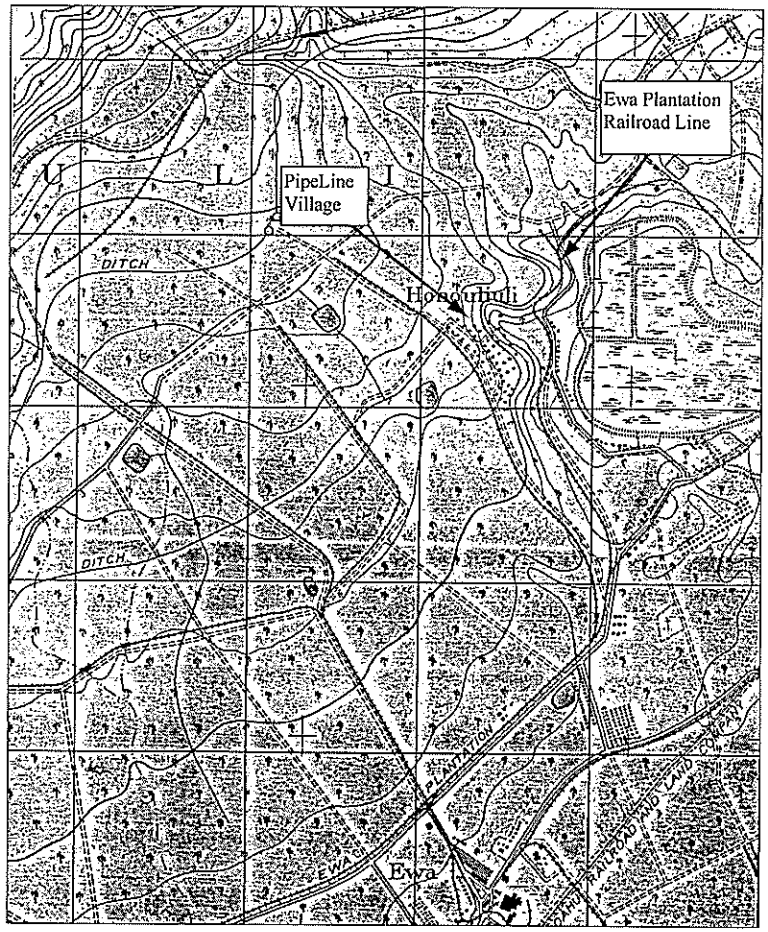


Figure 18. Portion of an 1908/1913 U.S. Army Fire Control map, showing 47 houses in PipeLine Village; map also shows the alignment for the Ewa Plantation railway

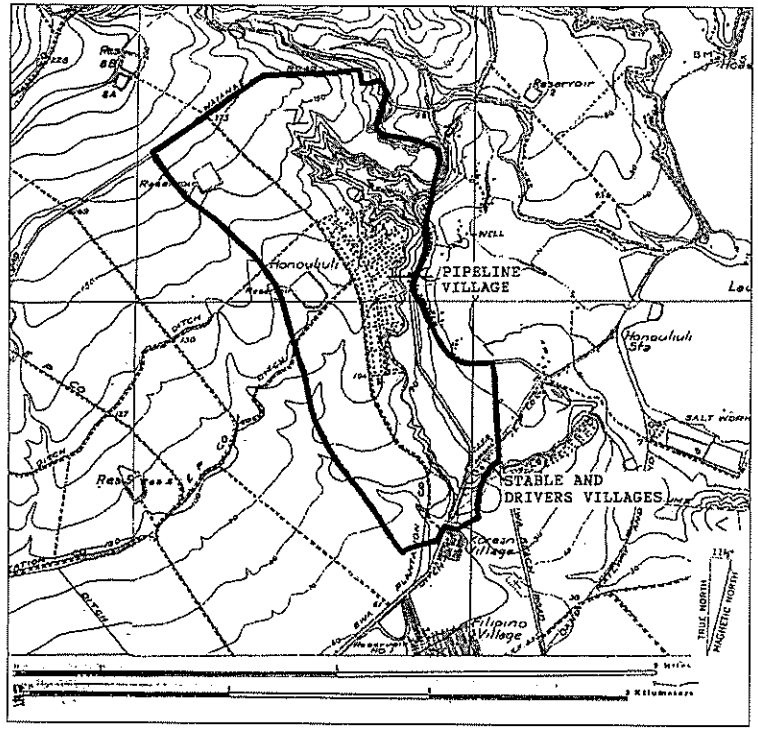


Figure 19. 1927/1928 US Geological Survey map, showing location of PipeLine Village, Stable Village, Driverss Village, and other Ewa Plantation structures

Figure 20. Portuguese family residence at PipeLine Village 1906

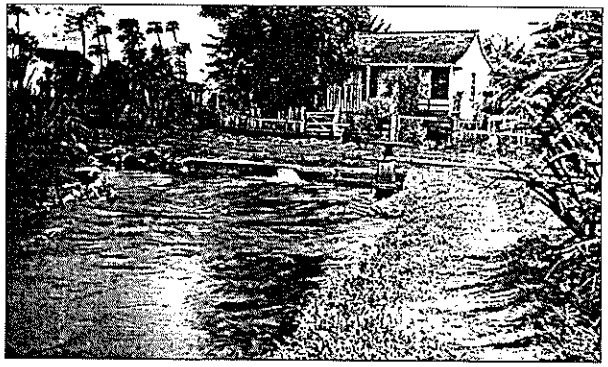


Figure 21. Discharge Pump No. 5, PipeLine Village 1907

Figure 22. PipeLine Village, famly houses built in 1909, photograph taken on January 1910

Figure 23. PipeLine Village, April 7, 1907; forno at center of photograph

during 1909)." A 1907 photo (Figure 23) shows blocks of houses separated by wooden fences, and a *forno*, a brick Portuguese bread oven in the center. One hundred and twenty-nine cottages were built for married laborers in that year and they include the majority of the houses at PipeLine Village. In 1911 "60 new houses, principally for Spanish and Portuguese workmen with families" were erected. Thus, it seems highly probable that PipeLine village was largely constructed between 1906 and 1911, but may have incorporated a number of relocated structures dating to 1890. The demolition of 1931 was probably quite thorough, and not a trace of the structures was found on later maps.

3.2.8.3 History of Stable Village and Drivers Village

The Ewa Plantation housing located in the southeastern corner of the project area, just north of the present Hale o Ulu School, is not well-documented. It appears that there were at least two small villages located here: "Stable Village" and "Drivers Village." The Ewa Plantation Company Annual Report for 1931 states that "The Drivers Village, located near the main stable was in such a bad location that it was decided to move all the fourteen cottages down to 'B' village near the factory." Drivers Village doubtlessly corresponds to the site of the 14 houses shown on the 1927/1928 map (see Figure 19), with Stable Village probably referring to the structures just to the south across the street. The date of construction of these villages is unknown. No houses are shown in this area on the 1908/1913 Fire Control map (see Figure 18). The villages were probably built in that flurry of construction in the first decade of this century. All of the structures of Stable Village and Drivers Village are shown on the War Department Map of 1943, but this map may be another example of a lack of military intelligence regarding the Pearl Harbor area; records indicate that the houses were probably all demolished around 1931.

3.2.8.4 Other Enterprises in Campbell Lands

As noted above, part of Mr. Campbell's lands were also used to grow rice. By 1885, 200 acres in Honouliuli were used for rice and 50 acres were used to grow bananas (article in *Pacific Commercial Advertiser*, August 15, 1885, summarized in Silva 1987:A-12). These rice fields were planted in former taro fields or in undeveloped swamps, such as those near the project area in the former Honouliuli Taro lands. The rice fields in 1882 were described by Frank Damon, during a tour of the area.

> . . . Towards evening we reached Honouliuli, where the whole valley is leased to rice planters . . . This was one of the largest rice plantations we visited. Sometimes two or three men only, have a few fields which they cultivate for themselves, and we often too came upon houses where there were eight or ten men working their own land. But the larger plantations are owned by merchants in Honolulu, who have a manager acting for them. . . . [Damon 1882:37].

In 1890, Dillingham leased all land below 200 ft to William Castle, who used most of the land for sugar cane, but also leased some lands for rice cultivation, pasture, wood lots, bee-keeping, garden crops, and quarries. Some land above 650 ft was also leased for the cultivation of canaigre, which may be a word used for pineapple (Frierson 1972:15-16).

An additional agricultural trial was conducted in the Honouliuli area for the cultivation of sisal, a plant used to make fibers for rope and other material. Some sisal was planted before 1898 and production continued until the 1920s (Frierson 1972:16). This was grown mainly on the coastal plain of Honouliuli in Kānehili, just *mauka* of Kualaka'i Beach (now Nimitz Beach). An article in the *Paradise of the Pacific* in 1902 described this venture in glowing terms.

> . . . The venture was made and a tract of land containing a large percentage of disintegrated coral, in the neighborhood of Ewa Plantation, where nothing else would grow, was chosen for the planting. . . . The Hawaiian Fiber Co., which Mr. Turner organized, and of which he is now manager, has 755 acres under fence, two and a half miles of which is stone wall with good gates at convenient places. . . . In a large field containing 130 acres, mauka of the Oahu Railway & Land Co. track, the first harvest is to be gathered in a few months. . . . Out of this section of 130 acres the company has figured on securing 50 tons of clean fiber, for which it is offered eight cents per pound in Honolulu or nine cents per pound in San Francisco . . . . [*Paradise of the Pacific* March 1902:17].

Although many of the fishponds at Pearl Harbor deteriorated from lack of care and lack of people to maintain them in the early nineteenth century, there was some action to reclaim these areas in the later part of the century. Some were converted to rice fields, but others were maintained as fish ponds or duck ponds. Records of the Minister of Public Instruction (1848) show that some ponds were maintained by local teachers and students, with the funds generated used for the upkeep of the school system. Some ponds as early as 1848 were also maintained by prisoners, possibly from the women's prison located at Honouliuli. In 1852, however, Levi Ha'alelea reasserted his claims to these neglected lands, when he claimed all of the mullet from this area be reserved to him (Hawaii Kingdom files, cited in Silva 1987:A-7 to A-9). During James Campbell's tenure of the land, fish ponds and Pu'uloa fishing rights were leased out to various entrepreneurs (Kelly 1985:175).

Into the early twentieth century, some Hawaiian families continued to live in Honouliuli and preserve the traditional lifestyle, including at the fishing village of Kualaka'i. One resident, Mrs. Eli Williamson, recalled:

> In the Honouliuli area the train stopped among the *kiawe* (algaraboa) trees and *malina* (sisal) thickets. We disembarked with the assorted food bundles and water containers. Some of the Kualaka'i '*ohana* (family) met us to help carry the '*ukana* (bundles) along a sandstone pathway through the *kiawe* and *malina*. The distance to the frame house near the shore seemed long. When we departed our '*ukana* contained fresh lobsters, *limu* (algae), fish and *i'a malo'o* (dried fish) . . . [Williamson in Kelly 1985:160].

3.2.9 The Military and Modern Developments

In 1891, Russian explorer Otto Von Kotzebue tried to observe Pearl River, but his group could not obtain a canoe. What he was told, however, led him to speculate on the possible importance of Pearl Harbor to the future.

> In the mouth of this river are several islands; it is so deep, that the greatest ship of the line can lie at anchor a few fathoms from the shore; and so broad, that a hundred vessels can conveniently find room in it. The entrance into the Pearl Rivers is in the same situation as the harbour of Hana-rura; but the windings between the reefs are, however, said to render a passage more difficult. If this place were in the hands of the Europeans, they would certainly employ means to make this harbour the finest in the world [Von Kotzebue 1821:338-348].

The early missionary Levi Chamberlain was able to take an outrigger canoe trip to Pearl River, and noted the difficulty of access for larger ships.

> Kawaa took passage in our canoe to go down the harbor to a place where oysters are abundant to give orders to his people to gather a mess. The sail down the harbor was delightful . . . The passage down the creek for a number of miles was very pleasant till we got down near the reef and our course altered. We then could sail no longer as the wind was against us. The sail was lowered the mast taken down and secured across the outrigger and the rowers plied their paddles [Journal of Levi Chamberlain 1822-1849, Hawaiian Mission Schools, Storage Case 4, p. 899, from Sterling and Summers 1978:51].

The first foreign attempt to survey Pearl Harbor was made in 1840 during the U.S. Exploring Expedition, led by Charles Wilkes.

> In this district is a large inlet of the sea, into which the river Ewa empties; at the entrance of this inlet is the village of Laeloa (at Kalaeloa Point): the shore is known by the name of Pearl River or harbour, from the circumstance that the pearl oyster is found here; and it is the only place in these islands where it occurs.
>
> The inlet has somewhat the appearance of a lagoon that has been partly filled up by alluvial deposits. At the request of the king, we made a survey of it: the depth of water at its mouth was found to be only fifteen feet; but after passing this coral bar, which is four hundred feet wide, the depth of water becomes ample for large ships, and the basin is sufficiently extensive to accommodate any number of vessels. If the water upon the bar should be deepened, which I doubt not can be effected, it would afford the best and most capacious harbour in the Pacific. . . . [Wilkes 1970:79].

Although Wilkes was impressed by the harbor, he was not at this time thinking of how this survey could benefit the American government in the future. In fact, Wilkes (1970:79) concluded, "As yet there is no necessity for such an operation, for the port of Honolulu is sufficient for all the present wants of the islands, and the trade that frequents them."

This had changed in less than 30 years, however. The U.S. military had tried to make a coaling station on Midway Island in 1869 by blasting through the coral reef to make a harbor; this plan failed. In 1873, General Schofield presented a confidential report to the U.S Secretary of War, recommending that Pearl Harbor should be available to the U.S. Navy. Schofield wrote:

> In case it should become the policy of the Government of the United States to obtain the possession of this harbor for naval purposes, jurisdiction over all the waters of Pearl River with the adjacent shores to the distance of 4 miles from any anchorage should be ceded to the United States by the Hawaiian Government. . . .
>
> The cession of Pearl River could probably be obtained by the United States in consideration of the repeal of the duty of Sandwich Island sugar. Indeed, the sugar –planters are so anxious for a reciprocity treaty, or so anxious rather for free trade in sugar with the United States, that many of them openly proclaim themselves in favor of annexation of these islands of the United States [Sen. Ex. Docs, 52nd Cong. 2nd Sess. No. 77, pp. 150-154, reproduced in Judd 1971:Appendix 3].

This reciprocity treaty was concluded in 1876 with the provision that Hawai'i would not "lease or relinquish sovereignty to another country or any harbor, etc." In 1887, the treaty was renewed and amended and allowed the United States the "exclusive right to enter the harbor of Pearl River, in the Island of Oahu, to establish and to maintain there a coaling and repair station for the use of vessels of the United States" (Judd 1971:128).

After annexation of the islands to the United States in 1899, development began in order to make a Pacific base that could be used as a staging area for the Spanish-American War (Coletta 1985:433). Dredging of the harbor began in 1901, and additional dredging to deepen and widen the channel was conducted in 1908 and again in the 1920s. Money for the funding of the construction of dry docks and other support facilities was approved in 1908. In 1931 the Navy built an ammunition depot at West Loch on a 213-acre parcel that it had bought from the Campbell Estate. Construction of a new depot in Lualualei Valley and at West Loch Harbor began in 1931.

In the early 1930s, the U.S. Navy leased 700 acres of the Campbell Estate to build Ewa Field, a base with a mooring mast for Navy dirigibles. Although the mast was completed, the program was abandoned before the *Akron*, the designated airship for the mast, was built. In 1937, 18 miles of roads were built in the coastal Honouliuli area, and in 1939-1940 the U.S. bought 3,500 acres of land in this area (Landrum et al 1997:62-67), to build several other military camps and installations, including Barbers Point Naval Air Station, at the site of the old mooring mast.

On December 7, 1941 the Japanese Navy launched the devastating surprise attack on the United States base at Pearl Harbor and other military facilities. Although the major battle damage to the US Pacific Fleet was at its base at Ford Island in the Middle Loch of Pearl Harbor, Honouliuli did not escape unscathed.

> The Waipahu and Ewa sugar plantation, next to Pearl Harbor and the town of Wahiawa, adjoining Schofield Barracks, saw more action than did Honolulu.
>
> At Waipahu, machine gun bullets, shrapnel, and shells started two cane fires, riddled the sugar mill, hit the plantation hospital in four places, went through the roof of the company store, exploding in an electric supply warehouse, and narrowly missed many houses. In nearly all of the fields of tall cane, many of which contained terrified women and children, shells buried themselves-dozens of

> them in some concentrated areas-blasting holes in the ground the size of barrels, and flattening cane for several square yards.
>
> At Ewa, after bombing the nearby Marine airfield [at Barbers Point], enemy planes machine-gunned the plantation's main street, the mill and power plant and some 30 houses and started two cane fires [Allen 1999:20].

The attack had consequences not only for the military, but also for the civilians, mostly Japanese, who lived around West Loch.

> Two permanent local evacuations were ordered in the first month of the war, partly to remove civilians from areas which might be dangerous in event of further attack and partly to protect installations from possible sabotage or espionage activities. On a Thursday less than two weeks after the bombing, farmers adjacent to West Loch at Pearl Harbor were ordered to leave their farms by sundown. The order was modified to allow two days to prepare and the men were permitted to return to their farms during daylight until livestock could be moved and crops harvested. The displaced farmers, who had only recently been established at West Loch by the Farm Security Administration were forced to seek temporary housing with friends and relatives at Ewa plantation. Since they had invested in the enterprises practically all of their life's savings and considerable money borrowed from the FSA as well, several suffered heavy losses [Allen 1999:122].

Section 4 Previous Archaeological Research

4.1 Early Archaeological Surveys

All archaeological projects conducted in Honouliuli and Pu'uloa are listed in Table 1. Two archaeological features, a boundary *pōhaku* or rock and a *hōlua*, or sledding site, are recorded only in the Boundary Commission Reports establishing the division lines between the *ahupua'a* of Honouliuli and Hō'ae'ae (to the east). The surveyor wrote of the southern point of this boundary:

> In regard to Hoaeae . . . the point of commencement is Pōhaku Palahalaha, a well known rock, now marked by an arrow and the name "Honouliuli" on one side and "Hoaeae" on the other, which I have made the initial point of the survey . . . [Boundary Commission Vol. 1:243].

This rock is shown on the Sterling and Summer map (see Figure 9) as Pōhaku Palaha. In another boundary survey, the *pōhaku* is called a "large, flat rock" (Boundary Commission Vol. 1:249), which may indicate the origin of the name from the Hawaiian word *pālaha*, which means "flattened, wide" (Pukui and Elbert 1986:307). As the surveyor continued to walk the Honouliuli/Hō'ae'ae boundary, he marked the northern point of the division as:

> The Kamaaaina took me to the corner of Pauhala (?)-Hoaeae and Honouliuli – there is an ancient holua or sleding [*sic*] place near this – which is agreed for the ancient corner. . . [Boundary Commission Vol. 1:243].

The earliest attempt to record archaeological remains in Honouliuli Ahupua'a was made by Thrum (1906:46). He reported the existence of a *heiau* located on Pu'uokapolei, west of the present study area. In a second monograph on *heiau*, Thrum (1917) called this *heiau* Palole'i (Kapolei). Emory mapped and photographed these structures in 1933 (field notes), but they were dismantled and destroyed sometime before McAllister's survey of the islands in the 1930s. According to legend, Pu'u Kapolei was the location on which Kamapua'a, the pig-god, resided with his grandmother, Kamaunuahihio (McAllister 1933:108).

In his surface survey of the 1930s, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister recorded seven specific sites at Honouliuli (numbered 133-139; McAllister 1933:107-108) (see Figure 9), and these became the first seven sites in the Bishop Museum's Site Numbering System (OA-B6-1 through OA-B6-7).

The first six sites are in the upland section of Honouliuli, *mauka* of the 'Ewa coral plain and Pu'u o Kapolei. Site 133 is a possible *heiau*, a small enclosure at the foot of Pu'u Kānehoa. It was still standing during McAllister's day, and local residents informed him of its sacred nature. Site 134 is Pu'u Kuina Heiau, located in a gulch at the foot of Mauna Kapu. Only traces of a large terrace remained. Site 135 is a series of enclosures *makai* of Pu'u Kuina Heiau. McAllister believed that the walls marked *kuleana* lots. Site 136 is a small platform near Mauna Kapu, a sacred site, possibly an altar. Site 137 is Pu'u Ku'ua Heiau, plotted on a ridge near Pu'u Ku'ua; it

Table 3. Previous archaeological work in Honouliuli and Pu'uloa

Author	Report Type	Location
Thrum 1906	Heiau study	Hawaiian Islands
McAllister 1933	All island survey	O'ahu Island
Kikuchi 1959	Site letter report	Barbers Point
Bowen and Soehren 1962	Burial Discovery	Barbers Point
Soehren 1964	Site letter report	Waimanalo Gulch
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
McCoy 1972	Survey	Pu'uloa Elementary School Site
Hommon 1973	Survey and Excavations	Honouliuli
Barrera 1975	Reconnaissance survey	Barbers Point (harbor area)
Clark and Connolly 1975	Reconnaissance survey	Barbers Point (harbor area)
Oshima 1975	Reconnaissance survey	Barbers Point
Sinoto 1976	Cultural resources survey	Barbers Point (harbor area)
Bordner 1977a	Reconnaissance survey	Kalo'i Gulch
Bordner 1977b	Reconnaissance survey	Makaiwa Gulch
Clark 1977	Reconnaissance survey	Puu O Kapolei
Connolly and Clark 1977	Reconnaissance survey	Puu O Kapolei
Davis 1978	Scholarly paper	Barbers Point (harbor area)
Davis and Griffin 1978	Archaeological Survey	Barbers Point (harbor area)
Hawai'i Marine Research Inc. 1978	Geoarchaeological reconnaissance	Barbers Point (harbor area)
Kirch 1978	Land snail study	Barbers Point (harbor area)
Sinoto 1978a	Reconnaissance Survey and Burial Salvage	NAVMAG -West Loch
Sinoto 1978b	Archaeological & Paleontological salvage	Barbers Point (harbor area)
Barrera 1979	Archaeological Survey	West Beach
Clark 1979	Reconnaissance survey	Barbers Point (harbor area)
Cleghorn 1979	Reconnaissance survey	Barbers Point
Davis 1979a	Emergency excavations	Barbers Point (harbor area)
Davis 1979b	Emergency excavations	Barbers Point (harbor area)
Davis 1979c	Emergency excavations	Barbers Point (harbor area)
Jourdane 1979	Reconnaissance Survey	'Ewa Marina Community
Komori and Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
Ahlo 1980	Reconnaissance survey	Solid Waste Processing Facility
Davis 1980	Research design	Barbers Point
Kirch and Christensen 1980	Land snail study	Barbers Point (harbor area)
Christensen and Kirch 1981	Land snail study	Barbers Point (harbor area)
Hammatt and Folk 1981	Archaeological and Paleontological	Barbers Point (harbor area)
Davis 1982	Academic paper	Barbers Point
McCoy et al. 1982	Proposal for investigations	Barbers Point (harbor area)
Neller 1982	Scholarly study	Barbers Point
Ahlo and Hommon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch
Davis 1983	Archaeological & Paleontological Excavations	Barbers Point
Ahlo and Hommon 1984	Test excavations	Barbers Point (harbor area)

Author	Report Type	Location
Hammatt 1984a	Reconnaissance survey	Kahe Point
Hammatt 1984b	Reconnaissance survey	Ewa Marina Community
Haun and Kelly 1984	Research design	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
Barrera 1985	Survey report	West Beach
Neller 1985	Review and evaluation	West Beach
Barrera 1986	Archaeological Investigations	West Beach
Davis and Haun 1986	Intensive survey and test excavations	West Beach
Davis et al. 1986a, b	Research design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Athens & Pietrusewsky 1987	Burial documentation	Iroquois Point
Davis and Haun 1987	Intensive survey & test excavations	West Beach
Dicks et al. 1987	Reconnaissance survey	West Loch
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Reconnaissance survey	Ko Olina Resort
Rosendahl 1987c	Reconnaissance survey	West Loch
Rosendahl 1987d	Reconnaissance survey	Kapolei Golf Course
Welch 1987	Reconnaissance survey	Naval Air Station
Davis 1988a	Subsurface Survey	'Ewa Gentry
Davis 1988b	Reconnaissance survey	Barbers Point HECO
Kennedy 1988a	Reconnaissance survey	'Ewa Gentry
Kennedy 1988b	Field Report	Waiau-Campbell Industrial Park
Rosendahl 1988	Reconnaissance survey	Camp Malakole
Sinoto 1988a	Reconnaissance survey	'Ewa Golf Course
Sinoto 1988b	Reconnaissance survey	Makakilo Golf Course
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial documentation	Kahe
Bath 1989c	Burial documentation	West Loch – Hō'ae'ae Point
Burgett and Rosendahl 1989	Subsurface archaeological testing	North of O.R.&L.
Hammatt and Shideler 1989a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1989b	Reconnaissance survey	Kahe Point
Carlson and Rosendahl 1990	Inventory survey	Kaomi Loop Subdivision
Cleghorn and Davis 1990	Archaeological and paleontological	Barbers Point (harbor area)
Collin and Kennedy 1990	Burial documentation	Pu'uloa Golf Course
Davis 1990a	Archaeological and paleontological study	Barbers Point (harbor area)
Davis 1990b	Archaeological and paleontological	Barbers Point (HECO area)
Davis et al. 1990	Survey and Test Excavations	Ewa Marina Community
Hammatt and Shideler 1990	Inventory survey	West Loch Bluffs
Hammatt, Robins, et al. 1990	Inventory survey	Makaiwa Hills
Hammatt, Shideler, et al. 1990	Inventory Survey	'Ewa Villages
Kawachi 1990	Inadvertent Burial find	Campbell Industrial Park
Miller 1990	Inadvertent Burial find	Barbers Point, Nimitz Beach
Rosendahl 1990a	Letter report	Kapolei Golf Course
Rosendahl 1990b	Archaeological Survey and Test Excavations	'Ewa Marina Community
Davis and Burtchard 1991	Inventory Survey	NAVMAG-West Loch
Dunn et al. 1991	Inventory Survey and Test Excavations	'Ewa Marina Community

Author	Report Type	Location
Folk 1991	Reconnaissance Survey	Kapolei Town
Goodman and Cleghorn 1991	Surface Survey	Laulani Fairways Housing
Kennedy 1991	Subsurface testing	Pu'u o Kapolei
Hammatt 1991	Reconnaissance Survey	Honouliuli Livestock Park
Hammatt and Shideler 1991a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1991b	Inventory Survey	St. Francis Medical Center West
Haun et al. 1991	Survey report	Naval Air Station
Burgett and Rosendahl 1992	Inventory survey	Barbers Point (harbor area)
Charvet-Pond and Davis 1992	Data Recovery	West Beach
Cleghorn and Anderson 1992	Inventory survey	Kahe Point
Hammatt and Folk 1992	Subsurface testing	Barbers Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Folk 1992	Subsurface Testing	Barbers Point
Hammatt 1992	Inventory Survey	Palikea
Jayatilaka et al. 1992	Survey and Test Excavations	Hawai'i Prince Golf Course
Kennedy et al. 1992	Inventory Survey	Pu'uloa Golf Course
Shideler et al. 1992	Assessment	Kahe Point
Trembly et al. 1992	Burial documentation	West Beach
Davis 1993	Archaeological and paleontological	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Goodman et al. 1993	Reconnaissance Survey	20-acre Commercial Project
Jones 1993	Fossil coral reefs study (Ph.D. dissertation)	Hawaiian Islands
Landrum and Schilz 1993	Reconnaissance and subsurface testing	Naval Air Station
Miller et al. 1993	Data recovery	Barbers Point (harbor area)
Nakamura et al. 1993	Inventory survey	Makakilo
Pantaleo and Sinoto 1993	Inventory survey	Ewa Gentry
Hammatt and Shideler 1994	Archaeological assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory survey	Barbers Point (harbor area)
Tuggle 1994	Inventory survey	Barbers Point
Davis et al. 1995	Archaeological & Paleontological Investigations	Barbers Point (harbor area)
Dye 1995	Burial documentation	Barbers Point
Franklin 1995	Data Recovery	Ewa Marina Community
Hammatt and Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
Yoklavich et al. 1995	CRM Overview	Barbers Point
Corbin et al. 1996	Reconnaissance Survey	Laulaunui Island
O'Hare et al. 1996	Intensive survey and testing	Naval Air Station
Spear 1996	Archaeological Survey	Honouliuli Treatment Plant
Athens et al. 1997	Cultural resources, paleoenvironmental	'Ewa Plain: Naval Air Station
Schilz and Landrum 1996	Test Excavations	Barbers Point
Spear 1996	Reconnaissance Survey	Kapolei Town
Borthwick 1997	Assessment	Palehua, Honouliuli
Hammatt 1997	Inventory survey	Pu'uloa
Hammatt and Chiogioji 1997	Reconnaissance Survey	Corridor in Honouliuli
Jensen and Head 1997	Reconnaissance Survey	NAVMAG-West Loch
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	'Ewa Plain

Author	Report Type	Location
Tuggle and Tomonari 1997a,b	Cultural resource inventory survey	Naval Air Station
Wickler and Tuggle 1997	Cultural resources, Inventory Survey	Naval Air Station
Wolforth and Wulzen 1997	Data Recovery	West Loch Estates
Wulzen and Rosendahl 1997	Data Recovery	Barbers Point Nimitz Beach
Goodfellow et al.	1998	West Loch
Hammatt and Shideler 1999	Inventory survey	Waimanalo Gulch
Magnuson 1999	Reconnaissance Survey	Farrington Hwy.
McDermott et al. 2000	Data recovery	Barbers Point (harbor area)
Elmore et al. 2001	Honouliuli	Pu'u Kapolei/Fort Barrette
Ostroff *et al.* 2001	Inventory survey	Pu'uokapolei
Tulchin et al. 2001	Inventory survey	'Ewa Shaft Renovation
McIntosh and Cleghorn 2003	Inventory survey	'Ewa Gentry Makai
Cordy and Hammatt 2003	Archaeological assessment	Barbers Point, North of O.R.&L.
O'Hare et al. 2005	Field Check	Kapolei Property
O'Hare et al. 2004	Documentation of Plantation Infrastructure	North of O.R.&L.
Terry et al. 2004	Archaeological Inventory Survey of Two	North of O.R.&L.
Hoffman et al. 2004	Archaeological inventory Survey	Between OR&L and Barbers Point

had been modified for use as a cattle pen; some areas had been cleared for pineapple cultivation or planted with ironwoods. Site 138 is Pu'u Kapolei Heiau, which had been on the *makai* side of the hill before it was destroyed. The stones of the structure had been crushed in a nearby rock crusher. McAllister was also told that there was once a cave on the hill, in which Kamapua'a and his grandmother lived (McAllister 1933:107-108).

The remaining eight sites recorded by McAllister are adjacent to Pearl Harbor or the coast. Site 139 is Kalanamaihiki Ko'a (fishing shrine) at Kapapapuhi Point (north of the current study area). McAllister described it as "two large rough stones about 2.5 feet in size, with six or seven smooth stones averaging 1 foot in size in a small pile adjoining the larger stones." Site 140 is a 4-5 acre fishpond on Laulaunui Island in West Loch, opposite Kapapapuhi Point. McAllister recorded the entire West Loch of Pearl Harbor as Site 141, Kaihuopala'ai. Although some versions of the legend of the traveling mullet (see Section 3.1, Mythological and Traditional Accounts) say that there was a fishpond called Kaihuopala'ai, McAllister recorded that local informants said there was never a fishpond by that name here; rather it was the name for the loch. Site 142 is Kapamuku, or Pamoku fishpond, a 3-acre fishpond, located south of the current study area, opposite the tip of Waipi'o peninsula. Site 143 is 'Oki'okiolepe fishpond, south of Loko Pamoku. The walls of this 6-acre fishpond were made of coral.

McAllister records Site 144 as the location of fish traps and a fishing shrine described by Stokes in his study of the fishtraps of Pearl Harbor. This is the location of the fishtraps Kapākule (Pākule) and Kepo'okala, as described by Samuel Kamakau (1976:88). McAllister listed Site 145 as Pu'uloa, a legendary site where the first breadfruit was planted. It is not known whether Pu'uloa referred to is the '*ili* of Pu'uloa or the harbor of Pu'uloa, or an area within the '*ili* near the harbor. Site 146 covers the entire 'Ewa coral plain. This includes historic features, such as cattle walls and the walls near the Pu'uloa Salt Works, pre-Contact sites such as habitation,

agricultural, and fishpond sites recorded by early European explorers, and paleontological sites, where in recent years many fossil bird bones have been discovered (McAllister 1933:108-110).

Between McAllister's 1930s study and the flurry of work that began in 1969, there are only a few sporadic pieces of research, which are not well documented. In 1933, Dr. Kenneth P. Emory recorded a well-preserved house site and a possible *heiau* (later destroyed by sugar cane cultivation) in the western part of the coral plains (Sinoto 1976:1). In 1959, William Kikuchi removed a number of burials from a burial cave site (Bishop Museum Site OA-B6-10) at the Standard Oil Refinery, which was subsequently destroyed (Barrera 1975:1). Kikuchi recovered 12-16 incomplete primary and/or secondary burials cached in a sinkhole or crevice exposed during construction activities near the big bend in Malakole Road (Kikuchi 1959; Davis 1990b: 146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling visited a house site (BPBM. Site OA-B6-8) within 'Ēkaha Nui Gulch. "Around this elevation (1200 feet), along the sides of the stream, were seen remains of many terraces and some house sites" (Sterling and Summers 1978:37). In 1962, Lloyd Soehren recorded another secondary human burial in a sinkhole at the Barbers Point Naval Air Station (Davis 1990a:147). In 1966, Lloyd Soehren carried out salvage excavations at a possible fishing shrine (BPBM. Site # 50-OA-B6-13). The site was reported as destroyed by construction (Barrera 1975:1), but Davis relocated the shrine and performed additional excavations in 1982 (Davis 1990a:148).

4.2 Previous Archaeological Work near Honouliuli town

Beginning in the late 1970s, archaeological research has been conducted in Honouliuli in the general vicinity of the present study area (Figure 24). Work has been focused on the West Loch Estates (east of the current project area), Pearl Harbor Naval Magazine (NAVMAG) – West Loch (east of the current project area), the 'Ewa Gentry project (south of the current study area), and 'Ewa Villages (south of the project area).

4.2.1 West Loch Estates

An archaeological reconnaissance survey (Rosendahl 1987c) was conducted in association with the development of the 232-acre "West Loch Estates" Residential Increments I and II (golf course and parks) project, which lies to the east of the present study area, in the section of the Honouliuli Taro lands adjacent to Pearl Harbor. This project covered portions of the old town of Honouliuli, the focus of population in the early historic period (and possibly earlier). This study identified a modern cemetery (Site 3319) with a remnant pre-Contact deposit, two historic sites of minimal integrity with some possible pre-Contact deposits (Site 3318 and 3320) at Kapapapuhi Point, a significant pre-Contact deposit with trash pits, fire pits and at least one human burial (Site 3321), a buried fishpond (Site 3322), an historic fishpond (Site 3323) built in the 1890s during the construction of the OR& L railroad, and a buried pond field system (Site 3324) (Rosendahl 1987c:7, 9). It was noted that some artifacts "indicate the possibility of pre-1900 occupation" (Rosendahl. 1987c:8). As noted in the final reconnaissance survey report (Dicks et al. 1987:28) for the surface and subsurface reconnaissance survey, an effort was also made to relocate McAllister's Site 139, Kalanamaihiki Ko'a (fishing shrine). The archaeologists

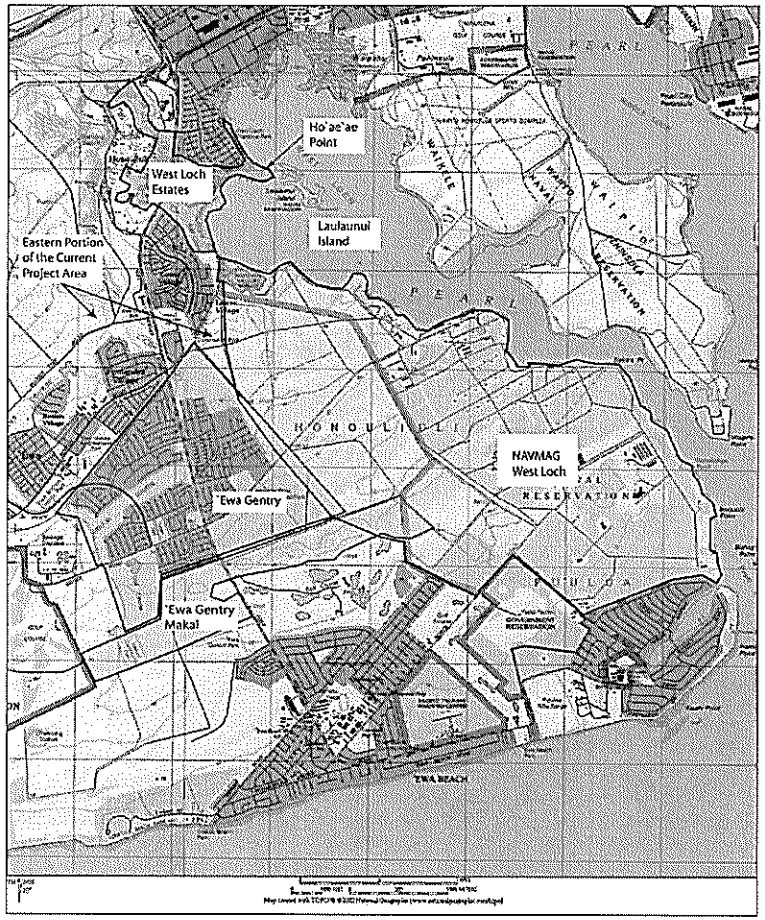


Figure 24. U.S. Geological Survey topographic map, showing previous archaeological project areas near the current study area

found a small boathouse and dock in the area and concluded that the shrine had been destroyed since McAllister's survey in the 1930s.

A total of 21 radiocarbon dates were determined; at Site 3321, the cultural deposit, the age of a lower cultural deposit was dated to A.D. 540-880, while an upper deposit was dated to A.D. 1327-1640. For the buried fishpond (Site 3322), ages ranged from A.D. 70-610 in the lowest layer to A.D. 1160-1410 in the upper layer. For the buried pond field systems (Site 3324), ages ranged from B.C. 400-A.D. 240 (interpreted as the original surface of the upper valley) in the lowest layers to A.D. 1430-1952 in the upper layers of upper valley area and A.D. 1020-1280 in lower valley area. In summary, the authors (Dicks et al. 1987:78-79) concluded that agricultural use of the Honouliuli Stream floodplain for pondfield cultivation of taro may have begun in the lower valley segment as early as A.D. 1000, while cultivation of the upper valley pondfields may have begun as early as the thirteenth and fourteenth centuries. Site 3321in the upper valley may have been a habitation locus established as early as the mid-sixth to mid-ninth century (Wolforth et al. 1998).

In 1989, a burial was found on Ho'ae'ae Point (formerly called Papapuhi Point), when someone was digging under a mango tree on a residential property. There is no follow-up report (Bath 1989) to whether the bones were left in place or disinterred. The burial was given the site designation 50-80-13-4816.

4.2.2 NAVMAG – West Loch

In 1978, Sinoto conducted an archaeological reconnaissance survey on a 32-acre portion of NAVMAG-West Loch. A sinkhole 200 m inland and northwest of 'Oki'okiolepe Fishpond was found, containing ten human burials (Site 50-80-13-2310). Historic artifacts were found in the pit, enough to determine that the pit was probably used by the Chinese in the historic period as a family crypt (Sinoto 1978a).

Davis and Burtchard (1991) conducted an archaeological inventory survey of a 36-acre lot for a proposed housing area in the Pu'uloa portion of NAVMAG-West Loch in 1991. No archaeological sites were found. They concluded that extensive alteration to the landscape due to military land disturbance had erased all surface traces of pre-Contact habitation.

In 1992, a crew from Archaeological Consultants of Hawai'i, Inc. (ARCH) conducted an archaeological inventory survey with subsurface testing, and later data recovery at the proposed Pu'uloa Golf Course (Kennedy et al. 1992). A total of 72 sites were identified, 47 from the pre-Contact/early historic period and 25 sites associated with ranching, military training, and modern quarrying. Radiocarbon dates of these habitation, agricultural, and ceremonial sites indicate that traditional Hawaiian use extended from A.D. 1090 to 1695.

An overview survey of the NAVMAG Lualualei was completed by Ogden Environmental and Energy Services in 1977 (Landrum et al. 1977). A total of ten sites had been previously recorded in the West Loch project area, three in the Honouliuli section, one within Pearl Harbor (Site 140, Laulaunui Island), five on Waipi'o peninsula, one in both (salt works), and one encompassing all lands (Pearl Harbor Navy Base). In Honouliuli, the sites were Site 141, Kaihuopala'ai (West Loch), Site 142, Loko Pamoku or Kapamuku, Site 143, 'Oki'okiolepe Fishpond, and salt works at Honouliuli (no site designation). NAVMAG-West Loch is considered part of the Pearl Harbor Navy Base (Site 50-80-13-9992) due to its importance during World War II. The site was listed

as a National Historic Landmark in 1966, on the National Register of Historic Places (NRHP) in 1966, on the State Inventory of Historic Places (SIHP), in 1971, and on the State Register of Historic Places in 1971 (Landrum et al. 1977:160).

In 1996, a crew from Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed a Phase I archaeological reconnaissance survey of the 1,483 acres of land at the U.S. Naval Magazine – West Loch Branch (Jensen and Head 1997). This survey covered the southern section of Waipi'o peninsula on the east side of West Loch, Laulaunui Island, the Naval Reservation on the west side of West Loch, and the West Loch Outleased Cultivated Lands, which included the National Wildlife Refuge. Only 25% of the outleased lands were actually surveyed. The PHRI crew found that most of the outleased area had been bulldozed for sugarcane cultivation. Only a small strip adjacent to West Loch was unmodified. In the West Loch Outleased Lands, eight features were recorded; all but one was associated with military use of the area. The seven military sites consisted of six concrete slabs (Sites 50-80-13-5040, 5080, 5081, 5133, 5134), a metal container (5080), and a pressure tank (5133). The one non-military site (4971) was a cave with a partially blocked (blocked with roof fall) entrance that the crew members believed should be investigated in the future to see if it at one time was used as a pre-Contact or historic burial site (Jensen and Head 1997:85).

In 1996, a field reconnaissance of Laulaunui Island and fishpond was conducted by the State Historic Preservation Division (Corbin et al. 1996) to determine if restoration of the fishpond was possible and if the site would be a good candidate to be used as an educational tool. The crew simply walked to the island from the West Loch Waterfront Park; water depth varied from one to four ft. Five concrete structures, probably built by the military, were observed. The fishpond was surrounded by mangroves and was silted in; portions of a coral wall (about 500 ft long) around the pond were still intact, and a concrete gate allowed water to circulate into the pond.

4.2.3 'Ewa Villages

In 1990, Cultural Surveys Hawaii conducted an archaeological reconnaissance survey of a 616-acre area, which included three extant plantation villages, (Renton, Tenney, and Varona Village), the sites of three former plantation villages (C Village, Mill Village, Middle Village), and other sites associated with the 'Ewa Plantation infrastructure (Hammatt, Shideler, et al. 1990:i). The survey found no evidence of any pre-Contact activity within the project area and recommended further documentation of some of the ruined plantation structure sites.

In 1996, Scientific Consultant Services (Spear 1996) conducted an archaeological survey in an area west of the Tenney and Varona plantation villages and north of the Honouliuli Treatment Plant. No archaeological sites were identified.

4.2.4 'Ewa Gentry Project

In the initial reconnaissance (Kennedy 1988a) of the 1,016 acre 'Ewa Gentry project area, no surface evidence of potentially significant pre-Contact remains was found. The old OR&L railroad bed/right of way (Site 50-80-12-9714) did form a portion of the *mauka* boundary. According to historic maps, a Filipino Camp for sugarcane workers once existed near the

intersection of the OR&L bed and a cane road near Ft. Weaver Road, but the archaeologists could find no surface remains for this camp.

A subsequent subsurface exploration was undertaken. Eighteen backhoe trenches were excavated; however, "no evidence of past in situ cultural activity was found anywhere in the Ewa Gentry project area" (Davis 1988).

An inventory survey was conducted in 1993 by Aki Sinoto Consulting (ASC) (Pantaleo and Sinoto 1993) for the 'Ewa Gentry Off-Site Drainage System. This proposed drainage project area is a narrow strip that extends along the western boundary NAVMAG West Loch, and is adjacent to the southern non-contiguous parcel (TMK 9-1-010:002) for the current study. An 1897 map of Pearl Harbor indicated that the OR&L railroad, salt pans, and a fishpond were within this project area; only the railroad bed was found during the ASC survey. Iron flumes and concrete culverts (one with an inscribed date of July 1935) used for sugarcane irrigation were found bulldozed to the edge of the sugar cane fields near the dropoff to the shoreline of Pearl Harbor. These were not considered historically significant due to the absence of structural and locational integrity. No further archaeological work was recommended for this project prior to commencement of construction of the drainage system.

In 2003, Pacific Legacy (McIntosh and Cleghorn 2003) conducted an archaeological survey of the proposed 'Ewa Gentry Makai Development project area, which is adjacent to the southern (*makai*) boundary of the 'Ewa Gentry project area for the 1988 surface and subsurface inventory surveys (Kennedy 1988a; Davis 1988).

4.2.5 Previous Archaeology in the Current Project Area

As noted previously, and as discussed in more detail in the next section, a 546-acre portion of the current project area (the southeastern section) was previously surveyed in 1990 by a crew from Cultural Surveys Hawai'i. In 2005, a field assessment was conducted over the entire current project area by archaeologists from the firm Archaeological Consultants of the Pacific, Inc. (Elison and Kouneski 2005). The archaeologists found one "stone-faced hill" in the northern section of the project area (north of Farrington Highway), but did not describe it further. The report presents recommendations for field work in the different sections of the project area, concluding that the majority of the project area is farm land and did not need to be surveyed. Only the area around Honouliuli Gulch, and other areas of natural vegetation in the northern section needed to be surveyed.

4.3 Background Summary and Predictive Model

4.3.1 Honouliuli Settlement Patterns

The *ahupua'a* of Honouliuli is the largest traditional land unit on the island of O'ahu. Honouliuli includes all the land from the western boundary of Pearl Harbor (West Loch) westward to the 'Ewa/Wai'anae District Boundary with the exception of the west side of the harbor entrance, which is in the *ahupua'a* of Pu'uloa (the 'Ewa Beach/Iroquois Point area). This comprises approximately 12 miles of open coastline from One'ula westward to Pili O Kahe. The *ahupua'a* extends *mauka* (almost pie-shaped) from West Loch nearly to Schofield Barracks, and

the western boundary is the Wai'anae Mountain crest running *makai* to the east ridge of Nānākuli Valley.

Not only is there a long coastline fronting the normally calm waters of leeward O'ahu, but there are also four miles of waterfront along West Loch. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless "desert" plain marked in pre-Contact times (previous to alluviation caused by sugar cultivation) by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Wai'anae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat 'Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch.

Honouliuli Ahupua'a, as a traditional land unit, had abundant and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain, which is the most readily visible terrain, does not do justice to the *ahupua'a* as a whole. The richness of this land unit is marked by the following available resources:

1) 12 miles of coastline with continuous shallow fringing reef, which offered rich marine resources.

2) Four miles of frontage on the waters of West Loch, which offered extensive fisheries (mullet, *awa*, shellfish), as well as frontage suitable for development of fishponds.

3) The lower portion of Honouliuli Valley in the 'Ewa plain offered rich level alluvial soils with plentiful water for irrigation from the stream as well as abundant springs. This land would have stretched well up the valley.

4) A broad limestone plain, which because of innumerable limestone sinkholes, offered a nesting home for a large population of avifauna. This resource may have been one of the early attractions to human settlement.

5) An extensive upland forest zone extending as much as 12 miles inland from the edge to the coastal plain. As Handy and Handy (1972:469) have pointed out, the forest was much more distant from the lowlands here than it was on the windward side, but on the leeward side was more extensive. Much of the upper reaches of the *ahupua'a* would have had species-diverse forest with *kukui*, *'ōhia*, sandalwood, *hau*, *ti*, banana, etc.

Within this natural setting, archaeological and traditional sources show a general pattern of three main areas of settlement within the *ahupua'a*: a coastal zone, the Honouliuli taro lands, and inland settlement at Pu'u Ku'ua.

4.3.2 The Coastal Zone - Kalaeloa (Barbers Point), Ko'ōlina (West Beach)

Kalaeloa (Barbers Point)

Archaeological research at Barbers Point has focused on the areas in and around the newly constructed Deep Draft Harbor (Barrera 1975; Davis and Griffin, 1978; Hammatt and Folk, 1981, McDermott et al. 2000). Series of small clustered shelters, enclosures and platforms show limited but recurrent use at the shoreline zone for marine-oriented exploitation. This settlement covers much of the shoreline with more concentrated features around small marshes and wet sinks. Immediately behind the shoreline, under a linear dune deposit, is a buried cultural layer believed to contain some of the earliest habitation evidence in the area.

The attraction of the area to early Hawaiians was the plentiful and easily exploited bird population. Particular evidence for taking of petrels occurs at Site -2763 (Hammatt and Folk, 197:213). Initial heavy exploitation of nesting seabirds and other species in conjunction with habitat destruction probably led to early extinction. There is some indication of limited agriculture in mulched sinkholes and limited soil areas. Considering rainfall, this activity would have been limited, but probably involved tree crops and roots (sweet potatoes). The archaeological content of the sites indicates a major focus on marine resources.

Davis and Griffin (1978) distinguish functional classes of sites, based on surface area size and argues that the Barbers Point settlement consists of functionally integrated multi-household residence groups. Density contours of midden (by weight) and artifacts (by numbers) plotted for residence sites by Hammatt and Folk (1981) generally indicate narrowly defined spatial foci of discard, possibly indicating continuous use, or at least with no refurbishing or additions to the structures through time (Hammatt and Folk 1981). The focus is small habitation sites, typically lacking the full range of features found in large permanent residence complexes such as high platforms, complex enclosures, and ceremonial sites.

Ko'ōlina (West Beach)

There are three available studies on the Ko'ōlina project area (Davis et a. 1986a; Davis et al. 1986b; and Davis and Haun 1987).

Davis documents around 180 component features at 48 sites and site complexes consisting of habitation sites, gardening areas, and human burials. Chronologically the occupation covers the entire span of Hawaiian settlement, in what Davis and Haun describe as "one of the longest local sequences in Hawaiian prehistory" (Davis and Haun 1987:37). The earliest part of the sequence relates to the discovery of an inland marsh, and early dates were also obtained for the beachfront site and an inland rock shelter.

4.3.3 Honouliuli Taro Lands

Centered around the west side of Pearl Harbor at Honouliuli Stream and its broad outlet into the West Loch are the rich irrigated lands of the *'ili* of Honouliuli, which give the *ahupua'a* its name. The major archaeological reference to this area is Dicks, Haun, and Rosendahl (1987) who

documented remnants of a once-widespread wetland system (*lo'i* and fishponds) as well as dryland cultivation of the adjacent slopes. The current study area is within this environmental zone.

The area bordering West Loch was clearly a major focus of population within the Hawaiian Islands, and this was a logical response to the abundance of fish and shellfish resources in close proximity to a wide expanse of well-irrigated bottomland suitable for wetland taro cultivation. The earliest detailed map (Malden 1825) shows all the roads of southwest O'ahu coalescing and descending the *pali* (cliff) as they funnel into the locality (i.e. Honouliuli Village). Dicks et al. (1987:78-79) conclude, on the basis of 19 carbon isotope dates and 3 volcanic glass dates that "Agricultural use of the area spans over 1,000 years." Undoubtedly, Honouliuli was a locus of habitation for thousands of Hawaiians. Pre-Contact population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census (Schmitt 1973:19) 1831-1832, the land (*'āina*) of Honouliuli contained 1026 men, women, and children. It is not clear whether this population relates to Honouliuli Village or the entire *ahupua'a*, but the village probably contained the vast majority of the district's population. The nature of the reported population structure for Honouliuli (less than 20% children under 12 years of age) and the fact that the population decreased more than 15% in the next 4 years (Schmitt 1973:22) suggests that the prehistoric population of Honouliuli Village may well have been significantly greater than it was in 1831-1832. A conservative estimate would be that tens of thousands of Hawaiians lived and died at Honouliuli Village.

4.3.4 Pu'uku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic in that there are relatively few documented archaeological sources. However, it is probable that the area around Pu'uku'ua, on the east side of the Wai'anae Ridge seven miles inland of the coast, was a Hawaiian place of some importance.

In 1899, Hawaiian Newspaper *Ka Loea Kālai'āina* relates a story of Pu'uku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

> There were two important things concerning this place. (1) This place was entirely deserted and left uninhabited and it seems that this happened before the coming of righteousness to Hawai'i Nei. Not an inhabitant is left. (2) The descendants of the people of this place were so mixed that they were all of one class. Here the gods became tired and returned to Kahiki [*Ka Loea Kālai'āina*, July 8, 1899, translated in Sterling and Summers 1978:33].

McAllister recorded three sites in this area, two *heiau* (134, 137) (Pu'u Kuina and Pu'uku'ua, both destroyed) and a series of enclosures in Kukuilua which he called "kuleana sites" (McAllister 1933). On the opposite side of the Wai'anae range, along the trail to Pōhākea Pass, Cordy (2002:36) states "Kākuihihewa was said to have built (or rebuilt) Nōi'ula, a *pō'okanaka heiau* (1,300 sq. m.) in Hālona in upper Lualualei, along the trail to Pōhākea Pass leading into 'Ewa, ca. A.D. 1640-1660" (Cordy 2002:36). There is no direct archaeological evidence available to the authors' knowledge that intensive Hawaiian settlement occurred here, but it is considered as a place of high probability, based on the above indications. John Papa 'Ī'ī (1959)

described a journey that Liholiho took which led him and an entourage through inland Honouliuli and over Pōhākea Pass. Geographically, the area receives sufficient quantities of water and would have had abundant locally available forest resources.

4.3.5 Summary

On the basis of archaeological studies, informed by historic records, the following may be concluded:

1) There are three areas of Hawaiian settlement in the *ahupua'a*; two are well-documented and one is problematic:
    a. the extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;
    b. the rich cultivated lands of Honouliuli 'ili for extensive wetland taro and clearly the *ahupua'a* population center; and,
    c. the uplands around Pu'uku'ua associated with *kauwā* residence but probably used for agriculture and forest resources.

2) Honouliuli is designed as a unit to contain all the geographic elements of a typical Hawaiian valley *ahupua'a*, except they are arranged geomorphically in an atypical relationship. The *ahupua'a* is not organized around a single drainage network but shares the west portions of Waikele drainage in its upper reaches. A typical and highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, an extensive limestone plain which would support only limited agriculture but would be excellent for bird catching in early times, and a huge expanse of sloping forest land. The richest forest land for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The surveys by Bordner (1983) and Hammatt and Shideler (1999) at Waimānalo Gulch indicated no evidence of Hawaiian occupation, but the gulch has been impacted in modern times (Bordner 1983).

3) The *makai* slope was not a major thoroughfare. We can see some very limited evidence of part-time agriculture in and around gulches and two foci of sparse habitation. The first is limited to *makai* portions of gulches and lava flats. This habitation is considered a *mauka* component or continuing of the Ko'ōlina coastal settlement rather than an independent focus. The second focus, separated from the first by a barren zone, is generally above the 800-foot elevation. This *mauka* habitation which could have been supported by seasonal dry land planting and forest foraging may be the lower portion of a thinly scattered, but widespread zone of settlement which stretches eastward and northeast along the east Wai'anae Range slopes and may increase in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

4) There is to date no archaeological evidence of high status residence in Honouliuli. Large residential structures are not present along the Pacific shoreline where they would be expected. The late prehistoric occurrence of chiefs' houses is not apparent, perhaps because the ocean shoreline, although rich in marine resources, is uninviting for sport and

unsuitable for fishponds. The chiefly focus of 'Ewa District was Waipi'o. Whatever activities of this class occurred in Honouliuli would have been in or near the rich lands fronting West Loch (the *'ili* of Honouliuli). Concerning status associations with Honouliuli, it is interesting to note the connection of the Pu'uku'ua settlement with slaves (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

5) The focus of population and agriculture within the *ahupua'a* of Honouliuli was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other prehistoric times, all other habitation zones were economically and socially co-dependent.

Section 5 Results of Fieldwork

5.1 1990 Survey Findings of the West Loch Bluffs Project Area

In 1990, the southeastern portion of the project area (a 546-acre parcel south of Farrington Highway then called West Loch Bluffs) was surveyed by CSH members (Hammatt and Shideler 1990). Five sites were recorded and given SIHP permanent site numbers (Figures 25-29). In addition, four areas of historical importance were researched. For the recent survey, these five previously identified sites were revisited and notes were made on their current condition. In addition, during the recent inventory survey, backhoe testing was conducted in the four areas identified in the 1990 CSH report as possibly containing important historical deposits or artifacts. Table 4 summarizes the findings of the 1990 survey and Figure 25 shows the location of sites and historically documented areas from the 1990 CSH survey.

Table 4. Sites Previously Identified during the 1990 CSH survey

SIHP 50-80-12-	Description	Function	Age
4344	Plantation infrastructure; 3 pipe features (destroyed sometime between 1990 and 2005)	Sugar cane cultivation and irrigation	Ewa and Oahu Plantation operated from 1890 to 1995
4345	Stone-faced Berm	Ewa Plantation Railroad Berm	The Ewa Plantation Railroad operated from 1890 to 1947
4346	Stone-lined Well & Associated Features	Pumping Station (Northern)	Pre-1928 to present
4347	Stone-lined Well & Associated Features	Pumping Station (Central)	Pre-1928 to present
4348	Stone-lined Well & Associated Features	Pumping Station (Southern)	ca. 1928 to present
No SIHP numbers were assigned to the next four areas since there were no surface remains			
	Land Court Awards (LCAs) in Honouliuli Taro Lands	Habitation and Agriculture	Documented in 1848; surviving to at least 1890 (founding of Ewa Plantation)
	Kapalani Catholic Church	Church, School, Residence; possibly cemetery	Built between 1840 and 1847 and destroyed between 1885 and 1890
	PipeLine Village	Plantation Camp for Portuguese and Puerto Rican workers; also a school and church	Some houses possibly built in 1890; main construction phase of 162 houses from 1906 to 1911; demolished in 1931
	Drivers and Stable Villages	Plantation Camp	Drivers Village probably built between 1900 and 1910; it was moved to a new location (outside the project area) in 1931; Stable Village seems to have consisted of only four houses

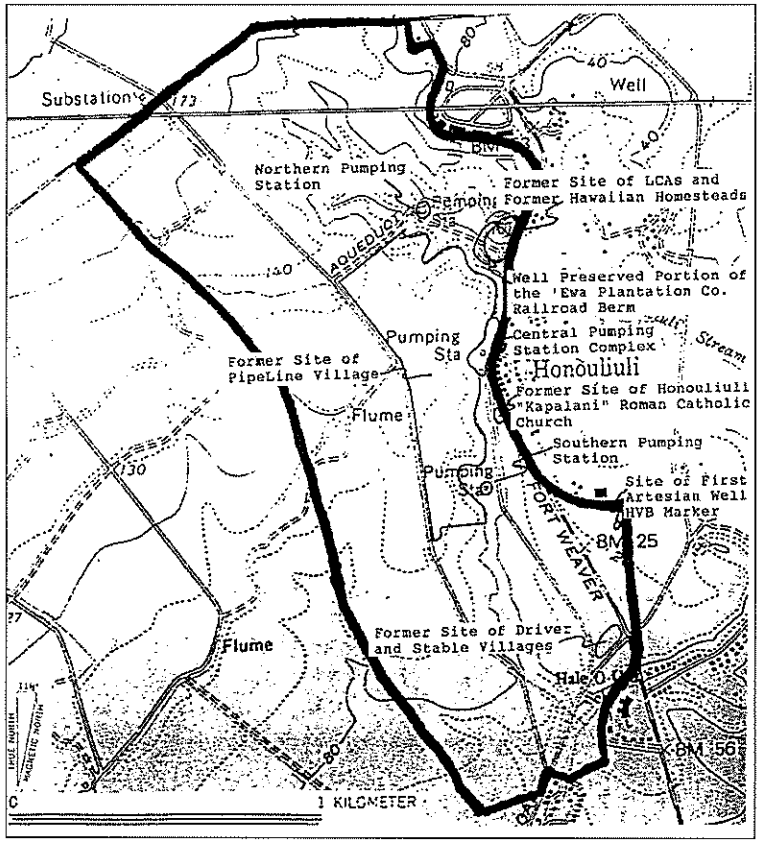


Figure 25. Map of sites and historically documented areas of interest identified during the 1990 CSH survey of a 546-acre parcel of the current project area

Figure 26. Site 50-80-12-4345, Stone-faced berm for Ewa Plantation railroad, view to the north

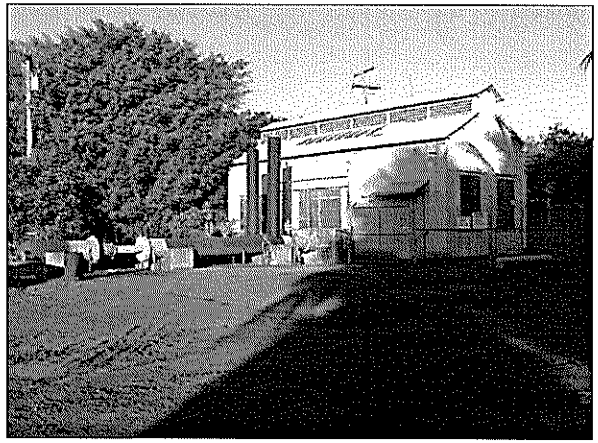


Figure 27. Site 50-80-12-4346, northern pumping station, view to the northwest

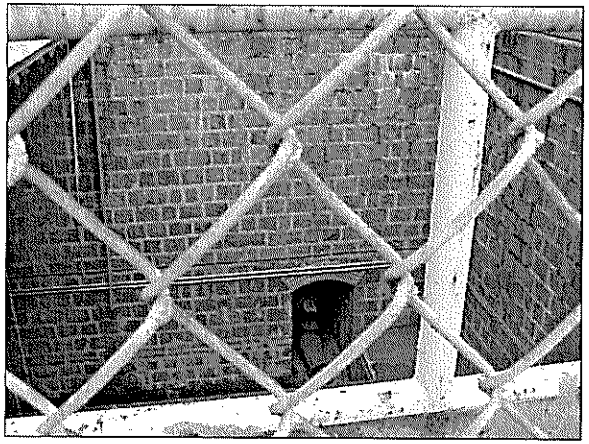


Figure 28. Site 50-80-12-4347, well wall of central pumping station, view to the north

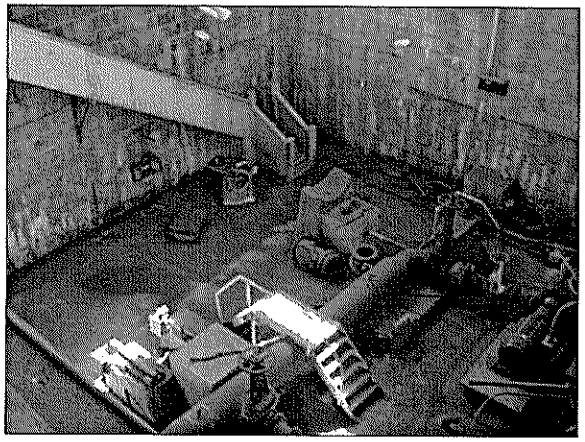


Figure 29. Site 50-80-12-4348, interior well of southern pumping station, view to the west

5.1.1 Sites Recorded during the 1990 Survey

There are three pumping stations within the project area, all which feature rectangular stone faced pits 9 m deep. The northern two (but not the southern one) appear on the 1927/28 USGS map. The southern one was built before 1946. A photo (Bishop Museum Visual Collection) dated 1923 shows what appears to be a brand new "Riedlier Steam Pump Driven by Triple Expansion Corlis Engine" in one of these large stone-faced rectangular wells.

An important part of life within the camps of the project area was the Ewa Plantation Company Railroad, which operated from 1890-1947. Near its peak in 1931, the Plantation Railway system included 18.95 miles of 36" gauge permanent track, 8 miles of portable track, seven oil-burning Baldwin locomotives, and 705 cars (Conde and Best 1974:283). Permanent rail lines ran from the southwest to the northeast up through the middle of the project area along the present can-haul road alignment and also near the eastern margin of the project area. In 1947, the rails were sold for scrap.

During the subsequent decades of the twentieth century, sugar cane operations in 'Ewa phased out and, more recently, former cane lands have been rezoned for residential development. Structures in the area of the former plantation villages have fallen into disrepair or have been demolished. However, portions of the area - including Varona Village, Tenney Village, and Renton Village - have been designated the 'Ewa Villages Historic District (State site 50-80-12-9786), which has been nominated for National Historic Landmark status. Additionally, the still-extant OR&L rail line through Honouliuli has been placed on the National Register of Historic Places (Site 50-80-12-9714).

5.1.1.1 Ewa Plantation Infrastructure (Site 50-80-12-4344)

In the immediate vicinity of the site of Drivers and Stable Villages, the 1990 CSH survey found three iron pipe features, including a tall metal post and two welded pipe constructions. These were collectively given SIHP number 50-80-12-4344, because they were tangible features, which by appearance and location, appeared to be more than 50 years old. The significance of these constructions is thought to exist only in so far as further determination of their age and function elucidate out record of Ewa Plantation life. During the recent CSH 2005 inventory survey, these features could not be refound; the area of their former location had been bulldozed and they had been destroyed.

5.1.1.2 Ewa Plantation Railroad (Site 50-80-12-4345)

The Ewa Plantation Co. ran a private railroad for the primary purpose of hauling cane; it included nearly 30 miles of permanent track. The railroad operated from 1890 to 1947, but most of the permanent track was in place by 1910 (Conde and Best 1973:280). It has been the policy of the Historic Sites section of the SHPD to encourage the retention of particularly good section of railroad berm. While many kilometers of permanent track ran through the project area, a particularly good example is only to be found in the northeastern portion of the project area in the mouth of the dry stream valley, in the traditional *'ili* of Maui. This stretch of the Ewa Plantation Railway was given SIHP number 50-80-12-4345. The railroad berm on either side of the valley access road features well-preserved facings commonly 2 m high. It is recommended that if the railroad berm in this area can be incorporated into development plans and preserved,

that this be done. If development plans require the demolition of a portion of this stretch of railroad berm then mitigation should be worked out with the State Historic Preservation Office in advance.

5.1.1.3 Ewa Plantation Pumping Stations (Sites 50-80-12-4346, -4347, and- 4348)

There are three pumping stations within the project area, all of which feature a deep rectangular basalt block, faced wall. The northern two (Sites -4346 and –4347) are thought to pre-date 1928 and the southern well (Site –4348) is thought to date to shortly thereafter. All three are still extant in the project area. The wells are very impressive structures and are of particular importance to the history of 'Ewa. It is recommended that these wells be preserved. If these wells are deemed a hazard or these area are required by development plants, it might be possible to fill, mark, and cover the wells. All three of the site designations for these wells include adjacent structures. In the case of the northernmost (Site –4346) and the southernmost (Site –4348) wells, the adjacent structure is limited to a single pump house, which has an exterior or corrugated sheet metal panel construction. Evaluation of possible historic significance of these structures is beyond our area of expertise, and it is recommended that issues of significance and proper historic documentation be resolved with the SHPD office in advance of any development of these areas to avoid adverse impacts.

The case of the Central Pump house (Site –4347) is more complicated, in that there are eight features related to the well. In addition, there are a number of small architectural and/or industrial features in the immediate vicinity of the well. In some cases, the age and exact function of these features in unclear. We recommend preservation of at least portions of this site. The significance of the area of Site –4347 would be evaluated after an assessment of the significance of its architectural features and the assessment of the significance of the Ewa Village area. If development of this area is desired, mitigation should be discussed with the SHPD Office.

5.1.2 Historically Documented Areas Identified during the West Loch Bluffs Project

Background research for the West Loch Bluffs report (Hammatt and Shideler 1990) also highlighted four other areas of concern:

5.1.2.1 Hawaiian Land Court Awards in the Honouliuli Taro Lands

An area along the northern portion of Old Fort Weaver Road that was once called the *'ili* of Maui. It contained house sites and taro patches tended by native Hawaiians, according to 1848 Māhele LCA testimony.

A house site (belonging to Pue) is shown on Monsarrat's map of 1878, and the presence of several more house sites in this area is clearly indicated in land records circa 1848. It seems very likely that any stones from pre-contact or early historic foundations would have been removed to facilitate cane cultivation and possibly for used in the construction of the adjacent Ewa Plantation railway berm. Is seems highly probably that plowing associated with pre-drip irrigation cane cultivation has badly disturbed sediments to a depth of nearly a meter (36 inches). However, it was thought possible that slope wash from induced erosion had sealed and protected these deposits and had thus insulated these deposits from the impact of subsequent plowing.

There many be intact gravels or other cultural deposits associated with this area. Thus it was recommended in the 1990 survey report that subsurface testing take place in this area before development.

5.1.2.2 Kapalani Catholic Church

There is an area along the southern portion of Old Fort Weaver Road that once had a Roman Catholic Church, shown on the Monsarrat map of 1878 as a fenced area enclosing three structures believed to include a church, a school, and a residence. This church (Kapalani Church) was built between 1840 and 1847 and is believed to have been destroyed between 1885 and 1890. From old survey maps, it appears that part or all of the site of the church structure is directly under Old Fort Weaver Road. However, this area is still of archaeological concern for its association with an important person in the history of Hawai'i and because there may be associated historic graves.

It seems highly probable that the Honouliuli Roman Catholic church site within the project area was a major focus of the life of Kahoaliikunaiewakamoku Kepelino (Zepherino) Keauokalani, who is best known by the name Kepelino. Kepelino was a major historian and the author of four fascicles that appeared from 1858-1860, called Hooiliili Hawaii "Hawaiian Collection" and his Mo'olelo Hawaii "Traditions of Hawaii" in 1868 (Valeri 1985:xxv-xxvi). He is of particular importance because he came from a family of high priests, he was a grandson of Kamehameha, he was Queens Emma's secretary, and he was the only major Hawaiian historic of the time who was not a pupil of the Lahainaluna School. Letters to Catholic newspapers dated 1860-1869, under the name Z. Kahoali'i place him in Honouliuli, and it seems probable that he lived in Honouliuli from 1851 into the 1870s. As he was known as an ardent Catholic and a school teacher, it seems likely that he taught for many years at the school within the Roman Catholic Church compound at Honouliuli (now covered by Old Fort Weaver Road).

Another issue regarding the Roman Catholic Church site area is that of graves. A history of the Roman Catholic Church in Hawai'i (Schoofs 1978:110) reports that, after the abandonment of the church, "in 1891 Honouliuli was still important enough to acquire its own Catholic cemetery." We know of only on Roman Catholic Church property in Honouliuli, and that is the church property within and adjacent to the project area. It is possible, therefore, that this cemetery was adjacent or on these church grounds. While the site of the Honouliuli church has been under sugar cane cultivation for many decades, the 36-inch plow zone many not have disturbed any historic interments, if present. Because no trace of this church was found on the surface during the CSH 1990 survey, no site number was given, however, additional background research into this church and subsurface backhoe testing before any development was recommended (Hammatt and Shideler 1990:55).

5.1.2.3 Ewa Plantation PipeLine Village

PipeLine Village was a substantial community including 162 houses (some duplexes), a school, and a church. PipeLine Village was also known as Spanish Camp because its residents were largely of Puerto Rican and Portuguese ancestry. Most of the structures in PipeLine Village are believed to have been built between 1906 and 1911, but it seems highly probably that there were a few older structures, possibly including some of the oldest structures of Ewa Plantation, dating to 1890. The village is believed to have been completely demolished in 1931.

All of the many photos of PipeLine Village houses (Figure 30, Figure 31, Figure 32, and Figure 33) show house foundations consisting of wood posts resting on small light colored blocks (tofu block construction). Thus, there would be virtually no trace of a building footprint after the building was dismantled. The only archaeological remains associated with this village that would be likely to survive 60 years of subsequent cane cultivation would probably be related to the privies, which were typically detached outhouses. If these were pit privies, there should be more than 160 discernible pits with associated durable artifacts, which might include bottles, coins, and personal effects. Some plantation privies had detachable compartments, which would be periodically emptied. If this type of privy was utilized, there would probably be no trace left. It is believed that refuse collection was highly organized by the plantation from early times and this disposal was outside of the present project area. There could however, be small trash pits.

The Ewa Plantation Company Annual Report for 1923 states that "coral roads were laid through villages" and it may well be that the grid of streets shown on the 1928 USGS map could be determined on the ground once the cane was cleared. There are also photos of Portuguese bread ovens (*forno*), which appear to be constructed of brick and plaster, but these were probably all demolished and completely removed. There may have been building slabs or other more durable features to the schoolhouse and church, but there are believed to have been bulldozed as well. It is anticipated that with the possible exception of privy pits and associated artifacts, that the thoroughness of demolition, the light nature of construction, and the sixty years of continuous cane cultivation would have removed almost all other traces of PipeLine Village.

Subsurface reconnaissance of the site of PipeLine Village was recommend in this area for the purpose of gaining further data regarding the layout of the village and for the recovery of artifacts, which might be useful in the study of ethnicity and the interpretation of Ewa Plantation village life. In the absence of any identifiable intact surface cultural features, no site number during the 1990 CSH survey was given to the former site of PipeLine Village.

5.1.2.4 Drivers and Stable Villages

Drivers Village and Stable Village were small communities previously located in the southeastern corner of the project area. Little is known about these villages. A 1931 Ewa Plantation Report states "The Drivers Village, located near the main stables was in such a bad location that it was decided to move all the fourteen cottages . . ." It seems highly probable that Drivers Village consisted of the fourteen structures shown on the 1928 map, that it was constructed between 1900 and 1910 and that it was moved in 1931. Stable Village seems to refer to the few structures just across the street to the south. As with PipeLine Village, the 1990 CSH report recommended reconnaissance after the removal of sugar cane and subsurface testing for the purpose of gaining further data regarding the layout of the village and the recovery of artifacts, which might be useful in the study of ethnicity and in the interpretation of Ewa Plantation village life. No site number were assigned to these village in the absence of any tangible clearly-related remains.

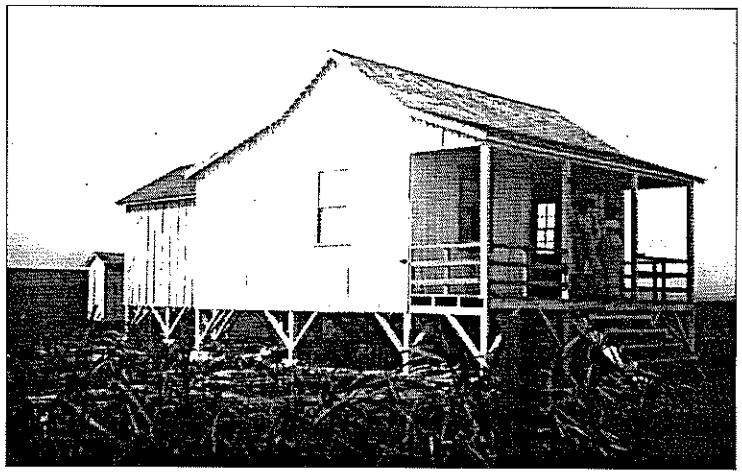


Figure 30. 1907 photograph of residence at PipeLine Village

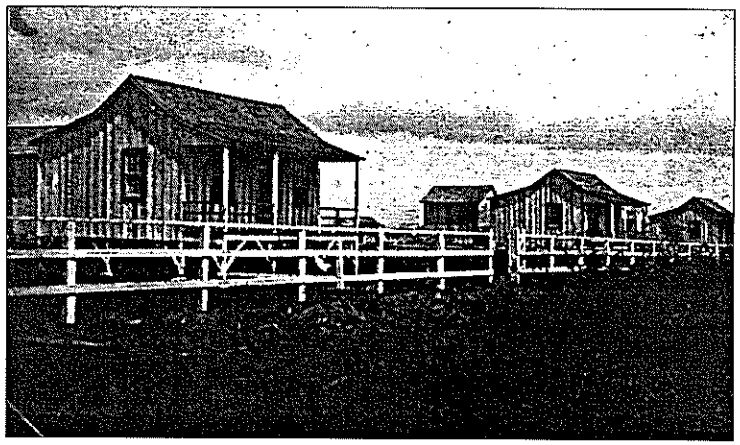


Figure 31. Undated photo of PipeLine Village, showing rows of houses

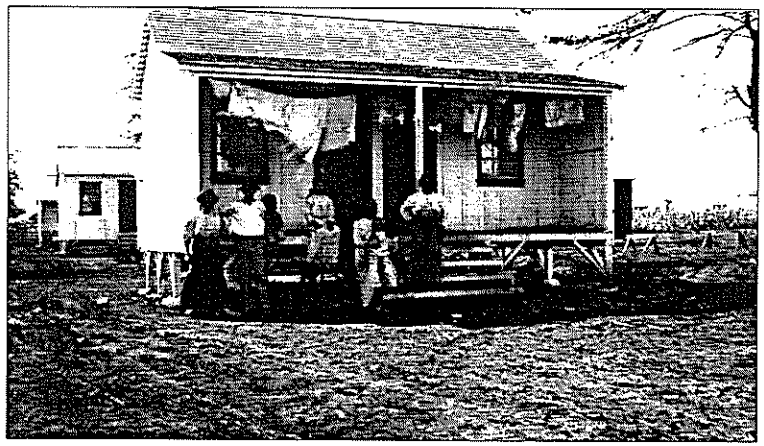


Figure 32. 1910 photograph of Puerto Rican family in PipeLine Village

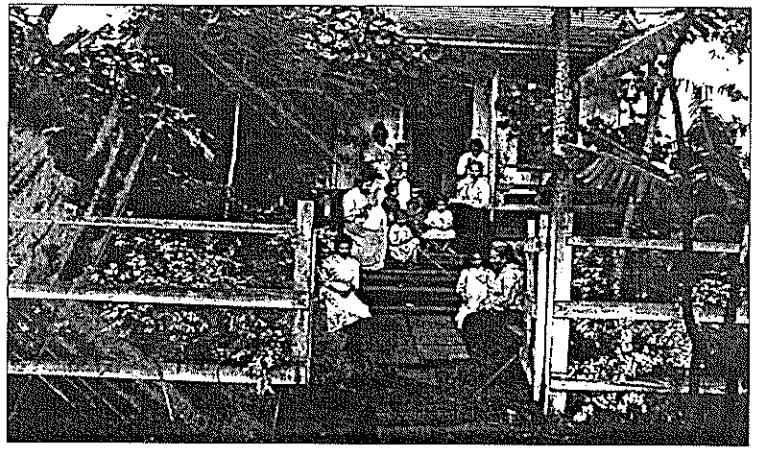


Figure 33. 1907 photograph of Portuguese family at PipeLine Village

5.2 2005 Surface Inventory Survey Findings

A surface pedestrian survey was conducted in the main project area on November 21 and 22, 2005 and January 13, 2006. Approximately 75% of the project area consists of plowed fields with low vegetation (pumpkins, squash and other ground vegetables). All roads surrounding these plowed fields were surveyed by car or by foot. In the southwestern section of the project area (south of Farrington Highway), only a linear corridor along an irrigation ditch had some (natural) weedy vegetation. This area was surveyed by foot. The southeastern section of the project area is a 546-acre parcel that was previously surveyed by CSH in 1990. Those areas with previously identified sites and areas selected for backhoe testing were revisited and additional notes were taken on the present condition of sites and areas. In the northern section of the project area (between I H-1 and Farrington Highway), larger sections of the project area were traversed on foot. Both banks of the Honouliuli Gulch were surveyed, the entire project area east of the gulch was surveyed, and a small weedy area in the northwestern corner of the project area was surveyed. The remaining portions of the main project area are plowed fields planted in crops or land covered with farm buildings.

Two non-contiguous parcels were surveyed by foot on January 13, 2006. The southern parcel (TMK 9-1-010:002) consisted of a triangular area bounded by a residential area, the West Loch Estates, on the west and Plantation Road on the west and south. The east side is bounded by the proposed Ewa Gentry Drainage Ditch, which was surveyed in 1993 (Sinoto and Pantaleo 1993). It is bisected by Arizona Road. The section south of Arizona Road is plowed fields; the northern section is covered with low grass and *koa haole* trees; the ground is extremely hummocky, as if it has been recently bulldozed (see Figure 5). Based on historic maps, Sinoto and Pantaleo (1993) thought they might find the remains of a portion of the OR&L track and sugar cane irrigation flumes in their project area. They found part of the OR&L roadbed berm, and also found the remains of metal flumes and concrete culverts, but these had been bulldozed into piles near the West Loch shoreline. These remains were not considered significant due to the absence of structural and locational integrity. During the recent CSH survey of the area, only a few concrete culverts, bulldozed into a ditch along the western border of the parcel, were found. The northern non-contiguous parcel (TMK 9-2-001:001) surrounds a reservoir north of the H-1 Interstate. This area has also been extensively bulldozed; the reservoir has been filled (is level with the surrounding ground) and a berm has been constructed around the former rim. There were no structural remains found in this area.

Four new features were recently identified in the project area. All four were found in the northern portion of the main project area along Honouliuli Gulch (Figure 34 and Figure 35). During the 1990 inventory survey of the West Loch Bluffs (southeastern 546-acre parcel), three sugar cane plantation infrastructure features (three pipe features) were grouped into Site 50-80-12-4344. Since all four new features found during the recent 2005 inventory survey are also related to sugar cane plantation infrastructure, these features have been subsumed into the same site designation. In this portion of the project area, Honouliuli Stream extends generally from the northwest to the southeast, but one portion is oriented east-west.

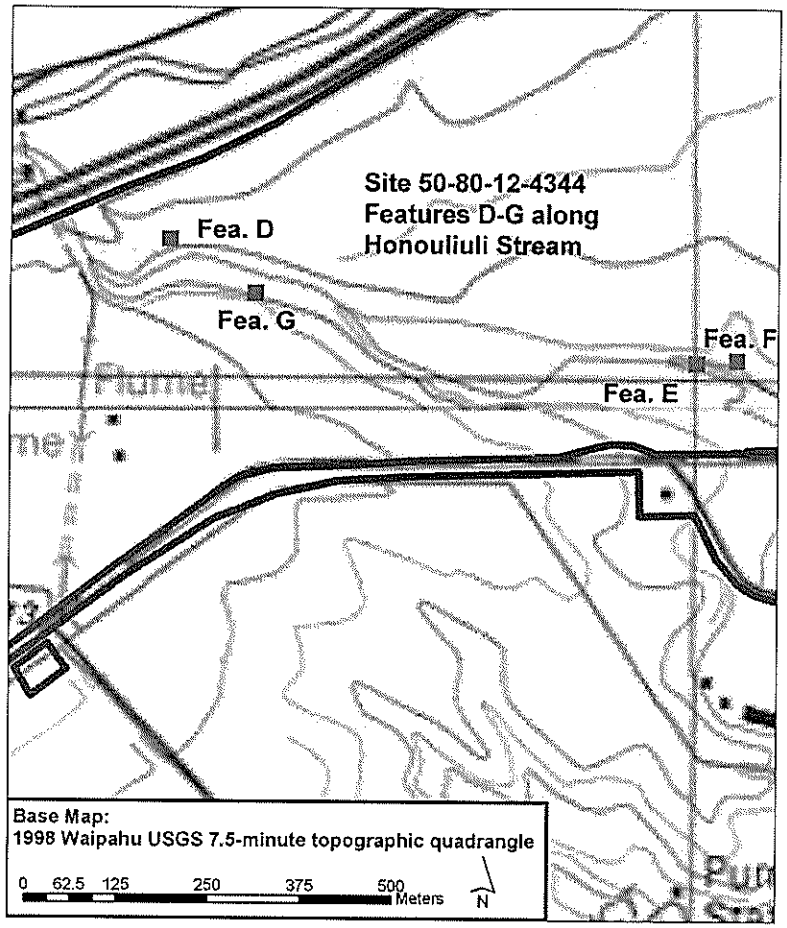


Figure 34. US Geological Survey map, showing location of Features D-F of Site 50-80-12-4344 along Honouliuli Stream

Figure 35. Typical vegetation in Honouliuli Gulch, view to the south

Site 50-80-12-4344, Features D-G

Feature D is a linear wall built against (parallel) to the east (or north) bank of Honouliuli Gulch (Figure 36 and Figure 37). It is 16 m long, 90 cm wide, 1.1 m high, and is oriented at a 77/277° angle. The wall is at the rim of the gulch. It is constructed of subangular basalt cobbles and boulders, 30-60 cm in diameter, stacked five to six courses high. One side abuts the gulch rim and the other side is faced; in some cases, the rocks have been split with metal tools, so that the outer side has a vertical face. Based on the location and construction, the wall functioned for erosion control.

Feature E is a linear wall on the west (or south) bank of Honouliuli Stream (Figure 38 and Figure 39). It is built perpendicular to the orientation of the gulch and is built on a slightly sloping terrace area near the top rim of the gulch. The wall is 4.5 m high, 55 cm wide, and 50 cm high. It is a core-filled wall, with basalt boulders 30-60 cm in diameter on the sides, and smaller cobbles in the interior. The function is unknown, but core-filled walls are usually historic in age. Its location near Honouliuli Gulch suggests it functioned for water or erosion control.

Feature F is a stone-faced berm on the west (south) bank of Honouliuli Stream at the top of the gulch rim (Figure 40 and Figure 41). It is constructed perpendicular to the orientation of the stream. The berm is faced with stones (some cut with metal tools to make a vertical face) on the northern side, stacked 6 to 8 courses high. The wall is not vertical, but slopes outward at the base. The construction is somewhat unusual in that the largest stones (up to 70 cm in diameter) are placed in the middle courses, not at the base, as is usual. The top of the berm is not particularly even and slopes down towards the gulch. The construction of this berm suggests it was constructed as some type of loading area, so that some type of vehicle could be parked or structure could be constructed on top of the berm, possible for loading or storing sugar cane or water.

Feature G consists of a concrete ditch and a concrete masonry catchment basement on the west (or south) bank of Honouliuli Gulch (Figure 42 and Figure 43). A metal pipe at the base of the flume and basin extends underground towards Honouliuli Gulch down a 45° slope at a due north/south orientation. The ditch is rectangular and 5.5 m long, 40 cm wide and 30 cm deep. The top of the ditch is covered with concrete slab lids, 90 cm long, 40 cm wide and 7 cm thick. The ditch itself is made with separate Waialua-type modal concrete units, which were made at the Ewa Plantation for their irrigation projects. The basin is C-shaped, constructed of rocks and mortar. The basin is 1.35 m long north/south, 1.3 m wide, 90 cm deep, with walls 28 cm thick. The outer side has an inset area that may once have had some type of sign or plaque. The ditch was used for irrigation or water control by the Ewa Plantation Company.

Figure 36. Feature D, Linear Wall abutting gulch rim, view to the north (upslope)

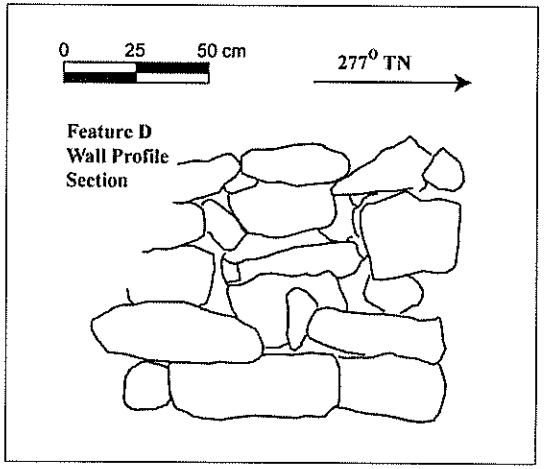


Figure 37. Feature D, Linear Wall, profile of 1.0 meter section

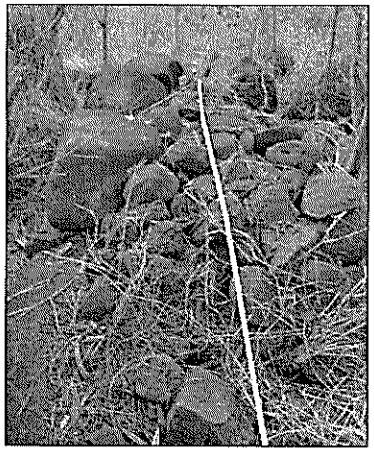


Figure 38. Feature E, Linear Wall, built perpendicular to orientation of Honouliuli Gulch, view to the east (upslope)

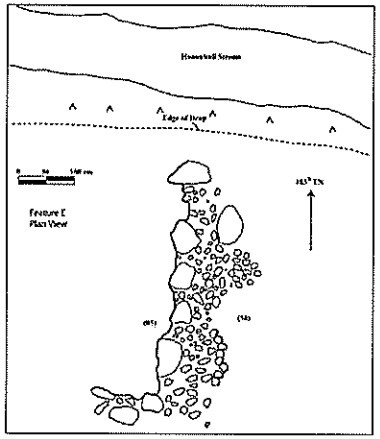


Figure 39. Feature E, Linear Wall, plan view

Figure 40. Feature F, Stone-faced berm, built perpendicular to orientation of Honouliuli Stream, view to the west (downlsope)

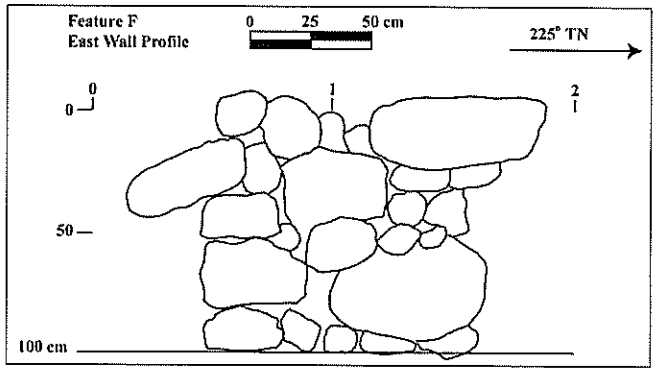


Figure 41. Feature F, Linear Wall of Berm, profile of 1.0 m faced wall section

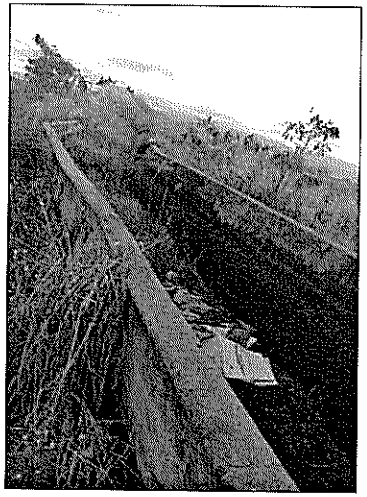


Figure 42. Feature G, concrete ditch, view to the west (upslope)

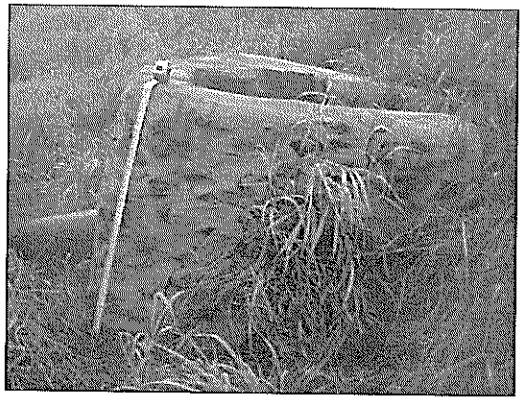


Figure 43. Feature G basin, showing steel pipe extending downslope to Honouliuli Stream, view to the south

5.3 2005 Backhoe Test Excavations Findings

Backhoe testing was conducted in four selected portions of the project area on November 28 and December 7 and 8, 2005. A total of 19 trenches were excavated in the project area in four specific areas (Figure 44 and Figure 45), the Honouliuli Taro Lands (5 trenches) adjacent to the northern portion of Old Fort Weaver Road, the probable location of the Kapalani Catholic Church (7 trenches) adjacent to the southern portion of Old Fort Weaver Road, the former site of Drivers and Stable Villages (1 trench) near the southeastern corner of the project area, and the former site of PipeLine Village (6 trenches) in the south-central section of the project area.

5.3.1 Roman Catholic Churchyard

Seven trenches (BHT 1-6, BHT 19) were excavated around the probable site of the Roman Catholic churchyard. As noted previously, a comparison of modern and nineteenth century maps indicates that the church building itself was once located under the present alignment of Old Fort Weaver Road. Only a small portion of the churchyard extended on the west side of the present road. There are fenced-in fields in this portion of the project area where staked beans are planted. There is only a small portion of open ground between this fenced-in area and a tall berm along the road. The seven trenches were placed around the sides of the fenced field and between the fields and the road berm. No shaped stones, mortar, cultural layers, or artifacts were found in any of the seven trenches.

Trenches 1-3, on the north side of the bean field, had complex stratigraphies with several silty loam or silty clay layers, probably deposited during flooding episodes. An old roadbed was present as the upper stratum of Trenches 4, 5, 6, and 19 (along the east side of the field adjacent to Old Fort Weaver Road). This is probably the old alignment of Fort Weaver Road, thus the yard of the Roman Catholic Road was probably located east of our trench placement. Either it was located under the present alignment of Old Fort Weaver Road, under the shoulder of the road, or under the earth berm adjacent to the road shoulder. Trench 4 had modern black plastic fragments (used for weed control in the gardens) at a depth of 210 cm. Another trench (Trench 3) had coral cobbles or boulders at depths of 150 cmbs, indicating a significant amount of soil disturbance in these trenches adjacent to the road.

Stratigraphic profiles for these seven trenches are illustrated in Figure 46 to Figure 52, with the stratigraphic soil descriptions following.

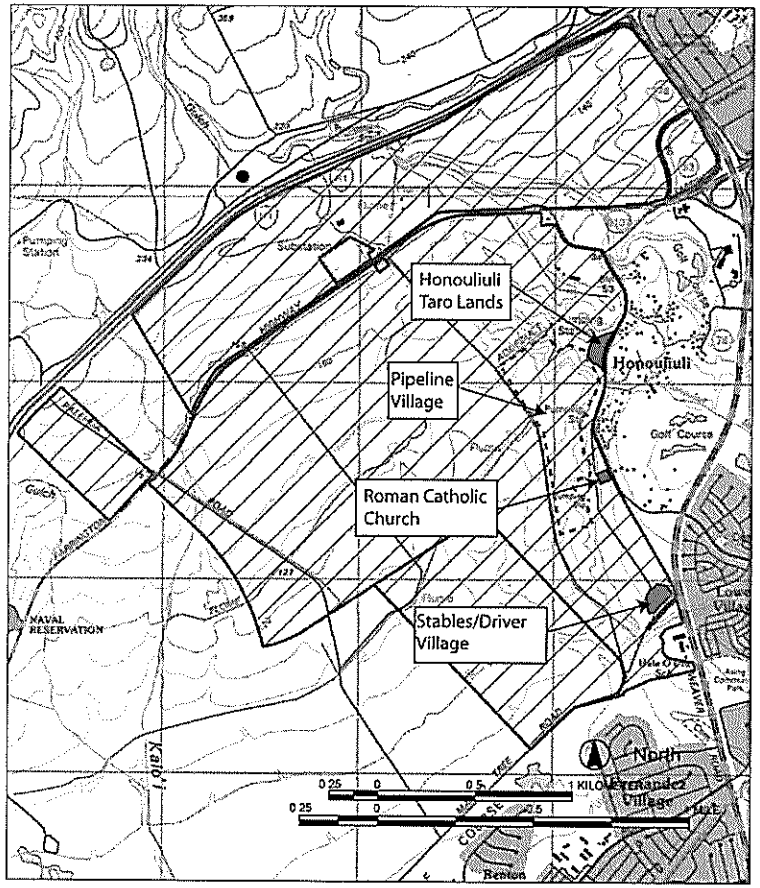


Figure 44. US Geological Survey map, showing four areas selected for backhoe testing

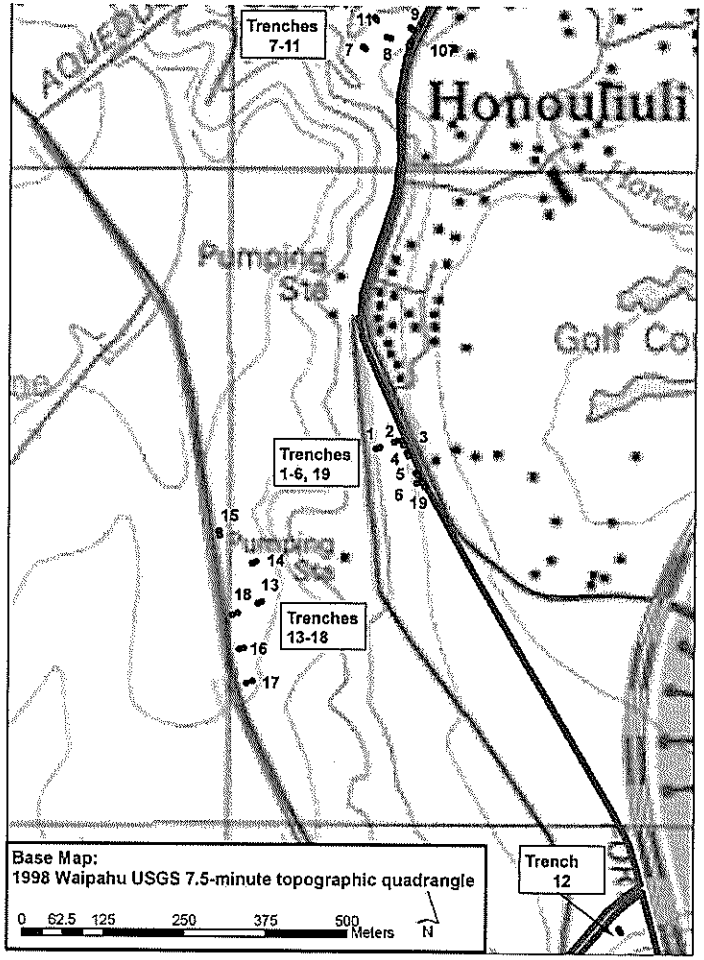


Figure 45. US Geological Survey map, showing location of Backhoe Trenches 1-19

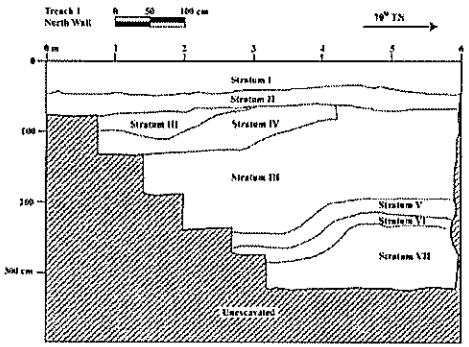


Figure 46. Backhoe Trench 1, north wall profile

Backhoe Trench 1
Stratum-Depth

I	0-60 cmbs	Very dark grayish brown (10YR3/2) silty clay loam; weak, fine, subangular blocky structure; very firm when moist, very sticky and moderately plastic consistence; terrestrial origin; abrupt, smooth boundary;
II	60-70 cmbs	Brown (10YR4/3) silty clay loam; moderate, medium subangular blocky structure; very hard when dry, slightly sticky and slightly plastic consistence; terrestrial origin; abrupt, smooth boundary;
III	60-240 cmbs	Very dark gray (10YR3/1) clay loam; strong, coarse, angular blocky structure; extremely hard when moist, slightly sticky and slightly plastic consistence; terrestrial origin; very abrupt, wavy boundary;
IV	65-120 cmbs	Gray (10YR6/1) ashy silt; structureless; slightly hard when moist; very sticky and slightly plastic consistence; terrestrial origin; abrupt, wavy boundary; stratum is between two Stratum III layers;
V	240-260 cmbs	Dark yellowish brown (10YR3/4) silty loam; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; very abrupt, wavy boundary;
VI	260-290 cmbs	Dark reddish brown (5YR3/2) silty loam; structureless; soft when dry, slightly sticky and moderately plastic; terrestrial origin; very abrupt, wavy boundary;
VII	290-330+ cmbs	Dark brown (10YR3/3) silty clay; moderate, medium angular blocky structure; hard when dry, slightly sticky and plastic; terrestrial origin; excavation arbitrarily terminated at 330 cmbs.

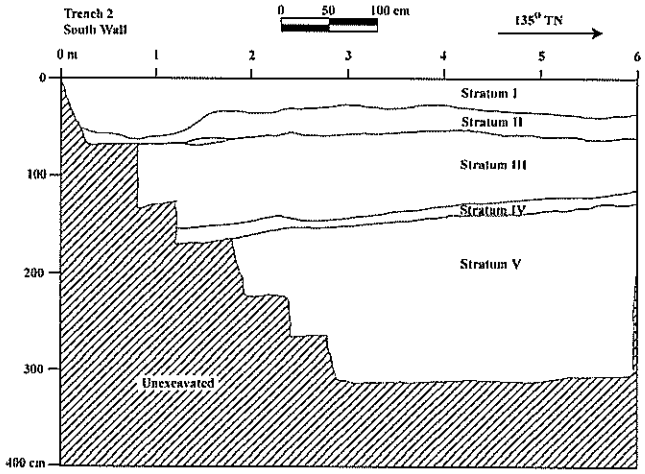


Figure 47. Backhoe Trench 2, south wall profile

Backhoe Trench 2
Stratum-Depth

I	0-25 cmbs	Very dark grayish brown (10YR3/2) silty clay loam; moderate, medium, subangular blocky structure; very firm when moist, very sticky and moderately plastic consistence; terrestrial origin; extensive charcoal flecking; abrupt, wavy boundary;
II	25-53 cmbs	Dark brown (7.5YR3/2) clay loam; moderate, medium subangular blocky structure; friable when moist, sticky and moderately plastic consistence; terrestrial origin; clear, smooth boundary;
III	53-140 cmbs	Very dark gray (10YR3/1) clay loam; strong, coarse, angular blocky structure; extremely hard when moist, sticky and slightly plastic consistence; terrestrial origin; very abrupt, wavy boundary;
IV	140-147 cmbs	Gray (10YR6/1) ashy silt; structureless; slightly hard when moist; very sticky and slightly plastic consistence; terrestrial origin; abrupt, wavy boundary;
V	147-310+ cmbs	Dark yellowish brown (10YR3/4) silty loam; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; excavation arbitrarily terminated at 310 cmbs.

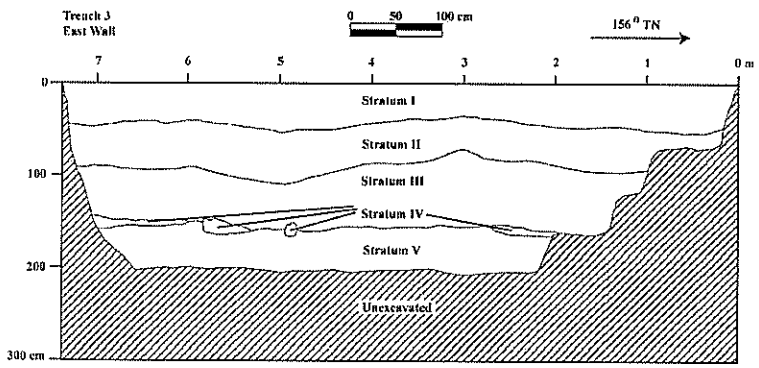


Figure 48. Backhoe Trench 3, north wall profile

Backhoe Trench 3
Stratum-Depth

I	0-41 cmbs	Very dark grayish brown (10YR3/2) silty clay loam with 90% gravel (old road bed); moderate, medium subangular blocky structure; very firm when moist, sticky and moderately plastic consistence; terrestrial origin; abrupt, smooth boundary;
II	40-85 cmbs	Dark brown (7.5YR3/2) clay loam; moderate, medium subangular blocky structure; friable when moist, sticky and moderately plastic consistence; terrestrial origin; abrupt, wavy boundary;
III	85-155 cmbs	Dark yellowish brown (10YR4/4) silty clay loam; moderate, medium structure; friable when moist, sticky and plastic; very abrupt, irregular boundary;
IV	145-162 cmbs	Gray (10YR6/1) ashy silt; structureless; slightly hard when moist; very sticky and slightly plastic consistence; terrestrial origin; abrupt, wavy boundary, several large coral borders at boundary;
V	155-200+ cmbs	Dark yellowish brown (10YR3/4) silty loam with 25% coral cobbles; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; excavation arbitrarily terminated at 200 cmbs.

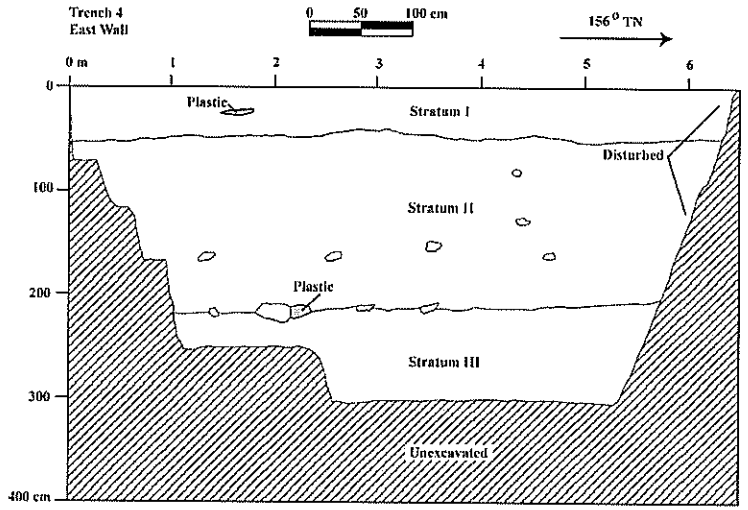


Figure 49. Backhoe Trench 4, north wall profile

Backhoe Trench 4
Stratum–Depth

I	0-48 cmbs	Very dark grayish brown (10YR3/2) silty clay loam with 25% gravel (old road bed); moderate, medium subangular blocky structure; very firm when moist, sticky and moderately plastic consistence; terrestrial origin; abrupt, smooth boundary;
II	40-210 cmbs	Dark brown (7.5YR3/2) clay loam; moderate, medium subangular blocky structure; friable when moist, sticky and moderately plastic consistence; terrestrial origin; scattered coral cobbles; abrupt, wavy boundary, modern plastic found at II/III interface at 210 cmbs;
III	210-300+ cmbs	Dark yellowish brown (10YR3/4) silty loam with 25% coral cobbles; structureless; loose when moist; slightly sticky and moderately plastic; terrestrial origin; excavation arbitrarily terminated at 300 cmbs.

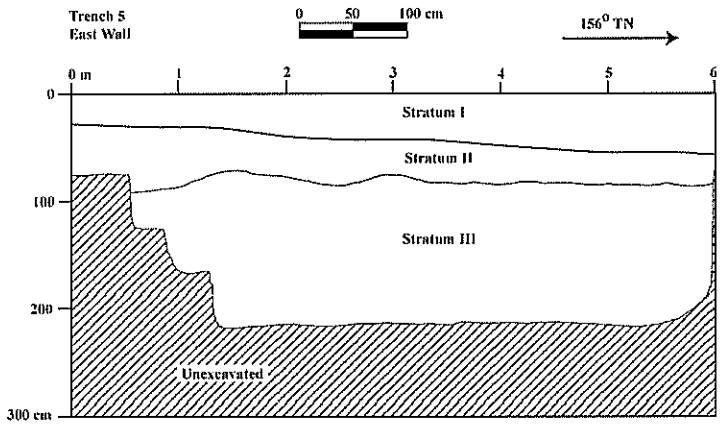


Figure 50. Backhoe Trench 5, east wall profile

Backhoe Trench 5
Stratum--Depth

I	0-50 cmbs	Old asphalt fragments;
II	50-82 cmbs	Very dark grayish brown (10YR3/2) clay loam with 1% basalt cobbles; moderate, medium angular blocky structure; extremely hard when dry, sticky and plastic consistence; terrestrial origin; diffuse, wavy boundary;
III	82-213+ cmbs	Dark brown (10YR3/3) silty clay loam; weak, fine subangular blocky structure; hard when dry, sticky and moderately plastic consistence; terrestrial origin; excavation arbitrarily terminated at 213 cmbs.

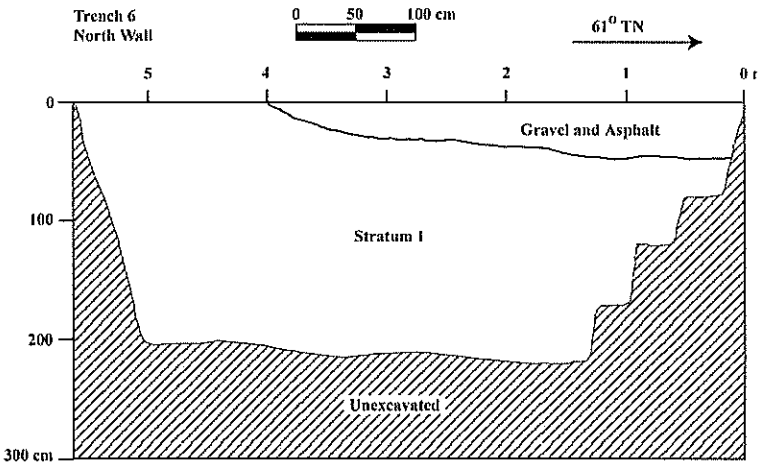


Figure 51. Backhoe Trench 6, north wall profile

Backhoe Trench 6
Stratum-Depth

I	0-48 cmbs	Old asphalt fragments;
II	48-119+ cmbs	Brown (10YR4/3) clay loam; medium moderate subangular blocky structure; moderately firm when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 119 cmbs.

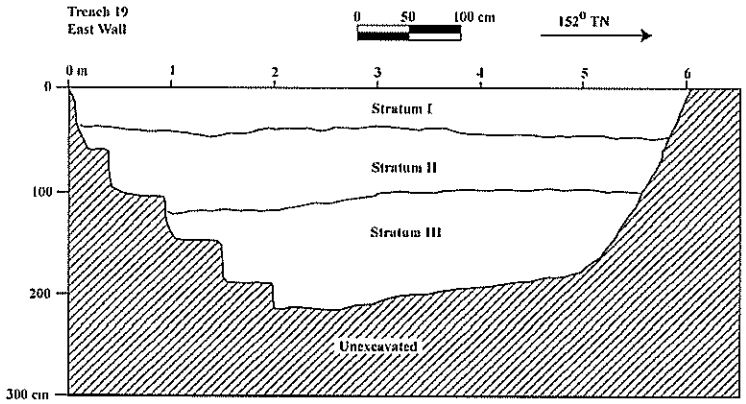


Figure 52. Backhoe Trench 19, east wall profile

Backhoe Trench 19
Stratum--Depth

I	0-48 cmbs	Old asphalt fragments;
II	48-102 cmbs	Very dark grayish brown (10YR3/2) clay loam with 1% basalt cobbles; moderate, medium angular blocky structure; extremely hard when dry, sticky and plastic consistence; terrestrial origin; diffuse, wavy boundary;
III	102-210+ cmbs	Dark brown (10YR3/3) silty clay loam; weak, fine subangular blocky structure; hard when dry, sticky and moderately plastic consistence; terrestrial origin; excavation arbitrarily terminated at 210 cmbs.

5.3.2 Honouliuli Taro Land Trenches

Five trenches (BHT 7-11) were excavated in the Honouliuli Taro Lands area. This portion of the project area was thickly vegetated with low (ca. 1 m tall) *koa haole* trees and larger *'opiuma* (*Pithecellobium dulce*) trees. The area available for backhoe testing was circumscribed by the presence of these larger trees; trenches could only be placed in areas where the smaller *koa haole* trees could be knocked down with the backhoe. There was also a large pit in the southwestern section of this area used for flood control. This area is adjacent and east of the Ewa Plantation Railroad berm (Site 50-80-12-4345).

No shaped stones, cultural layers, *'auwai* (irrigation ditches used in wetland cultivation) organic soils (soils once used for wetland agriculture), walls, habitation platforms, boundary walls or alignments, or artifacts were found in any of the five trenches; however, many of the trenches did contain fragments of limestone mortar, asphalt, and slag to a depth of 1.7 m below surface. One *Tellina* sp. bivalve shell was found at a depth of 150 cmbs, but it was adjacent to a fragment of slag at 170 cmbs, and thus was deposited in modern times (or is in a disturbed stratum). Only one stratum of soil was found in each of the five trenches; some trenches had trash deposits. The disturbed nature of the top stratum may be related to the nearby railroad berm. Stones and even soil may have been moved and excavated from this area to build the earth and rock berm for the railway bed. The presence of limestone mortar, slag, asphalt, and charcoal lenses found in several trenches may also be associated with this berm construction and use.

The stratigraphic profiles (Figure 53 to Figure 57) and soil descriptions for the five trenches follows.

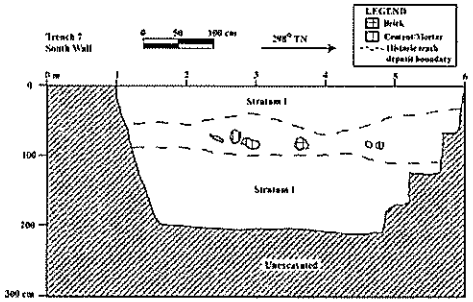


Figure 53. Backhoe Trench 7, south wall profile

Backhoe Trench 7
Stratum-Depth

I 0-210+ cmbs Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; layer containing brick, cement, and mortar extending within Stratum I from 40-100 cmbs; excavation arbitrarily terminated at 210 cmbs.

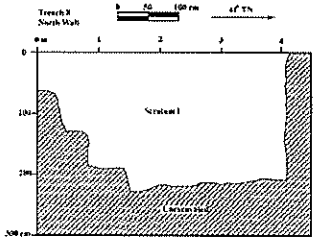


Figure 54. Backhoe Trench 8, north wall profile

Backhoe Trench 8
Stratum-Depth

I 0-230+ cmbs Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; cement fragments only on surface and top; has slag and decomposing limestone fragments throughout; excavation arbitrarily terminated at 230 cmbs.

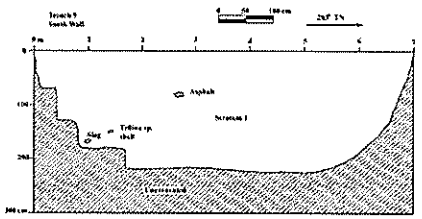


Figure 55. Backhoe Trench 9, south wall profile

Backhoe Trench 9
Stratum- Depth

I 0-227+ cmbs Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; decomposing limestone fragments throughout; *Tellina* sp. marine bivalve shell found at 150 cmbs; slag found at 170 cmbs; excavation arbitrarily terminated at 227 cmbs.

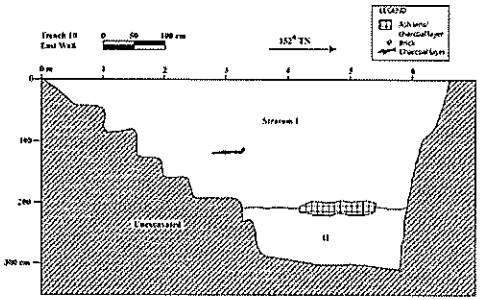


Figure 56. Backhoe Trench 10, east wall profile

Backhoe Trench 10
Stratum-Depth

I 0-305+ cmbs Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; slag, brick fragments, charcoal flecks, and decomposing limestone fragments throughout; charcoal lens at 120 cmbs and ash/charcoal lens at 200-220 cmbs; excavation arbitrarily terminated at 305 cmbs.

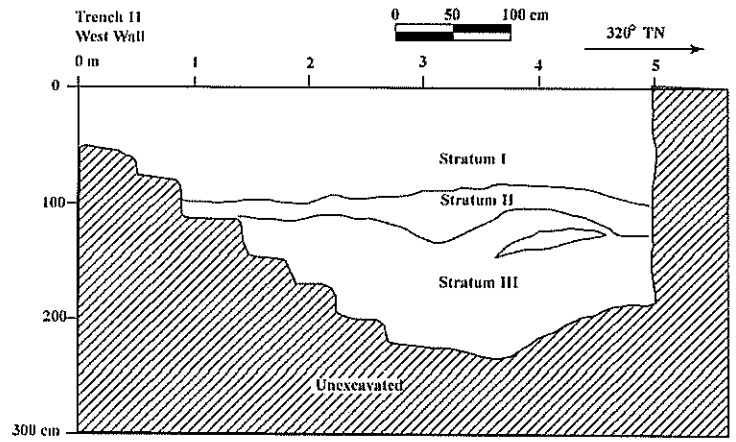


Figure 57. Backhoe Trench 11, west wall profile

Backhoe Trench 11
Stratum-Depth

I	0-88 cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; slag, brick fragments, charcoal flecks, and decomposing limestone fragments throughout; clear, wavy boundary;
II	88-110 cmbs	Brown (10YR4/3) silty clay loam; moderate, medium subangular blocky structure; very hard when dry, slightly sticky and slightly plastic consistence; terrestrial origin; abrupt, smooth boundary;
III	110-240+ cmbs	Very dark gray (10YR3/1) clay loam; strong, coarse, angular blocky structure; extremely hard when moist, slightly sticky and slightly plastic consistence; terrestrial origin; excavation arbitrarily terminated at 240 cmbs.

5.3.3 Drivers and Stable Villages

One trench (BHT-12) was excavated in the Drivers/Stable Villages area. In the last ten years, this area has been very susceptible to floods, so much so that when water would come into this area it would wash soil onto Old Fort Weaver Road. To control these floods, the majority of this area had been bulldozed, excavated, and filled with gravel. Only a small portion of this area near the extreme southeastern corner of the project area still had some vegetation and was thought to have been undisturbed by this excavation and filling. The one trench (BHT-12) excavated in this area had two strata, separated by an asphalt layer, possibly an old roadbed. It is unlikely that this road was built for the Drivers/Stable Village, since the name "Stable" suggests that horses and mules were still the predominant method of hauling and travel in this period, not car or tractors. There were no other artifacts or material from the villages indicated by this trench excavation. The stratigraphic profile (Figure 58) and soil descriptions for Trench 12 are presented below:

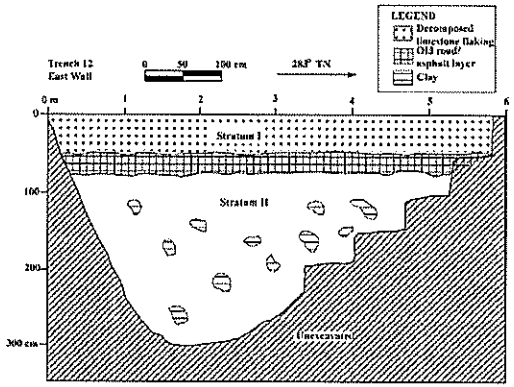


Figure 58. Backhoe Trench 12, east wall profile

Backhoe Trench 12
Stratum-Depth

I	0-50 cmbs	Very dark brown (7.5YR5/3) silt loam; moderate, medium, subangular blocky structure; slightly hard when moist, non-sticky and non-plastic consistence; terrestrial origin; with many small fragments of decomposed limestone; abrupt, smooth, boundary; old road/asphalt bed at 50-70 cmbs;
II	70-300+ cmbs	Dark brown (7.5YR3/4) silty clay loam; strong, medium blocky structure; friable when moist, slightly sticky and plastic consistence; strong cementation; terrestrial origin; soil intermixed with 50% pockets of clay; excavation arbitrarily terminated at 300 cmbs.

5.3.4 PipeLine Village

Six trenches (BHT-13-18) were excavated in the former location of PipeLine Village. The first trench was placed in the area thought to be the former location of the church shown on the 1927 USGS map (see Figure 19). This section of the project area is flat, open, plowed fields planted in pumpkins and squash. Trenches were placed on roads along the sides and between the plowed fields. The surface and the plow zone had a dense concentration of concrete fragments (less than 20 cm in diameter), especially near the southern section of the project area (near where the church may have been). Two to three strata were found in the six trenches. The concrete fragments were only found on the ground surface or within the loose soil, the top 20 cm of the plow zone. None were found any deeper. No privy pits were found, no food remains, no historic artifacts, and no firepits or other habitation features were found. In conclusion, it seems that when the houses of PipeLine Village were moved in 1931, little remained behind. The concrete fragments are probably fragments of the blocks on which the wooden houses rested, or are part of some of the coral/gravel roads between the house roads. The stratigraphic profiles for these six trenches (Figure 59 to Figure 64) are presented below, with the soil descriptions following.

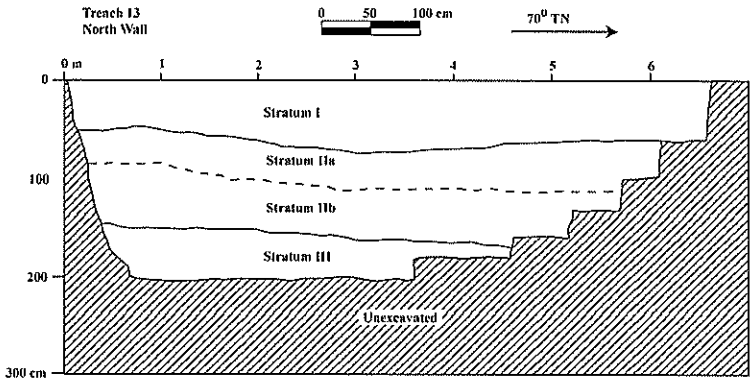


Figure 59. Backhoe Trench 13, north wall profile

Backhoe Trench 13
Stratum-Depth

I	0-60 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found only on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
IIA	60-100 cmbs	Strong brown (7.5YR4/6) sandy loam; moderate, fine, subangular blocky structure; firm when moist, slightly sticky and slightly plastic consistence; terrestrial origin, diffuse, irregular boundary;
IIB	100-150 cmbs	Brown (7.5YR4/3) sandy loam; strong, medium blocky structure; friable when moist, non-sticky and non-plastic consistence; 60% gravel; terrestrial origin; clear, wavy boundary;
III	150-200+cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 200 cmbs.

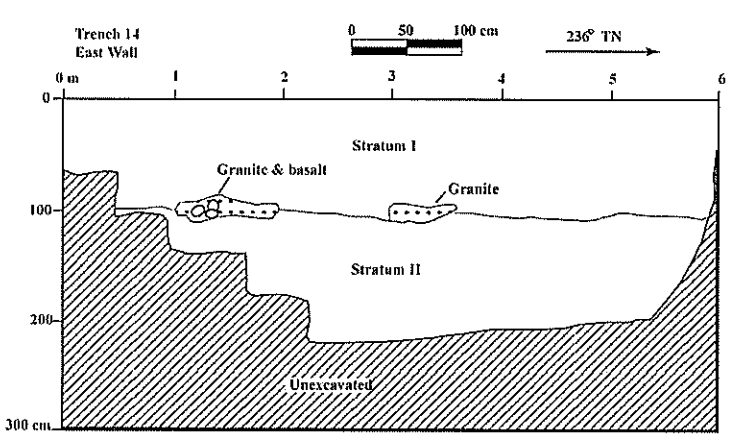


Figure 60. Backhoe Trench 14, east wall profile

Backhoe Trench 14
Stratum-Depth

I	0-110 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; basalt cobbles and boulders at I/II interface; abrupt, smooth, boundary;
II	110-220+cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 220 cmbs.

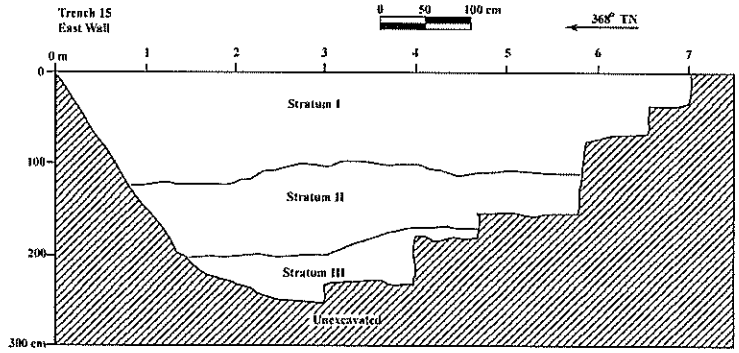


Figure 61. Backhoe Trench 15, east wall profile

Backhoe Trench 15
Stratum-Depth

I	0-98 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
II	90-200 cmbs	Yellowish red (5YR4/6) clay loam (50% clay); moderate, medium, blocky structure; firm when moist; sticky and plastic; strong cementation; terrestrial origin; abrupt, wavy boundary;
III	200-255+ cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 255 cmbs.

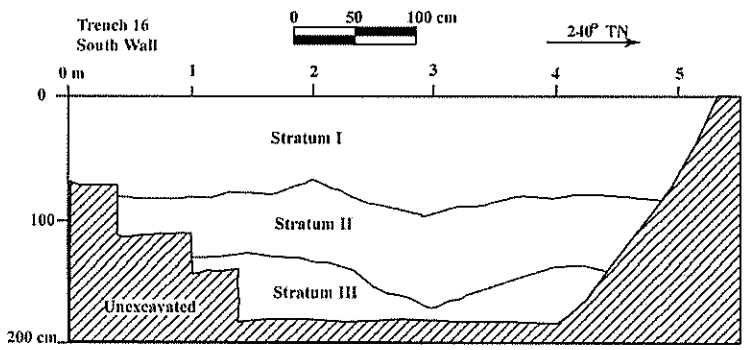


Figure 62. Backhoe Trench 16, south wall profile

Backhoe Trench 16
Stratum-Depth

I	0-100 cmbs	Dark Yellowish Brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky, moderately plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; abrupt, smooth boundary;
II	100-200 cmbs	Yellowish red (5YR4/6) clay loam; moderate, medium, subangular blocky structure; firm when moist, sticky and plastic consistence; terrestrial origin; abrupt, wavy boundary;
III	200-255+ cmbs	Brown (7.5YR4/2) clay; weak, very fine, platy structure; friable when moist; sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 255 cmbs.

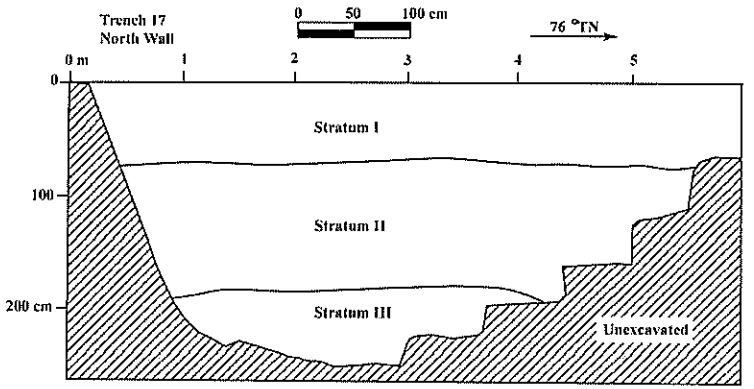


Figure 63. Backhoe Trench 17, north wall profile

Backhoe Trench 17
Stratum-Depth

I	0-41 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
II	41-132 cmbs	Yellowish red (5YR4/6) clay loam (50% clay); moderate, medium, blocky structure; firm when moist; sticky and plastic; strong cementation; terrestrial origin; abrupt, wavy boundary;
III	132-200+ cmbs	Brown (7.5YR3/2) clay loam; weak, medium subangular blocky structure; friable when moist; sticky and slightly plastic consistence; weak cementation; terrestrial origin; excavation arbitrarily terminated at 200 cmbs.

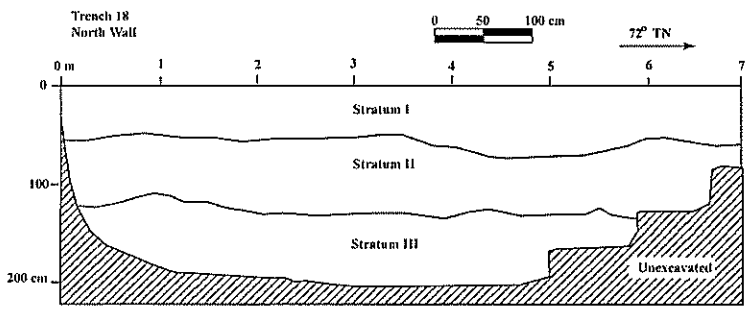


Figure 64. Backhoe Trench 18, north wall profile

Backhoe Trench 18
Stratum-Depth

I	0-70 cmbs	Dark yellowish brown (10YR3/4) silty clay loam; moderate, medium, subangular blocky structure; friable when moist, sticky and moderately non-plastic consistence; terrestrial origin; cobble-size concrete fragments found only on the surface and the upper 20 cm of loose soil; abrupt, smooth, boundary;
IIA	70-183 cmbs	Strong brown (7.5YR4/6) sandy loam; moderate, fine, subangular blocky structure; firm when moist, slightly sticky and slightly plastic consistence; terrestrial origin, diffuse, irregular boundary;
III	183-250+cmbs	Brown (7.5YR4/2) clay; weak, very fine prismatic structure; friable when moist, sticky and very plastic consistence; terrestrial origin; excavation arbitrarily terminated at 250 cmbs.

Section 6 Project Summary and Mitigation Recommendations

During a 1990 inventory survey of the southeastern portion of the current project area (West Loch Bluffs area), five sites, a railroad berm (Site 50-80-12-4345), three pumping station (Sites 50-80-12-4346, -4347, and -4348), and three features related to plantation infrastructure (Site 50-80-12-4344) were recorded and assigned SIHP permanent site numbers. During this survey, four historic documented areas of Hawaiian and later immigrant residence were also identified: the former sites of Honouliuli Taro Lands, Kapalani Church, PipeLine Village, and Drivers/Stable Village. Further work, especially subsurface testing, was recommended for these four areas.

During the recent 2005 surface survey of non-plowed areas of the 1594-acre East Kapolei project area, four new features related to sugar cane cultivation or irrigation were recorded. These four features (Features D-G) were subsumed under the previous site number, Site 50-80-12-4344, used for scattered plantation infrastructure features.

A total of 19 trenches were excavated in the four areas of historic habitation and/or agriculture identified in the 1990 CSH survey to determine if there were any subsurface remains of: (1) nineteenth century (or earlier) habitation and agricultural lots in the Honouliuli Taro Lands; (2) structures or burials associated with the nineteenth century Kapalani Catholic Church; (3) structures or historic domestic artifacts associated with the early twentieth century Drivers and Stable Village; and, (4) structures or historic domestic artifacts or pit/privy features associated with the early twentieth century PipeLine Village. No cultural deposits, no privy pits, no burials, and no artifacts or any type were found or recovered from the 19 trenches. It seems that sugarcane cultivation, irrigation, flood control, railroad construction, later road construction, the demolition and movement of workers camps, and other factors have obliterated all, or almost all, traces of these former traditional Hawaiian habitation and agricultural lands and the later sugar cane plantation workers camps, churches, and schools.

6.1 Significance Assessments

Sites are evaluated for significance according to the broad criteria established for the National and State Registers. The five criteria are:

A	Site reflects major trends or events in the history of the state or nation.
B	Site is associated with the lives of persons significant in our past.
C	Site is an excellent example of a site type.
D	Site may be likely to yield information important in prehistory or history.
E	Site has cultural significance; probable religious structures and/or burials present.

During the 1990 survey of the West Loch Bluffs project area (southeastern section of the current project area) five sites were identified and given SIHP site designations. All five sites were determined as significant under criteria C and D. The three features (Features A-C) of Site

50-80-12-4344 (plantation infrastructure) were not recommended for any further work or for preservation. Sites 50-80-12-4345 (railroad berm), and Sites 70-12-4346, -4347, and -4348 (three pumping stations) were all recommended for preservation.

During the recent 2005 survey of the East Kapolei project area, four additional plantation infrastructure features adjacent to Honouliuli Gulch were identified. These features (Features D-G) were added to the Site –4344 description. The significance and recommendation for this site remains the same (no further work and no preservation); they have all had adequate documentation and do not need to be preserved.

The four areas of historic interest identified in the 1990 West Loch Bluffs survey (Honouliuli Taro lands, Kapalani Catholic Church, PipeLine Village, and Drivers/Stable Village) were not given site designations in the 1990 report since there were no surface remains. In the recent 2005 subsurface inventory of these four areas, no trace of any remains (charcoal, food remains, structural remains, cultural layers, firepits, artifacts, burials, etc.) associated with these four former habitation areas could be found. Therefore, again, these four areas are not assigned permanent state site numbers.

6.2 Mitigation Recommendations

Five sites have been previously identified in the project area during a 1990 CSH survey. Four new features were found for one of these sites during the current 2005 survey. No subsurface remains were found within 19 trenches during the recent backhoe testing of four habitation loci (Honouliuli Taro Lands, Kapalani Catholic Church, PipeLine Village, Drivers/Stable Village) (see Figure 44 for location of four habitation loci). However, it is possible that some traces of these habitation areas remain in subsurface deposits in areas not covered by the test trenches. Thus, an on-call/on-site monitoring program is recommended for these four specific areas during any future development. A summary of findings and recommendations for the project area is presented in Table 5; areas of concern for mitigation recommendations are shown on Figure 65.

Table 5. Significance and Mitigation Recommendations

Site (50-80-12)	Description	Signifi-cance	Further Work	Mitigation Recommendation
-4344 Fea. A-C	3 pipe features	C, D	None. Features were destroyed sometime between the 1990 and 2005 survey	None
-4344 Fea. D-G	Sugar cane cultivation/ irrigation features	C, D	None. The features were adequately recorded during the 2005 survey.	No preservation
-4345	Ewa Plantation Railroad Berm	C, D	Architectural Evaluation	Preservation
-4346	Northern Pumping Station	C, D	Architectural Evaluation	Preservation
-4347	Central Pumping Station	C, D	Architectural Evaluation	Preservation
-4348	Southern Pumping Station	C, D	Architectural Evaluation	Preservation
Honouliuli Taro Lands	Nineteenth century (and earlier) Hawaiian Habitation/Agricultural Area	None	No surface or subsurface remains were found during a recent 2005 inventory survey. No additional testing is necessary.	On-call/on-site archaeological monitoring during future development of the area
Kapalani Church	Nineteenth century Hawaiian Catholic Church, schoolhouse, and possible cemetery area	None	No surface or subsurface remains were found. No additional inventory survey is necessary.	On-call/on-site archaeological monitoring during future development of the area
PipeLine Village	Early twentieth century immigrant plantation habitation camp	None	No surface or subsurface remains were found. No additional inventory survey is necessary.	On-call/on-site archaeological monitoring during future development of the area
Drivers/Stable Villages	Early twentieth century immigrant plantation habitation camps	None	No surface or subsurface remains were found. No additional inventory survey is necessary.	On-call/on-site archaeological monitoring during future development of the area

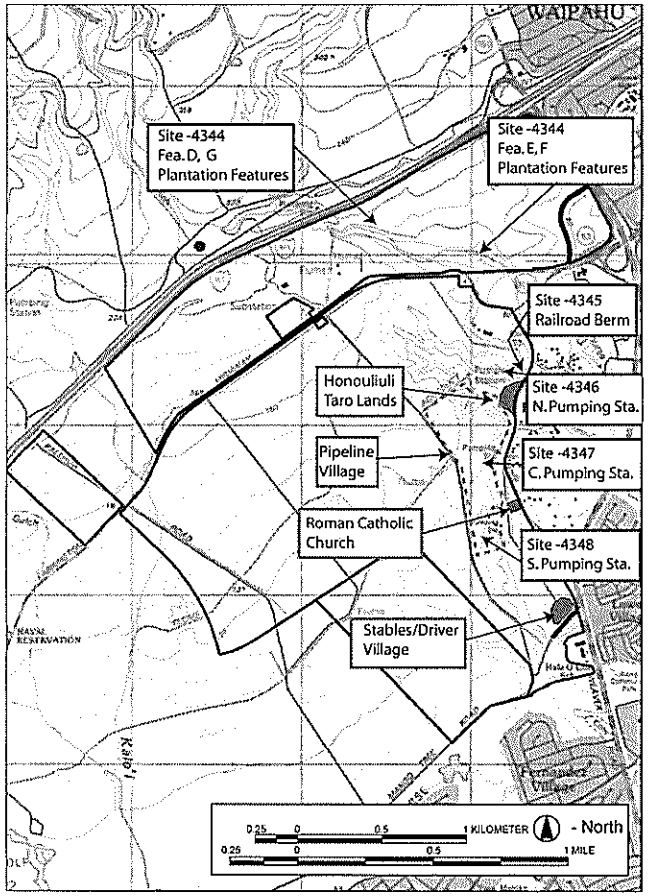


Figure 65. Areas of concern for significance and mitigation recommendations

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An Archaeological Assessment for the Ho'opili Project 440-Foot Elevation Reservoir and Waterline Project, Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu

TMK (1) 9-2-001:001 (por.), 004, 005, 006, 007 (por.); 9-2-002:002

Prepared for
PBR Hawai'i, Inc.

Prepared by
Randy Groza, M.A.,
Constance O'Hare, B.A.,
and
Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai'i, Inc.
Kailua, Hawai'i
(Job Code: HONOU 14)

December 2006

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Management Summary

Reference	An Archaeological Assessment for the Ho'opili Project 440-Foot Elevation Reservoir and Waterline Project, Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu TMK (1) 9-2-001:001 (por.), 004, 005, 006, 007 (por.); 9-2-002:002, by Randy Groza, Constance R. O'Hare, and Dr. Hallett H. Hammatt
Date	November 2006
Project Number (s)	CSH Job Code: HONOU 14
Investigation Permit Number	CSH completed the inventory survey fieldwork under state archaeological permit No. 0605 issued by the State Historic Preservation Division, per Hawai'i Administrative Rules (HAR) Chapter 13-13-282.
Project Location	The project area consists of several parcels which are identified by the following tax map key numbers: TMK (1) 9-2-001:001 (por.), 004, 005, 006, 007 (por.); 9-2-002:002. The project area is located within agricultural lands that are generally bound on the south by the H-1 Interstate (I H-1), on the east by Kunia Road, on the north by Kupehau Road, and the Honouliuli Gulch to the west. There are two non-contiguous sections linked by a waterline. The area of development immediately north of H-1 contains an existing reservoir, and the proposed waterline will run parallel to an existing waterline in the middle of an existing dirt road. The mauka area of development contains a pump house and is within a former pineapple field north of an existing dirt road.
Land Owner	TMK (1) 9-2-001:001 (por.), Monsanto Company TMK (1) 9-2-001: 004, HECO TMK (1) 9-2-001: 005, Monsanto Company TMK (1) 9-2-001:006, City & County of Honolulu TMK (1) 9-2-001:007 (por.) City & County of Honolulu TMK (1) 9-2-002:002 City & County of Honolulu
Reviewing Agencies	State Historic Preservation Division / Department of Land and Natural Resources (SHPD/DLNR)
Project Description	The client, PBR Hawai'i, Inc. plans to develop the project area with a 440-foot elevation reservoir and waterline in support of a new mixed residential, commercial, and recreational property (the Ho'opili project).
Project Acreage	Approximately 6 acres
Area of Potential Effect (APE)	For the purposes of this study the area of potential effect (APE) and the project area are considered one and the same.
Historic Preservation Regulatory Context	The client, PBR Hawai'i, Inc. proposed development of the Ho'opili Reservoir and Waterline Project constitutes a project requiring compliance with and review under State of Hawai'i historic preservation review legislation (Hawai'i Revised Statutes (HRS) Chapter 6E-42 and Hawai'i Administrative Rules (HAR) 13-284). At the request of PBR Hawai'i, CSH completed an archaeological assessment, per the requirements of HAR Chapter 13-13-276, of the subject 6-acre parcel. This archaeological assessment report was prepared to support the proposed property's historic preservation review and any other project-related historic preservation consultation.
Fieldwork Effort	Constance R. O'Hare, B.A., and Randy Groza, M.A. under the general direction of Hallett H. Hammatt, Ph.D. conducted surface survey in the project area. Fieldwork was conducted on November 7, 2006.
Number of Historic Properties Identified	No sites had been previously identified in the project area. During the recent 2006 surface survey, no sites were identified. No historic properties are believed to be present.
Mitigation Recommendation	No further work is recommended for the project area.

Table of Contents

List of Figures

Section 1 Introduction

1.1 Project Background

At the request of PBR Hawai'i, Inc. (1001 Bishop Street, Suite 650, Honolulu, Hawai'i 96813), Cultural Surveys Hawai'i, Inc. (CSH) has completed this archaeological assessment for the Ho'opili 440-Foot Elevation Reservoir and Waterline Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island (TMK:(1) 9-2-001:001, 004, 005, 006, 007 (por.); 9-2-002:002) (Figures 1 through 3). The project area is located within agricultural lands that are generally bound on the south by the H-1 Interstate (I H-1), on the east by Kunia Road, on the north by Kupehau Road, and the Honouliuli Gulch to the west. There are two non-contiguous areas linked by a waterline. The area of development immediately north of H-1 contains an existing reservoir, and the proposed waterline will run parallel to an existing waterline in the middle of an existing dirt road extending approximately 4,000 ft (1200 m) to the northeast. The *mauka* area of development contains two substations and is within a former pineapple field north of an existing dirt road. In all, the project area is approximately 6 acres. Plans are to develop these areas with two new reservoirs and a waterline for a mixed residential, commercial, and recreational property located south of H-1.

There seems to be little likelihood that this undertaking will impact any ongoing cultural practices. No traditional Hawaiian sites have been previously reported in the project area, and no new traditional Hawaiian or post-contact sites were found during the recent fieldsurvey; thus, this report is considered an archaeological assessment, not an inventory survey in the parlance of the State Historic Preservation Division. This archaeological assessment details the research and field inspection methods, presents a summary of all field inspection findings, and assesses the potential for significant historic properties (archeological/ historical potential) and potential impacts to cultural practices.

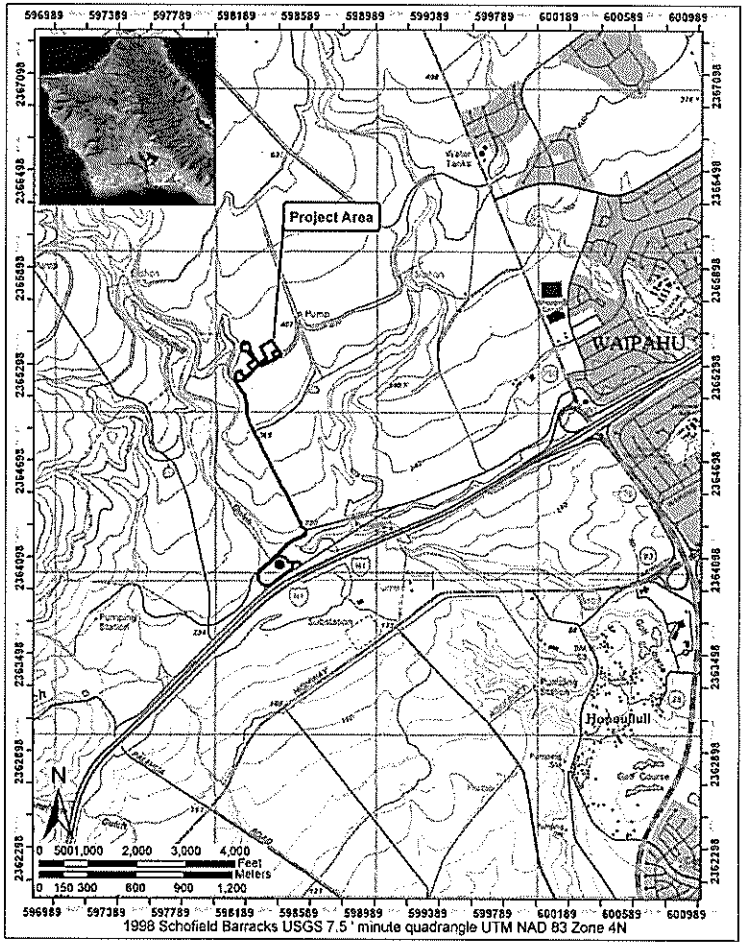

Figure 1. US Geological Survey map (1998), Schofield Barracks quadrangle, showing project area

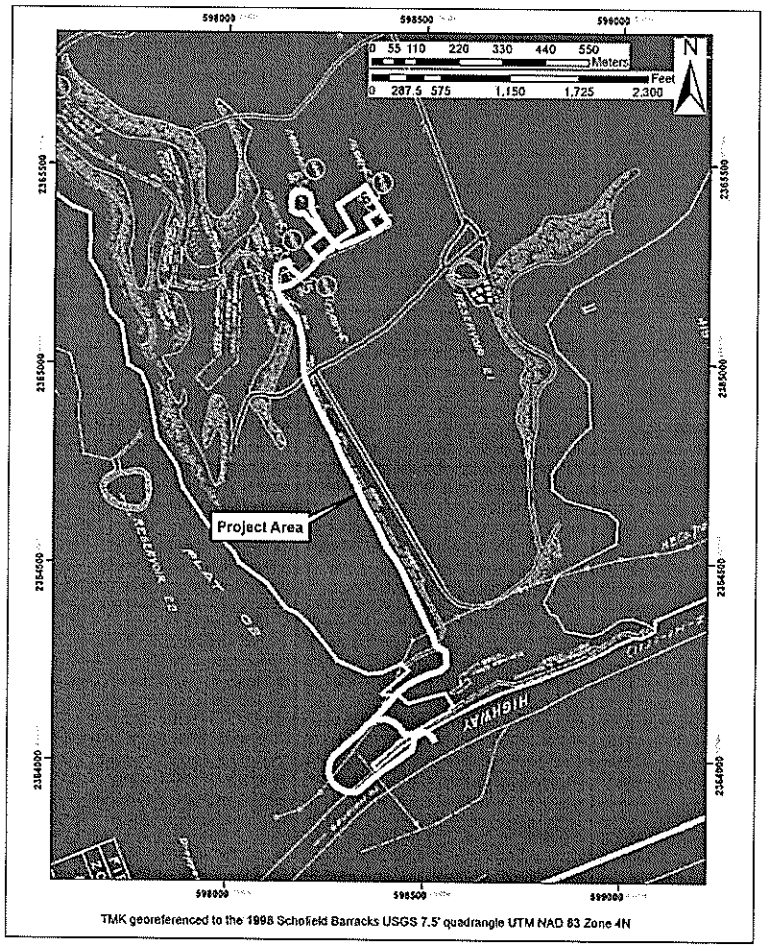

Figure 2. Portion of Tax Map Keys (TMK) Plats 9-2-001 and 9-2-002, showing project area

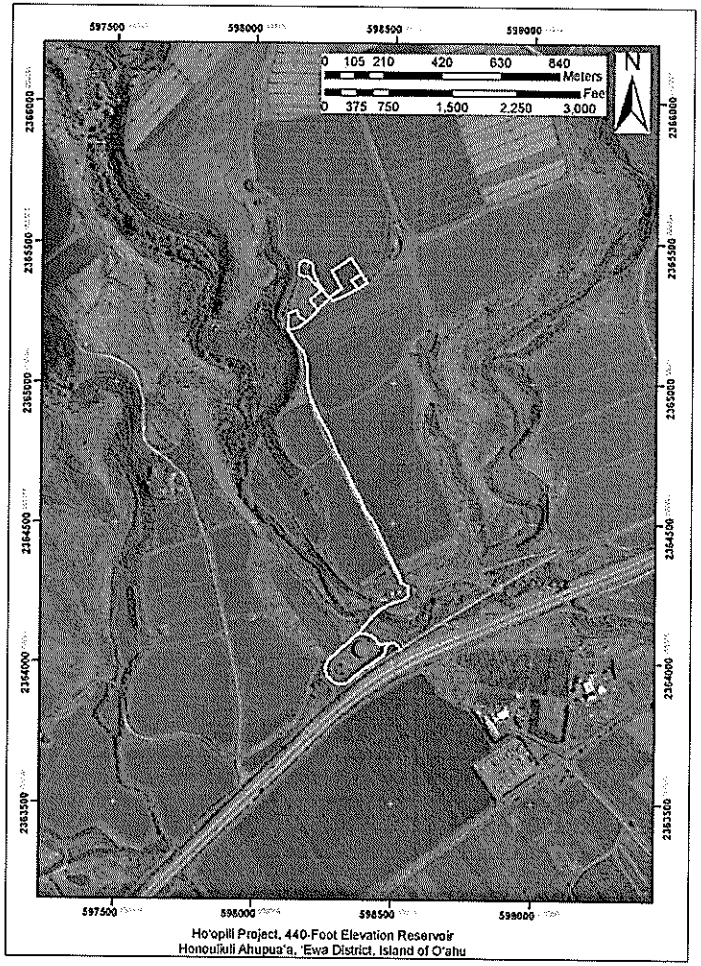

Figure 3. Aerial photograph showing the project area

1.2 Scope of Work

This archaeological assessment report details results of research and present conditions of the property. This report assesses both the potential for significant historic properties (archaeological/historical potential) and potential impacts to cultural practices.

The scope of work for this assessment includes:

a. Historical and previous archaeological background research to include study of archival sources, historic maps, Land Commission Awards, and previous archaeological reports to construct a history of land use and to determine if archaeological sites have been recorded on or near this property.

b. A complete ground survey of the entire project area for the purpose of site inventory was conducted to identify any surface archaeological features and to investigate and assess the potential for impact to such sites.

c. The report assesses the likelihood that the proposed project will not impact cultural practices. This assessment is based on the background research, and the review of land use within the vicinity of the project area.

d. Preparation of a report to include the results of the historical research and the fieldwork, with an assessment of archaeological potential based on that research, with recommendations for further archaeological work, if appropriate. This report was also to provide mitigation recommendations if there were any archaeologically sensitive areas that need to be taken into consideration.

1.3 Environmental Setting

1.3.1 Natural Environment

Honouliuli Ahupua'a is the largest traditional land unit on O'ahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupua'a at Pili o Kahe in the west. Honouliuli Ahupua'a includes approximately 19 km (kilometers), or 12 mi (miles) of open coastline from One'ula westward to Pili o Kahe. The *ahupua'a* extends *mauka* (inland) from West Loch nearly to Schofield Barracks in Wahiawā. The western boundary is the Wai'anae Mountain crest running north as far as Pu'u Hāpapa (or to the top of Ka'ala Mountain, according to some).

Topographically, the southern portion of the project area, north of H-1, and the northern portion are generally flat. The approximately 4,000-ft (1300 m) of existing dirt road that connects the northern and southern portions of the project area climbs from 220 to 400 feet (ft) or 67-122 meters (m).

Lying in the lee of the Wai'anae mountain range, the project area is one of the driest areas of O'ahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). Temperatures range between 60° to 90°F through the year; the highest temperatures are in August and September (Armstrong 1973). Elevation in the project area ranges from 220 ft

AMSL (above mean sea level) to 400 ft (67-122 m). Intermittently running Honouliuli Stream is approximately 500 ft (150 m) north of the southern portion of the project area, 1000 ft (300 m) west of the waterline, and 1300 ft (400 m) west of the northern portion of the project area.

A total of five soil series are found in the project area (Figure 4). The Kawaihapai Series consists of well-drained soils in drainage ways and on alluvial fans on the coastal plains, which formed in alluvium derived from basic igneous rock in humid uplands. The annual rainfall amounts to 30 to 50 inches. The natural vegetation consists of *kiawe*, *koa haole*, lantana, and bermudagrass. Kawaihapai clay loam (KiB), 2 to 6 percent slope, is used for sugarcane, truck crops, and pasture. The Kunia Series consists of well-drained soils on upland terraces and fans; the soils developed in old alluvium. They are nearly level to moderately sloping. Kunia silty clay, 0 to 3 percent slopes (KyA) and 3 to 8 percent slopes (KyB), are used for sugarcane, pineapple, and homesites. The Lahaina Series consists of well-drained soils on uplands that developed in material weathered from basic igneous rock. They are nearly level to steep. Lahaina silty clay, 7 to 15 percent slopes, is used for sugarcane and pineapple. Small acreages are used for truck crops, pasture, and wildlife habitat. The Molokai Series consists of well-drained soils on uplands, formed in material weathered from basic igneous rock. They are nearly level to moderately steep. Molokai silty clay loam, 3 to 7 percent (MuA) and 7 to 15 percent slopes (MuB), are used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. The natural vegetation consists of *kiawe*, *ilima*, *uhaloa*, feather fingergrass, and buffelgrass (Foote et al. 1972).

1.3.2 Built Environment

During the post-contact period, the project area was used for cattle grazing. In 1890, the land was primarily used for sugar cane and pineapple cultivation by the Ewa Plantation Company. Currently, the mauka area of the project area is fallow and contains low grass (Figure 5). There are also two substations within that northernmost portion (Figures 6 and 7). The central portion, the location of the water line, is an existing dirt road (Figure 8), and the southernmost portion is fenced and contains a water retention tank (Figure 9).

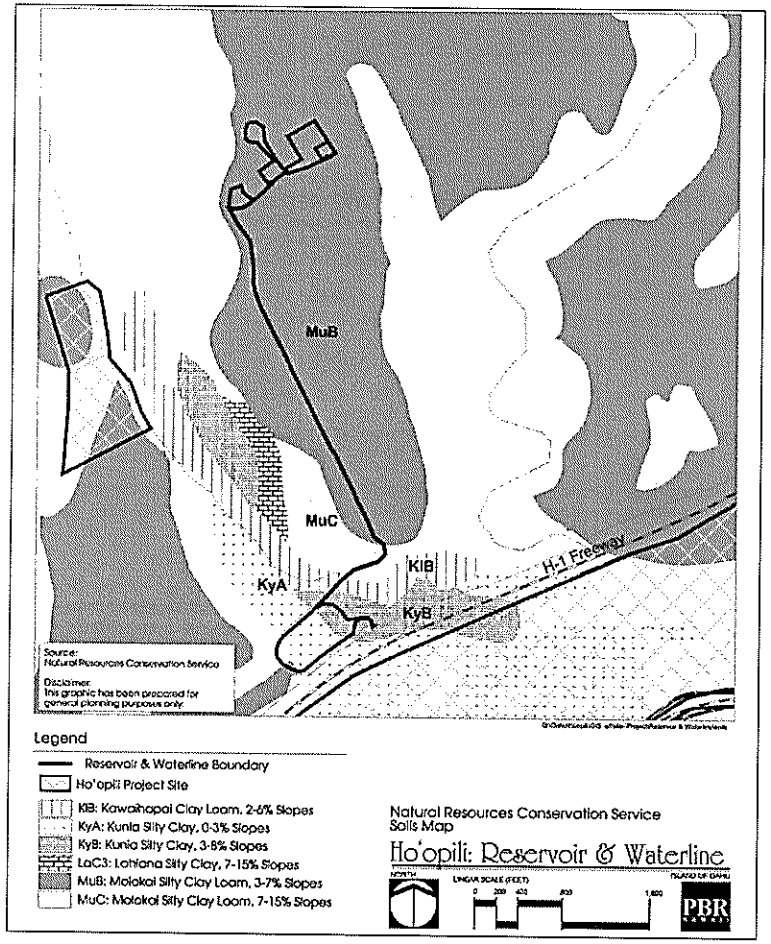

Figure 4. Soil Map of Ho'opili 440-Foot Elevation Reservoir and Waterline Project Area

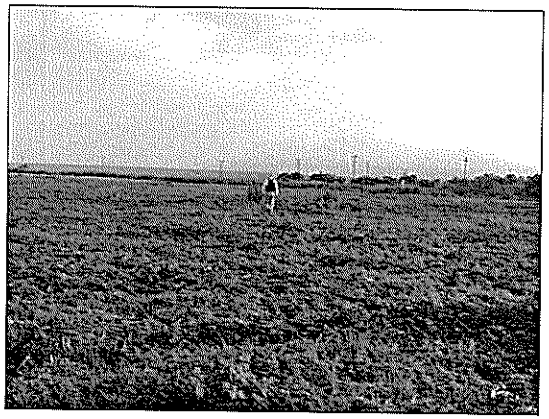

Figure 5. Northern parcel, view to northeast

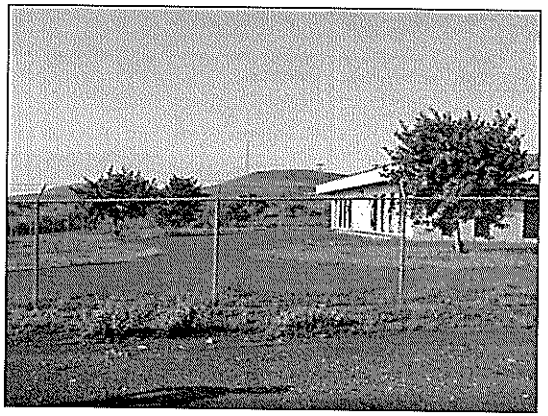

Figure 6. Substation within central portion of northern parcel, view to west

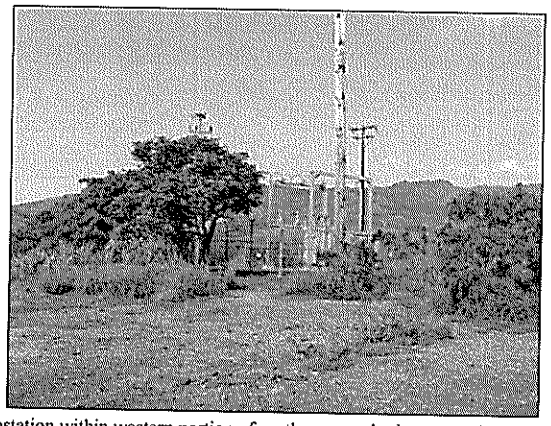

Figure 7. Substation within western portion of northern parcel, view to north

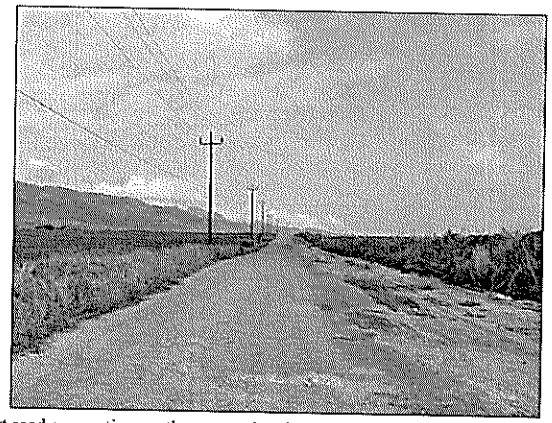

Figure 8. Dirt road connecting northern parcel and southern parcel, view to northwest

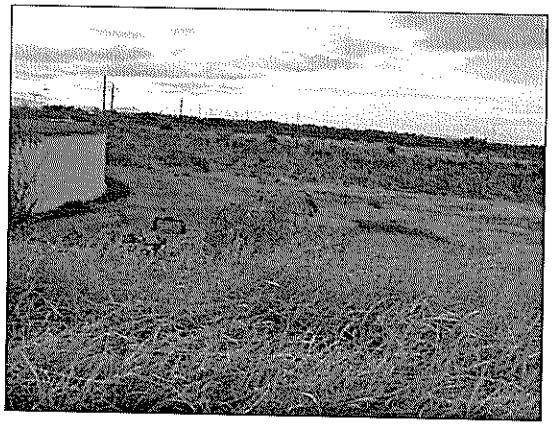

Figure 9. Southern parcel showing existing tank and location of planned tank, view to south/southeast

Figure 10. Southern parcel showing western portion and location of planned tank, view to southwest

Section 2 Methodology

For this report, CSH reviewed previous archaeological studies on file at the State Historic Preservation Division. CSH also reviewed geology and cultural history documents at Hamilton Library at the University of Hawai'i, the Hawai'i State Archives, the Hawai'i Public Library, and the Archives of the Bishop Museum. Additional research included a study of historic maps at the Survey Office of the Department of Accounting and General Services. Information regarding LCAs was obtained from the Waihona 'Āina Corporation's Māhele Data Base (www.waihona.āina.com).

2.1 Field Methods

The pedestrian inspection of the project area was conducted on November 7, 2006 with two Cultural Surveys Hawai'i staff archaeologists, Constance R. O'Hare, B.A., and Randy Groza, M.A., under the general direction of Hallett H. Hammatt, Ph.D. The entire northern portion of the project area was surveyed by pedestrian sweeps. CSH archaeologists conducted a windshield survey of the approximately 4,000 ft (1200 m) of existing road, where the new water line will run parallel to the existing water line in the center of the road and connect the northern portion of the project area with the southern portion. The southern section of the project area was reviewed through the chain link fence.

No historic properties were encountered and the pedestrian inspection was documented with field notes, maps, and photographs.

2.2 Laboratory Methods

Because no archaeological artifacts, midden, or soil samples were recovered, no laboratory work was undertaken.

2.3 Consultation

Pre-contact sites were not perceived to be present nor were any pre-contact sites found within the project area, and there appears to be little likelihood that the undertaking will impact any ongoing cultural practices. Pursuant to Chapter 13-276-5 (g), there was no need indicated for consultation, and a summary of findings has been sent to the Office of Hawaiian Affairs (see Appendix A).

Section 3 Documentary Research

3.1 Mythological and Traditional Accounts

The traditions of Honouliuli Ahupua'a have been compiled by several authors, in studies by Sterling and Summers (1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), Maly (1992), and Tuggle and Tomonari-Tuggle (1997). Some of the traditional themes associated with this area include connections with Kahiki, the traditional homeland of Hawaiians in central Polynesia. There are several versions of the chief Kaha'i leaving from Kalaeloa for a trip to Kahiki; on his return to the Hawaiian Islands he brought back the first breadfruit (Kamakau 1991a:110) and planted it at Pu'uloa, near Pearl Harbor in 'Ewa (Beckwith 1940:97). Several stories associate places in Honouliuli to the gods Kāne and Kanaloa, with the Hawaiian pig god Kamapua'a and the Hina family, and with the sisters of Pele, the Hawaiian volcano goddess, all of who have strong connections with Kahiki (Kamakau 1991a:111; Pukui et al. 1974:200). The locations of traditional places names for Honouliuli are illustrated in Figure 11.

3.1.1 The Naming of 'Ewa and Honouliuli

Honouliuli is the largest *ahupua'a* in the *moku* (district) of 'Ewa. One translation of the name for this district is given as "unequal" (*Saturday Press* Aug. 11, 1883). Others translate the word as "strayed" and associate it with the legends of the gods, Kāne and Kanaloa.

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of the land they would throw a stone and where the stone fell would be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Wai'anae range and it landed somewhere, in the Waimānalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

Honouliuli means "dark water," "dark bay," or "blue harbor" and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua'a*. The Hawaiians called Pearl Harbor, Pu'uloa (*lit.* long hill). Another explanation for the names comes from the "Legend of Lepeamoa", the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa (Thrum 1923:164-184). "Her grandfather gave his name, Honouliuli to a land district west of Honolulu . . ." (Thrum 1923:170). Westervelt (1963:209) gives an almost identical account.

It seems likely the boundaries of the western-most *ahupua'a* of 'Ewa were often contested with Wai'anae people. The 'Ewa people could cite divine sanction that the dividing point was between two hills at Pili o Kahe:

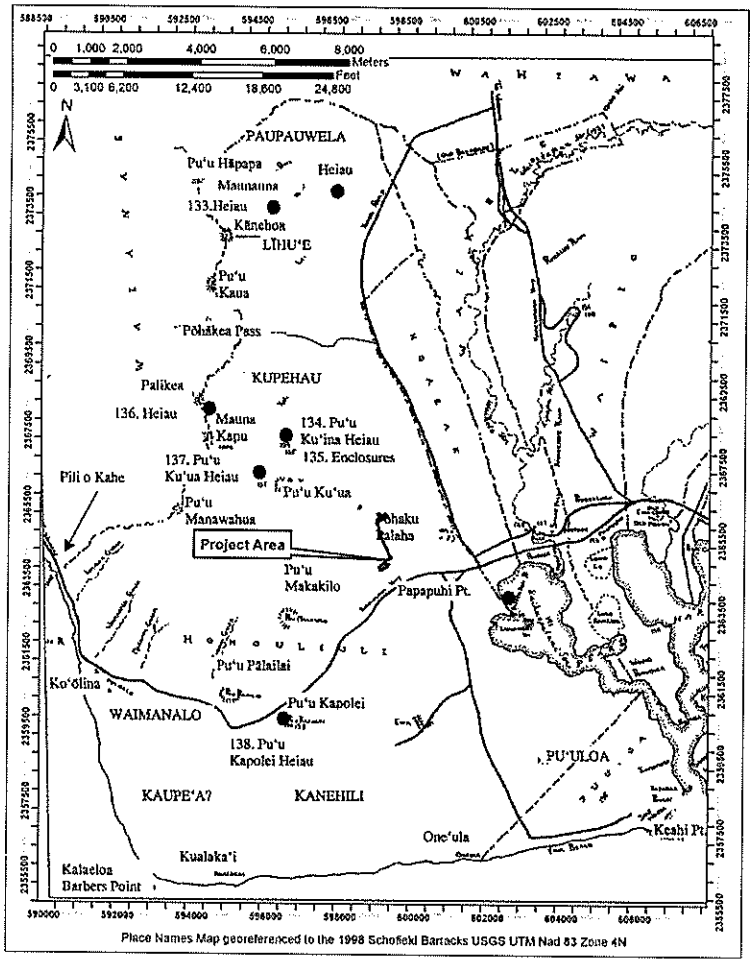

Figure 11. Place Names of Honouliuli (map adapted from Sterling and Summers 1978)

Eventually the stone was found at Pili o Kahe. This is a spot where two small hills of the Wai'anae Range come down parallel on the boundary between Honouliuli and Nānākuli ('Ewa and Wai'anae). The ancient Hawaiians said the hill on the 'Ewa side was the male and the hill on the Wai'anae side was female. The stone was found on the Wai'anae side hill and the place is known as Pili o Kahe.

> (Pili = cling to, Kahe = flow). The name refers, therefore, to the female or Wai'anae side hill. And that is where the boundary between the two districts runs [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

3.2 Historic Background

3.2.1 Pre-Contact and Early Post-Contact Periods

By ca. A.D. 1320, 'Ewa, along with Kona, and Ko'olaupoko were the dominant polities, ruled by the sons of a chief named Māweke (Cordy 2002:21). 'Ewa at this time included the traditional districts of 'Ewa, Wai'anae, and Waialua (Fornander 1880:48). Around A.D. 1400, the entire island was ruled by King La'akona; chiefs within his line, the Māweke-Kumuhonua line, reigned until about A.D. 1520-1540, with their major royal center in Līhu'e, in 'Ewa. (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line; he was slain by his men at the fortress of Waewae near Līhu'e (Kamakau 1991b:54-54; Fornander 1880:88). Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūali'i achieved control of all of O'ahu by defeating the Kona chiefs, then the 'Ewa chiefs, and then expanding his control on windward Kaua'i. Peleiholani, the heir of Kūali'i, gained control of O'ahu ca. 1740, and later conquered parts of Moloka'i. He was ruler of O'ahu until his death in ca. 1778 when Kahahana, of the 'Ewa line of chiefs was selected as the ruler of O'ahu (Cordy 2002:24-41).

After Kamehameha's O'ahu victory, he gave the *ahupua'a* of Honouliuli to Kalanimōkū as part of the *panalā'au*, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kame'eleihiwa 1992:58, 112). Kalanimōkū subsequently gave the *ahupua'a* to his sister, Wahinepi'o.

Various Hawaiian legends and early historical accounts indicate that the *ahupua'a* (land division) of Honouliuli was once widely inhabited by pre-Contact populations, including the Hawaiian *ali'i* (chiefly class). This would be attributable for the most part to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the *ahupua'a* include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy (1972:429) report:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko'olau range. Between the valleys were ridges, with steep sides, but a very

gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous.

In addition, breadfruit, coconuts, *wauke* (paper mulberry; *Broussonetia papyrifera*), bananas, and *olona* (*Touchardia latifolia*) and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *mamaki*. It was also famous for a rare taro called the *kai o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

> He has eaten the Kāī-koi taro of 'Ewa. *Ua 'ai i ke kāī-koi o 'Ewa.*
> Kāī is O'ahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of 'Ewa, who, like the Kāī taro, is not easily forgotten [Pukui 1983:#2770].

The lochs of Pearl Harbor were ideal for the construction of fishponds and fish traps. Forest resources along the slopes of the Wai'anae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469-470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP site 50-80-12-4322) is present in Maka'īwa Gulch at 152 m (500 ft) above mean sea level (Hammatt, et al. 1990).

John Papa 'Ī'ī described a network of Leeward O'ahu trails, which in historic times encircled and crossed the Wai'anae Range, allowing passage from Honouliuli to Wai'anae by three different trails. "As mentioned before, there were three trails to Wai'anae, one by way of Pu'u o Kapolei, another by way of Pohakea, and the third by way of Kolekole" ('Ī'ī 1959:97). Following 'Ī'ī's description, a portion of the coastal trail would have passed close to the existing Farrington Highway, approximately 1 km (.6 mi) south of the southern portion of the project area, as seen in an 1825 map (Figure 12) map of the south coast of O'ahu by Charles Malden of the British ship the *Blonde*.

Early historical accounts of the general region typically refer to the more populated areas of the 'Ewa district, where missions and schools were established and subsistence resources were perceived to be greater. However, the presence of archaeological sites along the barren coral plains and coast of southwest Honouliuli Ahupua'a, indicate that prehistoric and early historic populations also adapted to less inviting areas, despite the environmental hardships.

3.2.2 Observations of Early Explorers and Foreign Residents

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka'i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it . . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen's huts [Vancouver 1798, Vol. I:167].
>
> . . . from the commencement of the high land to the westward of Opooroah [Pu'uloa], was composed of one very barren rocky waste, nearly destitute of

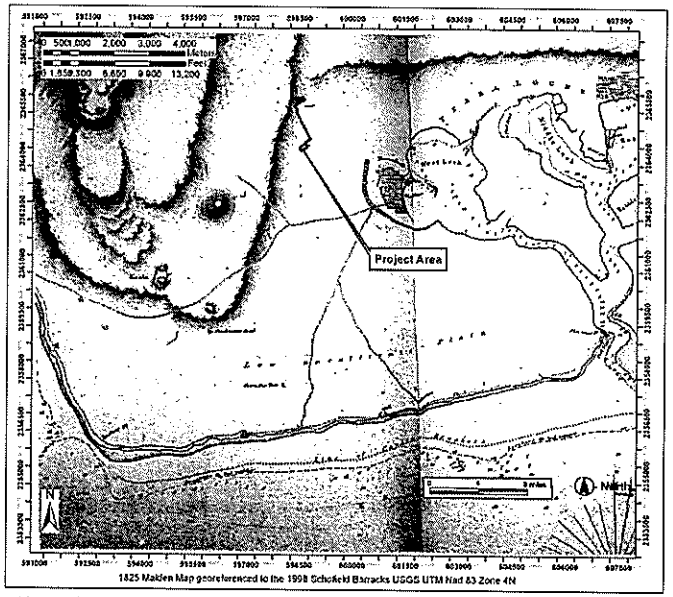

Figure 12. Portion of 1825 Map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde*

> verdure, cultivation or inhabitants, with little variation all the way to the west point of the island . . . [Vancouver 1798, Vol. II:217]. . . . This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced . . . [Vancouver 1798, Vol. III:361-363].

Archibald Campbell, an English seamen who was given some land in Waimano Ahupua'a by King Kamehameha in 1809, described his land around Pearl Harbor:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. . . . We passed by footpaths, winding through an extensive and fertile

> plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for the taro beds. Where there was not water, the land was under crops of yams and sweet potatoes [Campbell 1967:103-104].

Pearl and mother-of-pearl shells are found here in considerable quantity. Since the king has learned of their value, he has kept the fishing to himself, and employs divers for the purpose [Campbell 1967:114-115].

Subsequent to western contact in the area, the landscape of the 'Ewa plains and Wai'anae slopes was adversely affected by the removal of the sandalwood forest, and the introduction of domesticated animals and new vegetation species. Domesticated animals, including goats, sheep and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. It is unclear when the domesticated animals were brought to O'ahu, however, L.A. Henke reports the existence of a longhorn cattle ranch in Wai'anae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. Within the current project area, the majority of the (non-cultivated) vegetation is comprised of introduced species, mainly grasses.

At contact, the most populous *ahupua'a* on the island was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the population as 1,026. Within four years the population was down to 870 (Schmitt 1973:19, 22). In 1835, there were eight to ten deaths for every birth (Kelly 1991:157-158). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of 'Ewa and Wai'anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of 'Ewa was probably abandoned by the mid-nineteenth century, due to population decline and consolidation of the remaining people in the town of Honouliuli (at Kapapapuhi Point, southeast of the project area). A detailed discussion of the historic population counts in the 'Ewa District has been presented by Charvet-Pond and Davis (1992).

The first mission station in 'Ewa was established in 1834 at Kalua'aha near Pearl Harbor. Charles Wilkes, of the U.S. Exploring Expedition visited the missionary enclave at Honouliuli town in 1840.

> At Ewa, Mr. Bishop has a large congregation. The village comprises about fifty houses, and the country around is dotted with them. . . . The natives have made some advance in the arts of civilized life; there is a sugar-mill which, in the season, makes two hundred pounds of sugar a day. . . . In 1840, the church contained nine hundred members, seven hundred and sixty of whom belonged to Ewa, the remainder to Wai'anae; but the Catholics have now established themselves at both these places, and it is understood are drawing off many from their attendance on Mr. Bishop's church [Wilkes 1970:80-81].

A portion of the 1825 map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde* (see Figure 12) depicts substantial settlement at the "Honouliuli Taro Land" in the Kapapapuhi Point area, and it seems clear that in early historic

times, this was the focus of the population of Honouliuli. The amenities of the area - including fishponds, taro *lo'i*, abundant shellfish, and salt pans - would have focused population there in pre-Contact times as well.

3.2.3 Mid-Nineteenth Century and the Māhele

The Organic Acts of 1845 and 1846 initiated the process of the *māhele* - the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848, the crown and the *ali'i* (chiefly class) received their land titles. The common people received their *kuleana* (individual parcels) in 1850.

During the *Māhele* of 1848, 72 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III (Tuggle and Tomonari-Tuggle 1997:34). The 72 *kuleana* awards, awards given to commoners, were almost all made adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields. Kepā Maly (1997, Table 3: 38-42) provides a table recording information on each award, including awardee, *'ili*, and land use of the *'āpana* (lot). Project area lands were unclaimed and subsequently were granted to Miriam Ke'ahi-Kuni Kekau'ōnohi.

3.2.4 Honouliuli Māhele Awards to *Ali'i*

In 1855, the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke'ahikuni Kekau'ōnohi (Royal Patent #6971 in 1877; Parcel #1069 in the Land Court office), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O'ahu (Indices of Awards 1929; Kame'eleihiwa 1992). Kekau'ōnohi was also awarded the *ahupua'a* of Pu'uloa, but she sold this land in 1849 to Isaac Montgomery, a British lawyer.

Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahalai'a, who was governor of Kaua'i (Hammatt and Shideler 1990:19-20:20). Subsequently, Kekau'ōnohi ran away with Queen Ka'ahumanu's stepson, Keli'iahonui, and then became the wife of Chief Levi Ha'alelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. A lawsuit (Civil Court Case No. 348) was brought by Ha'alelea in 1858, to reclaim the fishing rights of the Pu'uloa fisheries from Isaac Montgomery, and the court ruled in Ha'alaea's favor. In 1863, the owners of the *kuleana* lands deeded their lands back to Ha'alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha'alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney (Yoklavich et al 1995:16).

3.2.5 Early Ranching on the 'Ewa Plain

John Coney rented the land to James Dowsett and John Meek in 1871, who used the land for cattle grazing. In 1877, the land, except for the *'ili* of Pu'uloa, was sold to James Campbell. He drove off 32,237 head of stock belonging to Dowsett and Meek and to James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). He let the land rest for one year and then began to restock the ranch, so that he had a head of 5,500 head after a few years (Dillingham 1885, cited in Frierson 1972:14)

In 1880-81, the Honouliuli ranch was described as:

> . . . Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. . . . There are valuable fisheries attached to this estate . . . . [Bowser 1880:489].
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. . . . Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts [Bowser 1880:495].

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Co. 1923:6-7). In 1879, Campbell brought in a well-driller from California to search the 'Ewa plains for water, and the well, drilled to a depth of 240 feet near Campbell's home in 'Ewa, resulted in ". . . a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d., cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource.

3.2.6 History of Oahu Sugar Company

3.2.6.1 General History of the Company

In 1897, B. F. Dillingham established the Oahu Sugar Company on 12,000 acres leased from the John Papa 'Ī'ī, Bishop, and Robinson estates. Prior to commercial sugar cultivation, these lands were described as being "of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project" (Condé and Best 1973:313). Dillingham had successfully promoted the Ewa Plantation Company in 1890; the sprawling sugar company was just south of and adjacent to the Oahu Sugar Company. Artesian wells had converted those arid Eva lands into a thriving plantation and Dillingham recognized the same potential in the northern area.

The project area is located in the western portion of the Oahu Sugar Company, which was also known as the Oahu Plantation (Figure 13and Figure 14). The northern portion of the project area is within Field 37; the central portion of the project area extends from Field 27 to Field 37, and the southern portion of the project area is within Field 28. Water to irrigate the upper cane fields was initially pumped to levels of 500 ft (150 m) by some of the "largest steam pumps ever manufactured" (Dorrance and Morgan 2000:49). Oahu Sugar Company's innovations to utilize the arid Ewa Plains and increase production within the plantation were so successful that the improvements were incorporate throughout the sugar cane industry. The Oahu Sugar Company constructed Hawai'i's first 12-roller mill in 1907, and P.A. Messchaert, the plantation's chemist,

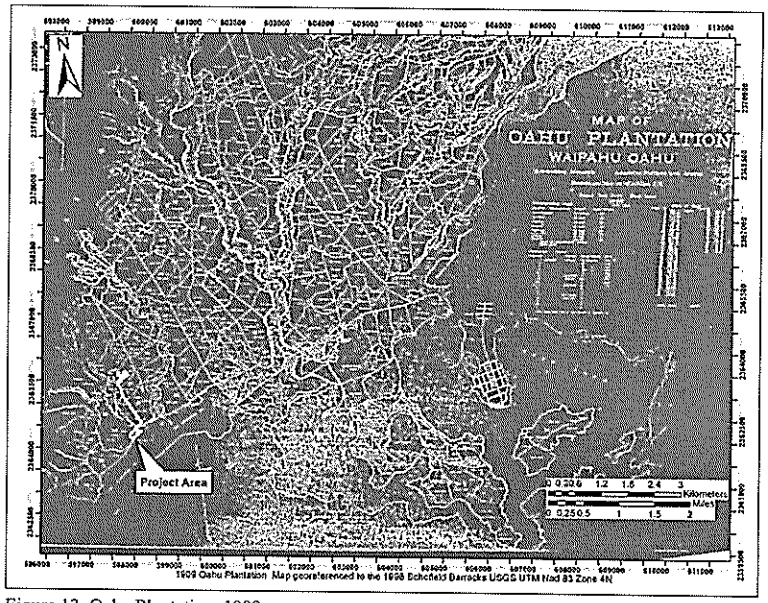

Figure 13. Oahu Plantation, 1909

invented a mechanized grooving method in 1913 that maintained pressure on the processing cane while allowing the cane juice to flow (Dorrance and Morgan 2000:49).

The expense of pumping water to the high elevations of the plantation led to the proposal to transport water from the windward side of the Koolaus. The Waiahole Water Company was formally incorporated in 1913 and was originally a subsidiary of the Oahu Sugar Company. The Waiahole Ditch was designed by engineer Jorgen Jorgensen, with recommendations by engineer J.B. Lippencott and assisted by W.A. Wall. The ditch began in Kahana Valley at an elevation of 790 ft (240 m), and ran almost entirely through tunnels through the Waikane and Waiahole valleys, the Koolaus, and was finally captured in a reservoir at 600-foot (180 m) elevation in the Wai'anae Range. Upon its completion in 1916, the Waiahole Ditch was 21.9 miles long (35 kilometers) and cost $2.3 million. The 32 million gallons of daily water enabled the O'ahu Sugar Company to grow to "some 20 square miles . . . ranging in elevation from 10 feet at the Waipio Peninsula . . . to 700 feet at the Waiahole Ditch" (Condé and Best 1973:313).

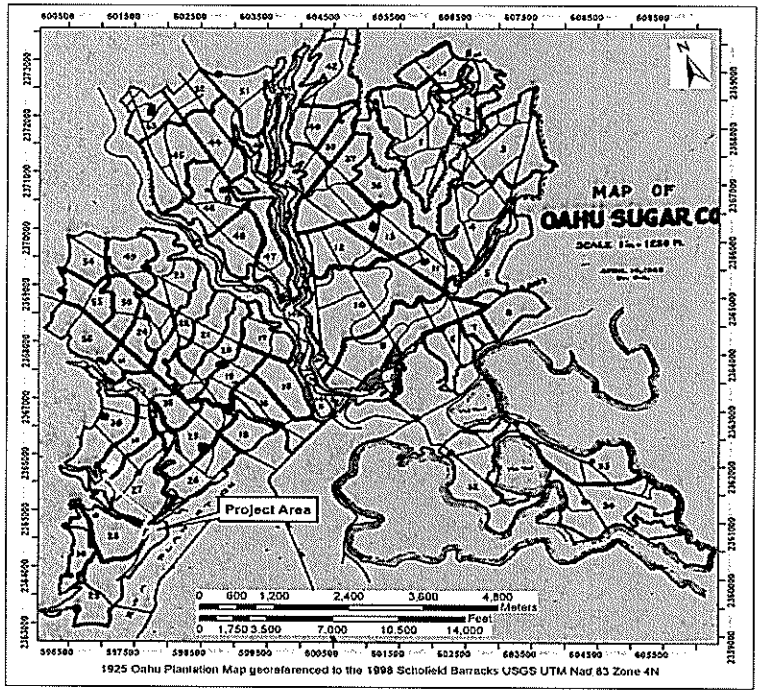

Figure 14. Oahu Sugar Company 1925, project area depicted in white

Annual sugar production increased to over 50,000 tons in 1918 and exceeded 40,000 tons annually for decades. In 1928, the Oahu Sugar Company broke a world's record by averaging more than 12 tons of sugar per acre. Mechanical harvesting innovations within the industry continued to develop and further increased production. They included mechanically loading cane in 1924, the removal of impurities during processing with an Oliver filer in 1926, and, during World War II, all cane was mechanically harvested. In 1950, sugar railroads were replaced with trucks.

By 1960, the Oahu Sugar Company was the largest producer on Oahu, with 75,000 tons annually. The company took control of the Ewa Plantation lands (Figure 15) in 1970 and continued operations until 1995, when sugar cane production in the combined plantation area ended (Dorrance and Morgan 2000:45, 50).

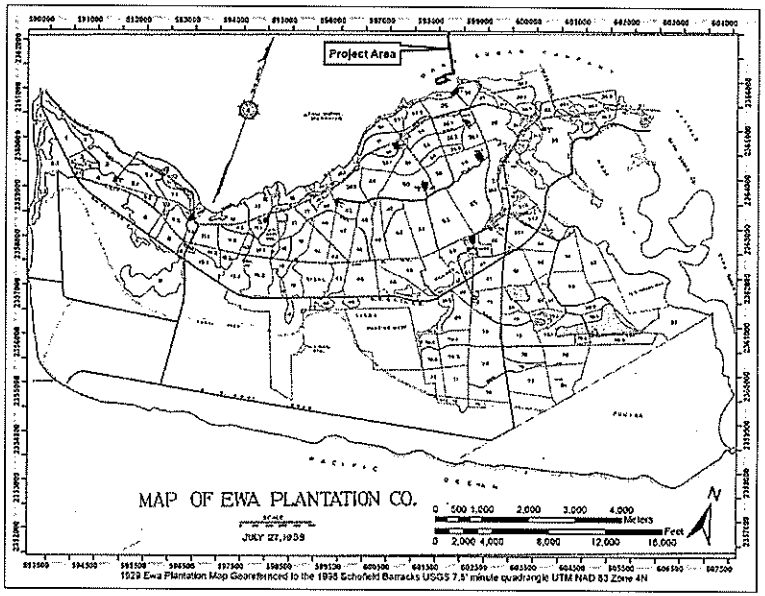

Figure 15. 1939 map of the Ewa Plantation Co. lands, showing project area

3.2.7 History of the Ewa Sugar Plantation

In 1886, James Campbell and B. F. Dillingham put together the "Great Land Colonization Scheme," which was an attempt to sell Honouliuli land to homesteaders (Thrum 1886:74). This homestead idea failed, but with the water problem solved by the drilling of artesian wells, Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Wai'anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:III, 100). This railroad line eventually ran across the center of the 'Ewa Plain at the lower boundary of the sugar fields.

To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly-formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company. Throughout this time, and continuing into

modern times, cattle ranching continued in the area, and Honouliuli Ranch - established by Dillingham - was the "fattening" area for the other ranches (Frierson 1972:15).

Ewa Plantation Company was incorporated in 1890 for sugar cane cultivation. As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964). By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific*, Dec. 1902:19-22, cited in Kelly 1985:171).

3.2.8 Pineapple Production

Although the northern portion of the project area was within the Oahu Sugar Company on the 1925 map (see Figure 14), these lands have been under pineapple cultivation for decades. Libby, McNeill and Libby began leasing the lands in 1921 (Smith 1924:133).

The first pineapples to arrive in Hawai'i may have been transported as early as 1527 by the Spanish. In 1794, a Spanish horticulturalist, Francisco de Paula Marin, immigrated to Hawai'i; he began experimentally raising pineapples in the early 1800s. Captain John Kidwell began pineapple crop development trials in 1885. Kidwell is considered to by the founder of Hawai'i's pineapple industry although James Drummond Dole is credited with advancing the industry. Dole became Hawai'i's "Pineapple King" after incorporating the Hawaiian Pineapple Company and commercially growing pineapples in 1901. Pineapple production grew to be Hawai'i's second largest industry (Fisher 2006).

Recently, the northern portion of the project area has been within pineapple fields cultivated by Del Monte. Del Monte had planned on harvesting their last crop of pineapple within the vicinity of the project area in 2008. However, the current crop has just been abandoned and future plans for the vicinity are unknown.

Section 4 Previous Archaeological Research

4.1 Overview of Archaeological Studies in Honouliuli

Two archaeological features, a boundary *pōhaku* or rock and a *hōlua*, or sledding site, are recorded only in the Boundary Commission Reports establishing the division lines between the *ahupua'a* of Honouliuli and Hō'ae'ae (to the east). The surveyor wrote of the southern point of this boundary:

> In regard to Hoaeae . . . the point of commencement is Pōhaku Palahalaha, a well known rock, now marked by an arrow and the name "Honouliuli" on one side and "Hoaeae" on the other, which I have made the initial point of the survey . . . [Commission on Boundaries, Vol. 1:243].

This rock is shown on the Sterling and Summer map (see Figure 11) as Pōhaku Palaha, east of the project area. In another boundary survey, the *pōhaku* is called a "large, flat rock" (Boundary Commission Vol. 1:249), which may indicate the origin of the name from the Hawaiian word *pālaha*, which means "flattened, wide" (Pukui and Elbert 1986:307). As the surveyor continued to walk the Honouliuli/Hō'ae'ae boundary, he marked the northern point of the division as:

> The Kamaaaina took me to the corner of Pauhala (?)-Hoaeae and Honouliuli – there is an ancient holua or sleding [*sic*] place near this – which is agreed for the ancient corner. . . [Commission on Boundaries Vol. 1:243].

The earliest attempt to record archaeological remains in Honouliuli Ahupua'a was made by Thrum (1906:46). He reported the existence of a *heiau* located on Pu'u Kapolei, southwest of the present study area. In a second monograph on *heiau*, Thrum (1917) called this *heiau* Palole'i [Kapolei]. Emory mapped and photographed these structures in 1933 (field notes), but they were dismantled and destroyed sometime before McAllister's survey of the islands in the 1930s. According to legend, Pu'u Kapolei was the location on which Kamapua'a, the pig-god, resided with his grandmother, Kamaunuahihio (McAllister 1933:108).

In his surface survey of the 1930s, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister recorded six sites (see Figure 11 for site locations) in the upland section of Honouliuli, *mauka* of the 'Ewa coral plain and Pu'u o Kapolei. Site 133 is a possible *heiau*, a small enclosure at the foot of Pu'u Kānehoa. It was still standing during McAllister's day, and local residents informed him of its sacred nature. Site 134 is Pu'u Kuina Heiau, located in a gulch at the foot of Mauna Kapu. Only traces of a large terrace remained. Site 135 is a series of enclosures *makai* of Pu'u Kuina Heiau. McAllister believed that the walls marked *kuleana* (commoner) lots. Site 136 is a small platform near Mauna Kapu, a sacred site, possibly an altar. Site 137 is Pu'u Ku'ua Heiau, plotted on a ridge near Pu'u Ku'ua. This *heiau* had been modified for use as a cattle pen; some areas had been cleared for pineapple cultivation or planted with ironwoods (McAllister 1933:107-108).

Between McAllister's 1930s study and the flurry of work that began in 1969, there are only a few sporadic pieces of research, which are not well documented. In 1933, Dr. Kenneth P. Emory

recorded a well-preserved house site and a possible *heiau* (later destroyed by sugar cane cultivation) in the western part of the coral plains (Sinoto 1976:1). In 1959, William Kikuchi removed a number of burials from a burial cave site (Bishop Museum Site OA-B6-10) at the Standard Oil Refinery, which was subsequently destroyed (Barrera 1975:1). Kikuchi recovered 12-16 incomplete primary and/or secondary burials cached in a sinkhole or crevice exposed during construction activities near the big bend in Malakole Road (Kikuchi 1959; Davis 1990b: 146, 147): In 1960, Yoshi Sinoto and Elspeth Sterling visited a house site (BPBM. Site OA-B6-8) within 'Ēkaha Nui Gulch. "Around this elevation (1200 feet), along the sides of the stream, were seen remains of many terraces and some house sites" (Sterling and Summers 1978:37). In 1962, Lloyd Soehren recorded another secondary human burial in a sinkhole at the Barber's Point Naval Air Station (Davis 1990a:147). In 1966, Lloyd Soehren carried out salvage excavations at a possible fishing shrine (BPBM. Site # 50-OA-B6-13). The site was reported as destroyed by construction (Barrera 1975:1), but Davis relocated the shrine and performed additional excavations in 1982 (Davis 1990a:148). In 1969, artifacts were recovered by Roger Green from a beach midden site (B6-14), south of the barge harbor.

4.2 Previous Archaeological Work in the Vicinity of the Project Area

Beginning in the late 1970s, archaeological research has been conducted in Honouliuli south and east of the general vicinity of the project area (Figure 16).

CHS has recently completed an archaeological inventory survey just south of H-1 and the current project area (O'Hare, et al 2006). The reported findings are based on a 1990 CSH inventory survey and a 2005 CSH surface survey. A total of five sites, a railroad berm (Site 50-80-12-4345), three pumping stations (Sites 50-80-12-4346, -4347, and -4348), and three features related to plantation infrastructure (Site 50-80-12-4344) were recorded and assigned SIHP permanent site numbers. During the 1990 survey, four historic documented areas of Hawaiian and later immigrant residence were also identified: the former sites of Honouliuli Taro Lands, Kapalani Church, PipeLine Village, and Drivers/Stable Village. Further work, especially subsurface testing, was recommended for these four areas. During the recent 2005 surface survey of 1,630-acres, four new features related to sugar cane cultivation or irrigation were recorded. These four features (Features D-G) were subsumed under the previous site number, Site 50-80-12-4344, used for scattered plantation infrastructure features. A total of 19 trenches were excavated in the four areas of historic habitation and/or agriculture identified in the 1990 CSH survey to determine if there were any subsurface remains of: (1) nineteenth century (or earlier) habitation and agricultural lots in the Honouliuli Taro Lands; (2) structures or burials associated with the nineteenth century Kapalani Catholic Church; (3) structures or historic domestic artifacts associated with the early twentieth century Drivers and Stable Village; and, (4) structures or historic domestic artifacts or pit/privy features associated with the early twentieth century PipeLine Village. No cultural deposits, no privy pits, no burials, and no artifacts of any type were found or recovered from the 19 trenches.

The recent CHS survey included a non-contiguous northern parcel that is approximately 1640 feet (500 meters) west of the current project area (O'Hare, et al. 2006). No evidence of historic or prehistoric activity was identified within that portion of the project area.

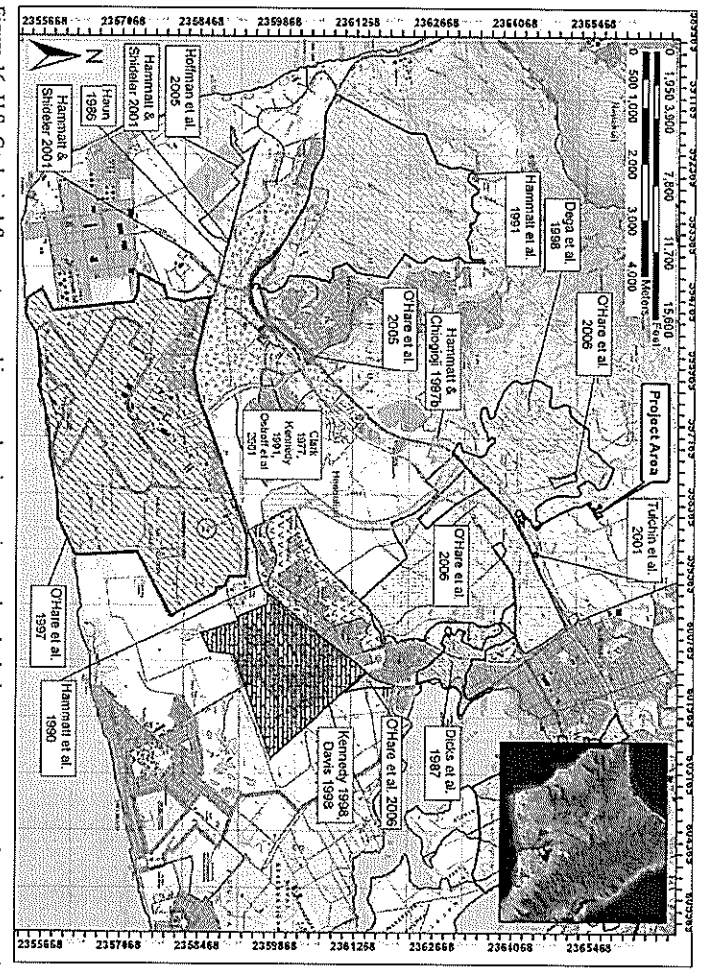

Figure 16. U.S. Geological Survey topographic map, showing previous archaeological survey areas near the current project area

In 1987, a reconnaissance survey was conducted on an approximately 200-acre property in 'Ewa (Kennedy 1987). The land is east of the current project area and within the *ahupua'a* of Hō'ae'ae, adjacent to the boundary of Honouliuli Ahupua'a. No prehistoric properties were found during the survey. The Waiahole ditch runs through the project area and two recently constructed reservoirs are within the project area. No further work was recommended since ground visibility was 100% and there was no indication the property contained subsurface deposits.

In 1991, Cultural Surveys Hawai'i conducted an archaeological inventory survey of the "Makaīwa Hills" development project (Hammatt, et al. 1991). The project area included a 1,915 acre parcel in Honouliuli *Ahupua'a*, between the town of Makakilo and Waimānalo Gulch (to the west of the current project area). 34 sites were located, including habitation structures (temporary and permanent), agricultural features (terrace and mounds), rock shelters, petroglyphs, and various other structures associated with sugar cane cultivation attributable to the Ewa Plantation Company. Eighteen of the recorded sites were considered significant and preservation was recommended. Sixteen of the sites, including cattle walls and other structures associated with the 'Ewa Plantation Co., were considered to be no longer significant and no further work was recommended.

An archaeological inventory survey of the University of Hawai'i, West O'ahu Campus, was conducted adjacent to and west of the southern portion of the current project area in 1998 (Dega, et al. 1998). Many historical features associated with sugarcane production and irrigation were identified and recorded as State Site Number 50-80-08-5593. Since sufficient data was collected, the site was considered no longer significant and no further work was required

In 2001, Cultural Surveys Hawai'i conducted an archaeological inventory survey of the proposed 'Ewa Shaft Renovation Project (Tulchin, et al. 2001). The approximately 1-acre project area is approximately 2,500 ft (750 m) east of the southern portion of the current project area. No prehistoric or historic properties were observed during the surface survey or subsequent subsurface testing.

4.3 Background Summary and Predictive Model

4.3.1 Honouliuli Settlement Patterns

The *ahupua'a* of Honouliuli is the largest traditional land unit on the island of O'ahu. Honouliuli includes all the land from the western boundary of Pearl Harbor (West Loch) westward to the 'Ewa/Wai'anae District Boundary with the exception of the west side of the harbor entrance, which is in the *ahupua'a* of Pu'uloa (the 'Ewa Beach/Iroquois Point area). This comprises approximately 12 miles of open coastline from One'ula westward to Pili O Kahe. The *ahupua'a* extends *mauka* (almost pie-shaped) from West Loch nearly to Schofield Barracks, and the western boundary is the Wai'anae Mountain crest running *makai* to the east ridge of Nānākuli Valley.

Not only is there a long coastline fronting the normally calm waters of leeward O'ahu, but there are also four miles of waterfront along West Loch. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless "desert" plain marked in pre-Contact times (previous to alluviation caused by sugar cultivation)

by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Wai'anae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat 'Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes, they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch.

Honouliuli Ahupua'a, as a traditional land unit, had abundant and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain, which is the most readily visible terrain, does not do justice to the *ahupua'a* as a whole. The richness of this land unit is marked by the following available resources:

1) 12 miles of coastline with continuous shallow fringing reef, which offered rich marine resources.

2) Four miles of frontage on the waters of West Loch, which offered extensive fisheries (mullet, *awa*, shellfish), as well as frontage suitable for development of fishponds.

3) The lower portion of Honouliuli Valley in the 'Ewa plain offered rich level alluvial soils with plentiful water for irrigation from the stream as well as abundant springs. This land would have stretched well up the valley.

4) A broad limestone plain, which because of innumerable limestone sinkholes, offered a nesting home for a large population of avifauna. This resource may have been one of the early attractions to human settlement.

5) An extensive upland forest zone extending as much as 12 miles inland from the edge to the coastal plain. As Handy and Handy (1972:469) have pointed out, the forest was much more distant from the lowlands here than it was on the windward side, but on the leeward side was more extensive. Much of the upper reaches of the *ahupua'a* would have had species-diverse forest with *kukui*, *'ōhia*, sandalwood, *hau*, *ti*, banana, etc.

Within this natural setting, archaeological and traditional sources show a general pattern of settlement within the *ahupua'a* that includes the inland settlement at Pu'u Ku'ua.

4.3.2 Pu'u Ku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is problematic in that there are relatively few documented archaeological sources. However, it is probable that the area around Pu'u Ku'ua, on the east side of the Wai'anae Ridge, was a Hawaiian place of some importance.

Pu'u Ku'ua is approximately 8,000 ft (2.5 km) west-south-west of the project area and is separated from the project area by Honouliuli Gulch.

There are two aspects of the stories related to Pu'u Ku'ua. One story relates that Pu'u Ku'ua was formerly a place of chiefs that was named for a chiefess. The other story relates that Pu'u Ku'ua was populated by the kauwa, or slaves.

In 1899, Hawaiian Newspaper *Ka Loea Kālai'āina* relates a story of Pu'uku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

There were two important things concerning this place. (1) This place was entirely deserted and left uninhabited and it seems that this happened before the coming of righteousness to Hawai'i Nei. Not an inhabitant is left. (2) The descendants of the people of this place were so mixed that they were all of one class. Here the gods became tired and returned to Kahiki [*Ka Loea Kālai'āina*, July 8, 1899, translated in Sterling and Summers 1978:32-33].

Thrum (1998:93) also mentions the hill Pu'uku'ua in the legend of the hero Kalelealuaka. In this legend, Kalelealuaka, who resides in Keahumoe in Waipi'o, 'Ewa, can transport himself long distances across the island of O'ahu. On a day before he is to meet the local chief, he transports to Helemano (near Wahiawa town) for a purifying bath, next transports himself to a place behind the visiting chief's retinue, and then flies with them to Pu'uloa (the east coastal area of Honouliuli).

> Returning from his purification, Kalelealuaka alighted just to the rear of the party, who had not noticed his absence, and becoming impatient at the tedious slowness of the journey, --for the day was waning, and the declining sun was already standing over a peak of the Wai'anae Mountains called Puukuua,--this marvelous fellow caught up the lame marshal [of the chief] in one hand and his two comrades in the other, and, flying with them, set them down at Puuloa. But the great marvel was, that they knew nothing about being transported, yet they had been carried and set down as from a sheet [Thrum 1998:93].

The same Hawaiian Newspaper *Ka Loea Kālai'āina* article cited above also states that the term *kauwā* (meaning slave or outcast) was first used to identify Pu'u Ku'ua because of a one armed chiefess who was ashamed and ran when other chiefs would visit. She was not a *kauwā* she only behaved as one [*Ka Loea Kālai'āina*, July 8, 1899, translated in Sterling and Summers 1978:33].

Another description of the *kauwā* residing in the vicinity of Pu'u Ku'ua follows:

> . . If you are above Puuloa, you will see Pu'u-o-Kapolei, a small hill. Lying below and back of that hill is the government road going to Wai'anae. Above that is also a small hill and back of that, is a big hill and above it is a large hollow. That is Pu'u-Kuua where the very dirty ones lived [*Ka Loea Kālai'āina* July 15, 1899, translation in Sterling and Summers 1978:32].

Kamakau says that the *kauwā* of O'ahu used the disruptions caused by the inter-island wars against several chiefs to assimilate into the general Hawaiian society.

The *kauwa* of Oah'u became "lost in the shuffle" (*huikau*) when Kahahana and the Oah'u chiefs died and Kahekili and his Maui chiefs took over the kingdom in 1783, and again when Kamehameha and his Hawai'i chiefs took the kingdom in 1795. The *kauwa* hid themselves until the time when the *kapu akua*, the god's kapus, were overthrown, and the kingdom became a "free-eating' one, *ke aupuni 'ainoa* [one without gods]. That released the *kauwa*. . . . By mixing here, mixing there, the blood of lords has become mixed with the blood of *kauwa*, and there is nothing that can cleanse it (*'a'ole mea nana i hiukala*) [Kamakau1991a:9].

Additionally, Kapo, Pele's sister, is believed to have left her flying vagina (*kohe lele*) at Pu'uku'ua.

McAllister recorded three sites in the vicinity of the project area and Pu'uku'ua, two *'heiau* (134, 137) (Pu'u Kuina and Pu'uku'ua, both destroyed) and a series of enclosures in Kukuilua which he called "kuleana sites" (McAllister 1933). McAllister (1933) noted that most of the stones of heiau 137 were used for a cattle pen located on the sea-side of the site; the portion of *heiau* that was cleared for pineapples has been planted in ironwood. On the opposite side of the Wai'anae range, along the trail to Pōhākea Pass, Cordy (2002:36) states "Kākuihihewa was said to have built (or rebuilt) Nōi'ula, a *pō'okanaka heiau* (1,300 sq. m.) in Hālona in upper Lualualei, along the trail to Pōhākea Pass leading into 'Ewa, ca. A.D. 1640-1660" (Cordy 2002:36). There is no direct archaeological evidence available to the authors' knowledge that intensive Hawaiian settlement occurred here, but it is considered as a place of high probability, based on the above indications. John Papa 'Ī'ī (1959) described a journey that Liholiho took which led him and an entourage through inland Honouliuli and over Pōhākea Pass. Geographically, the area receives sufficient quantities of water and would have had abundant locally available forest resources.

4.3.3 Project Area Predictive Model

Although the project area is near the Pu'uku'ua settlement area, approximately 8,000 ft (2.5 kilometers) west-south-west of the project area, it is separated from the project area by Honouliuli Gulch. The project area is not located near a source of water and was probably outside the boundary of the Pu'uku'ua population center. The project area was therefore not likely a focus for permanent habitation or agriculture.

Previous archaeological work conducted within the vicinity of the current project area also indicates that the project area is unlikely to contain subsurface prehistoric deposits.

4.3.4 Summary

On the basis of archaeological studies, informed by historic records, the following may be concluded:

1) There are three areas of Hawaiian settlement in the *ahupua'a* indicated in the historic record:
    a. the extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;

b. the rich cultivated lands of Honouliuli 'ili for extensive wetland taro and clearly the *ahupua'a* population center; and,

c. the uplands around Pu'uku'ua associated with *kauwā* residence but probably used for agriculture and forest resources.

2) Honouliuli is designed as a unit to contain all the geographic elements of a typical Hawaiian valley *ahupua'a*, except they are arranged geomorphically in an atypical relationship. The *ahupua'a* is not organized around a single drainage network but shares the west portions of Waikele drainage in its upper reaches. A typical and highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, an extensive limestone plain which would support only limited agriculture but would be excellent for bird catching in early times, and a huge expanse of sloping forest land. The richest forest land for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The surveys by Bordner and Silva (1983) and Hammatt and Shideler (1999) at Waimānalo Gulch indicated no evidence of Hawaiian occupation, but the gulch has been impacted in modern times.

3) The *makai* slope was not a major thoroughfare. We can see some very limited evidence of part-time agriculture in and around gulches and two foci of sparse habitation. The first is limited to *makai* portions of gulches and lava flats. This habitation is considered a *mauka* component or continuing of the Ko'ōlina coastal settlement rather than an independent focus. The second focus, separated from the first by a barren zone, is generally above the 800-foot elevation. This *mauka* habitation which could have been supported by seasonal dry land planting and forest foraging may be the lower portion of a thinly scattered, but widespread zone of settlement which stretches eastward and northeast along the east Wai'anae Range slopes and may increase in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

4) There is to date no archaeological evidence of high status residence in Honouliuli. Large residential structures are not present along the Pacific shoreline where they would be expected. The late prehistoric occurrence of chiefs' houses is not apparent, perhaps because the ocean shoreline, although rich in marine resources, is uninviting for sport and unsuitable for fishponds. The chiefly focus of 'Ewa District was Waipi'o. Whatever activities of this class occurred in Honouliuli would have been in or near the rich lands fronting West Loch (the *'ili* of Honouliuli). Concerning status associations with Honouliuli, it is interesting to note the connection of the Pu'uku'ua settlement with slaves (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

5) The focus of population and agriculture within the *ahupua'a* of Honouliuli was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other prehistoric times, all other habitation zones were economically and socially co-dependent.

Section 5 Results of Fieldwork

The pedestrian inspection of the project area was conducted on November 7, 2006 with two Cultural Surveys Hawai'i staff archaeologists, Constance R. O'Hare, B.A., and Randy Groza, M.A., under the general direction of Hallett H. Hammatt, Ph.D. At least 90% of the project area has been denuded of all natural vegetation and had been previously planted with pineapple. The entire northern portion of the project area, which appeared to have been bulldozed and contained remnants of black plastic for weed control, was surveyed by pedestrian sweeps. CSH archaeologists conducted a windshield survey of the approximately 4,000 ft (1200 m) of existing road, where the new water line will run parallel to the existing water line in the center of the road and connect the northern portion of the project area with the southern portion. The southern section of the project area was fenced; it contains an existing water tank and is the proposed location of the new water tank. This southern portion was reviewed through the chain link fence.

No historic properties were encountered and the pedestrian inspection was documented with field notes, maps, and photographs.

Section 6 Summary and Mitigation Recommendations

Background historical research for this project indicates that this area of the 'Ewa Plain was not a locus for traditional Hawaiian habitation, agriculture, or ceremonial activities. No historic properties were found in the project area during the recent field survey. Based on the results of the background research, previous work conducted by CSH within the vicinity of the project area, and the field assessment of the project area, it appears that no further archaeological or cultural work is appropriate for this project. The proposed construction of the new reservoirs and waterline to support a mixed residential, commercial, and recreational property that is located south of the H-1 will have no effect on any historic properties or on any on-going cultural practices in the project area.

As always, if in the unlikely event that development activities uncover significant subsurface finds, all work in the immediate vicinity should stop and the State Historic Preservation Division should be promptly notified.

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Appendix A

Letter to OHA

Cultural Surveys Hawai'i, Inc.
Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

P.O. Box 1114 • Kailua, Hawai'i 96734 • Ph.: (808) 262-9972 • Fax: (808) 262-4950
dshideler@culturalsurveys.com • www.culturalsurveys.com

December 15, 2006

Clyde Nāmu'o, Administrator
Office of Hawaiian Affairs
711 Kapi'olani Boulevard
Honolulu, HI 96813

Dear Mr. Nāmu'o:

A complementary copy of our archaeological assessment, *An Archaeological Assessment for the Ho'opili Project 440-Foot Elevation Reservoir and Waterline Project,Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu, TMK:(1) 9-2-001:001, 004, 005, 006, 007 (por.); 9-2-002:002*, is enclosed.

No sites or cultural materials were found during the survey and background information also indicated that no sites were present.

If you have any questions or concerns about the location of the proposed project, please call me.

Sincerely,

David W. Shideler

David Shideler

APPENDIX E

SHPD Archaeological Inventory Acceptance Letter

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR - LAND

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ACTING DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

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

November 3, 2006

Dr. Hallett H. Hammatt
Cultural Surveys of Hawai'i, Inc.
P.O. Box 1114
Kailua, Hawai'i 96734

LOG NO: 2006.3670
DOC NO: 0611amj01
Archaeology

Dear Dr. Hammatt:

SUBJECT: **Chapter 6E-42 Historic Preservation Review –**
Revised Archaeological Inventory Survey for the Ho'opili Project
Hono'uli'uli Ahupua'a, 'Ewa District, Island of O'ahu
TMK: (1) 9-1-010:002, 9-1-017:004, 059, 072, 9-1-018:001, 004, 9-2-002:004, 005

Thank you for submitting the revised report by O'Hare *et al.* (2006), which we received on September 6, 2006. We apologize for the delay in responding. Five historic properties (SIHP Nos. 50-80-12-4344, 4345, 4346, 4347, and 4348) were documented during inventory survey of a 2625-acre project area. In a letter (LOG NO. 2006.1523, DOC NO: 0605CM22) dated June 6, 2006, we reviewed a previous version of this report, and requested a number of revisions, which you have now made to our satisfaction.

All five historic properties have been assessed as eligible for the State Register of Historic Places under criteria C and D, except for Site 4344, which is only eligible under criterion D. We concur with these significance assessments.

We also concur with your mitigation recommendations, which include: (1) no further archaeological work at Site 4344, (2) preservation of Sites 4345, 4346, 4347, and 4348, and (3) archaeological monitoring in the vicinity of the four areas of historic habitation (Hono'uli'uli taro lands, Kapalani Catholic Church, Pipeline Village, and Drivers/Stable Village).

The report is now accepted in fulfillment of HAR 13-284 and 13-276. We look forward to receipt of a preservation plan and an archaeological monitoring plan.

Please contact Mr. Adam Johnson (O'ahu Assistant Archaeologist) at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Melanie Chinen, Administrator
State Historic Preservation Division

amj:

APPENDIX F
Cultural Impact Assessment

Cultural Impact Assessment
for the Ho'opili Project,
Honouliuli Ahupua'a, 'Ewa District, Island of O'ahu
TMK: [1] 9-1-010:002; 9-1-017:004 & 059; 9-1-018:001, 004 & 072; and 9-2-001:001 (por)

Prepared for
D. R. Horton – Schuler Division

Prepared by
Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai'i, Inc.
Kailua, Hawai'i
(Job Code: HONO 76)

December 2006

www.culturalsurveys.com

Maui Office
16 S. Market Street, Suite 2N
Wailuku, Hawai'i 96793
Ph: (808) 242-9882
Fax: (808) 244-1994

Section 1 Management Summary

Reference	A Cultural Impact Assessment Report for the Ho'opili Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island TMK: TMK: [1] 9-1-010:002; 9-1-017:004 & 059; 9-1-018:001, 004 & 072; and 9-2-001:001 (por)
Date	December 2006
Project Number (s)	CSH Job Code: HONO 76
Project Area	The Project Areaproposed Project Area consists of several parcels which are identified by the following Tax Map Key numbers TMK: [1] 9-1-010:002; 9-1-017:004, 059; 9-1-018:001, 004 & 072.
Project Location	East Kapolei, 'Ewa District, O'ahu. The Project Area is generally bound on the north by the H-1 Interstate (I H-1), on the south by Mango Tree Road (a dirt road along the 'Ewa Villages Golf Course), Palehua Drive on the west, and Old Fort Weaver Road on the east There are two non-contiguous parcels,the first is located on the east side of new Fort Weaver Road (TMK 9-1-010:002), and the second is north of the H-1 Interstate in proximity to a reservoir (TMK 9-2-001:001).
Land Owner	TMK: [1] 9-1-010:002 D.R. Horton-Schuler Homes LLC 9-1-017:004 & 059; D.R. Horton-Schuler Homes LLC 9-1-018:001, 004 & 072; D.R. Horton-Schuler Homes LLC 9-2-001:001 (por) Monsanto Company
Reviewing Agencies	State of Hawai'i Department of Health (DOH)/ Office of Environmental Quality Control (OEQC)
Project Description	The landowner plans to develop the project area into a mixed residential, commercial, and recreational property.
Project Acreage	1,630 acres
Document Purpose	Article IX and XII of the state constitution, other state laws, and the courts of the state require government agencies to promote and preserve cultural beliefs, practices and resources of native Hawaiians and other ethnic groups pursuant to this legal mandate, cultural Surveys Hawai'i Inc. (CSH) conducted an analysis of the proposed projects impacts on cultural practices and features identified within the Project Area. CSH prepared this report in accordance with the requirement set forth under Hawaii revised status as amended (HRS), Chapter 343 and the OEQC's guidelines for assessing cultural impacts.

Consultation Effort	CSH consulted with various Hawaiian organizations, agencies and community members were contacted in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the Project Area and the surrounding area. CSH consulted with the State Historic Preservation Division, the Office of Hawaiian Affairs, the O'ahu Island Burial Council, and the 'Ewa Neighborhood Board. Information gathering sessions with the following community members: Arline Eaton, Richard Hirata, Richard Oshiro, Kenneth Soma, and Charles Nakamatsu along with many others in the community.
Summary and Recommendation	No contemporary or continuing cultural practices currently occur within the Project Area. It should be noted that subsurface historic properties associated with former traditional Hawaiian activities in the Project Area, such as artifacts and cultural layers, may be present despite the decades of modern activities such as ranching and sugar cane. As a precautionary measure, personnel involved in future development should be informed of the possibility of inadvertent cultural finds, and should be made aware of the appropriate notification measures to follow.

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Section 2 Introduction

2.1 Project Background

At the request of D.R. Horton-Schuler Division (828 Fort Street Mall, 4th Floor, Honolulu, HI 96813), Cultural Surveys Hawai'i, Inc. (CSH) has completed this Cultural Impact Assessment Report for the East Kapolei Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island TMK: TMK: [1] 9-1-010:002; 9-1-017:004 & 059; 9-1-018:001, 004 & 072; and 9-2-001:001 (por) (Figure 1 and Figure 2).

The H-1 Interstate (I H-1) runs along the northern boundry of the project area. Mango Tree Road (i.e. a dirt road along the 'Ewa Villages Golf Course) is on the south. Pelehua Drive on the west, and Old Fort Weaver Road on the east.

Article IX and XII of the state constitution, other state laws, and the courts of the state require government agencies to promote and preserve cultural beliefs, practices and resources of native Hawaiians and other ethnic groups pursuant to this legal mandate, cultural Surveys Hawaii Inc. (CSH) conducted an analysis of the proposed projects impacts on cultural practices and features identified within the Project Area. CSH prepared this report in accordance with the requirement set forth under Hawaii revised status as amended (HRS), Chapter 343 and the OEQC's guidelines for assessing cultural impacts

2.2 Scope of Work

The scope for the Cultural Impact Assessment is summarized as follows:

1) Examined historical documents, Land Commission Awards, historic maps, with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal and other resources or agricultural pursuits, as may be indicated in the historic record.
2) Reviewed the existing archaeological information pertaining to the sites within the profect area as they allowed us to reconstruct traditional land use activities and identify and describe the cultural resources, practices, and beliefs associated with the parcel and identify present uses, if appropriate.
3) Conducted oral interviews with persons knowledgeable about the historic and traditional practices in the Project Area and the surrounding region. We experienced both formal and informal interviews.
4) Preparaed a report on items 1-3 summarizing the information gathered related to traditional practices and land use. The report assessed the impact of the proposed action on the cultural practices and any features identified.

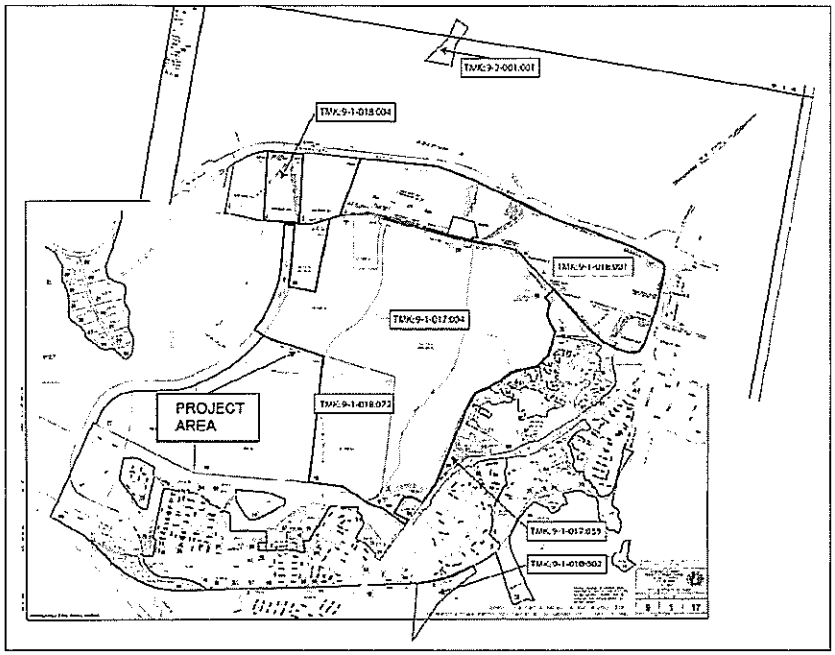

Figure 2. Tax Map Key (1) 9-1-010, 9-1-17, 9-1-018 and 9-2-002, showing Project Area

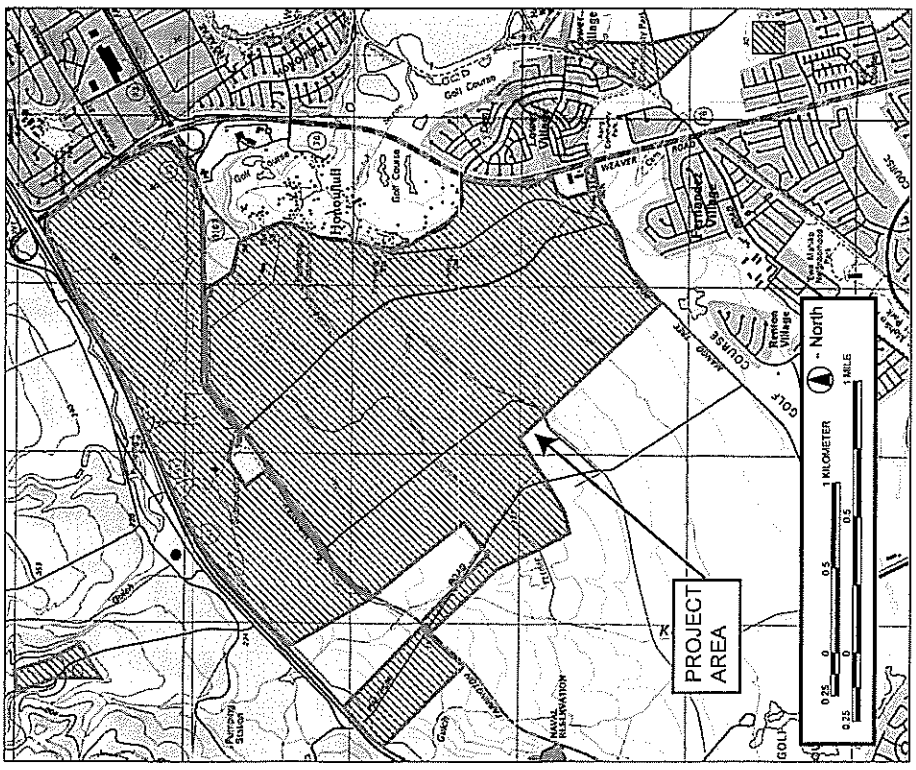

Figure 1. US Geological Survey map (2002), Waipahu quadrangle, showing Project Area (hatched area)

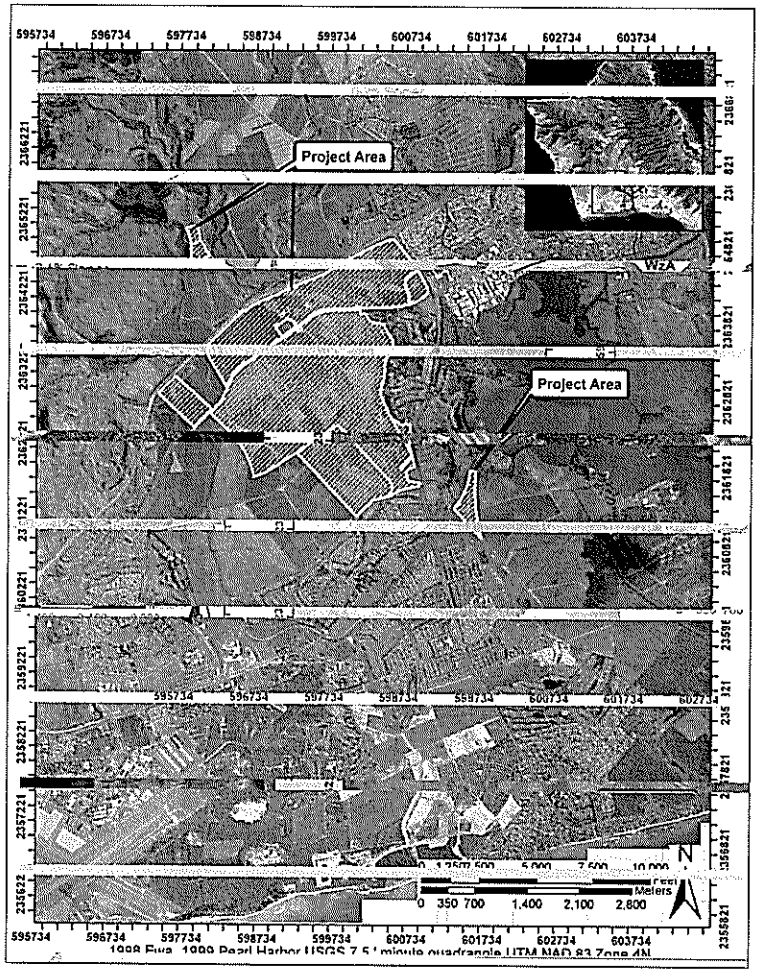

Figure 3. 2000 Aerial photograph of the Project Area, showing plowed fields

2.3 Environmental Setting

2.3.1 Natural Environment

Honouliuli Ahupua'a is the largest traditional land unit on O'ahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupua'a at Pili o Kahe in the west. Honouliuli Ahupua'a includes approximately 19 km (kilometers), or 12 mi (miles) of open coastline from One'ula westward to Pili o Kahe. The *ahupua'a* extends *mauka* (inland) from West Loch nearly to Schofield Barracks in Wahiawā; the western boundary is the Wai'anae Mountain crest running north as far as Pu'u Hāpapa (or to the top of Ka'ala Mountain, according to some).

Topographically, the portion of the Project Area to the south of Farrington Highway is most notable for a scarp feature, typically 50 ft (15 m) high, the feature runs roughly north/south through the southeastern portion of the Project Area. This scarp is a Pleistocene fossil sea bluff. The northern portion of the Project Area is generally flat, except along Honouliuli Gulch, which runs through the center of this western portion.

Lying in the lee of the Wai'anae mountain range, the Project Area is one of the driest areas of O'ahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). Temperatures range between 60° to 90° Fahrenheit through the year; the highest temperatures are in August and September (Armstrong 1973). Elevation in the Project Area ranges from 40 ft (feet) AMSL (above mean sea level) to 240 feet, or 12 to 73 meters. The Project Area is located within the 'Ewa Plain, which is a Pleistocene (>38,000 years old) reef platform overlain by alluvium from the southern end of the Wai'anae Mountain Range. This alluvium supported commercial sugar cane cultivation for over a century.

In pre-contact Hawai'i the Project Area would have been mostly lowland dry shrub and grassland, dominated by species such as *wiliwili* (*Erythrina sandwicensis*), *lama* (*Diospyros ferrea*), sandalwood (*Santalum* sp.), *'a'ali'i* (*Dodonea eriocarpa*), scrub *'ōhi'a* (*Metrosideros collina*) and *pili* grass (*Heteropogon contortus*). Today in contrast, the non-cultivated portions of the Project Area are dominated by introduced species such as *kiawe* and *koa haole*. Understory plants include *'ilima ku kula* (*Sida cordifola*), cayenne vervain (*Stachytarpheta urticaefolia*), *ko'oko'olau* (*Bidens pilosa*), and morning glory (*Ipomoea indica*) (Moore and Kennedy 2002:3). The vast majority of the Project Area consists of plowed fields, with crops of pumpkins, squash, cucumbers, bananas, beans, and other vegetable products.

A total of ten soil series are found in the Project Area (Figure 4). The Ewa Series consists of well-drained soils in basins and on alluvial fans, developed in alluvium derived from basic igneous rock. They are nearly level to moderately sloping. These soils are used for sugarcane, truck crops, and pasture. The Helemano Series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches, which developed in alluvium and colluvium derived from basic igneous rock. They are steep to extremely steep. These soils are used for pasture, woodland, and wildlife habitat. The Honouliuli Series consists of well-drained soils on coastal plains; which developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. These soils are used for sugarcane, truck crops, orchards, and pasture. The Kaloko Series consists of poorly drained soils on coastal plains which developed in alluvium

derived from basic igneous rock; the alluvium has been deposited over marly lagoon deposits. The soils are nearly level. These soils are used for irrigated sugarcane and pasture. The Kawaihapai Series consists of well-drained soils in drainageways and on alluvial fans on the coastal plains. The soils formed in alluvium derived from basic igneous rock in humid uplands. These soils are used for sugarcane, truck crops, and pasture. The Keaau Series consists of poorly drained soils on coastal plains, which developed in alluvium deposited over reef limestone or consolidated coral sand. They are nearly level and gently sloping. These soils are used for sugarcane and pasture. The Kunia Series consists of well-drained soils on upland terraces and fans; the soils developed in old alluvium. They are nearly level to moderately sloping. These soils are used for sugarcane, pineapple, homesites, and military reservations. The Molokai Series consists of well-drained soils on uplands, formed in material weathered from basic igneous rock. They are nearly level to moderately steep. These soils are used for sugarcane, truck crops, orchards, and pasture. The Waipahū Series consists of well-drained soils on marine terraces, which developed in old alluvium derived from basic igneous rock. They are nearly level to moderately sloping. These soils are used for sugarcane and homesites (Foote et al. 1972).

2.3.2 Built Environment

During the post-contact period the Project Area was primarily used for pastureland and for sugar cane irrigation and cultivation. At present, the Project Area is currently used for diversified agricultural activities, pastureland, seed cultivation, etc.

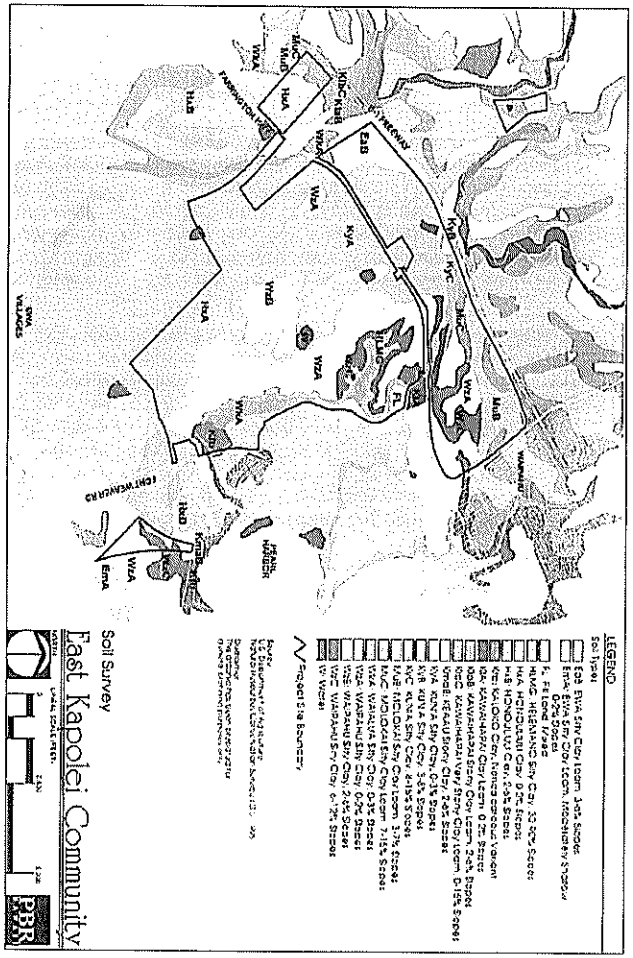

Figure 4. Soil Map of the Ho'opili Community Project Area

2.4 Methods

2.4.1 Documentary Research

CSH reviewed previous archaeological studies on file at the State Historic Preservation Division, CSH also reviewed geology and cultural history documents at Hamilton Library at the University of Hawai'i, the Hawai'i State Archives, the Mission House Museum Library, the Hawai'i Public Library, and the Archives of the Bishop Museum. Further research included a study of historic photographs at the Hawai'i State Archives and the Archives of the Bishop Museum, a study of historic maps at the Hawai'i State Archives and the Archives of the Bishop Museum, and a study of historic maps at the Survey Office of the Department of Accounting and General Services. Information regarding LCAs was obtained from Waihona 'Āina Corporation's Māhele Data Base (www.waihona.com).

2.4.2 Identification of Knowledgeable Informants

CSH consulted with various organizations and member of the community in order to identify *kūpuna* and other individuals with historic knowledge with respect to the Project Area and the surroundings. CSH consulted the Office of Hawaiian Affairs, the O'ahu Island Burial Council, 'Ahahui Siwila Hawai'i O Kapolei Hawaiian Civic Club, and the 'Ewa Neighborhood Board.

Based on recommendations from organizations and the community, the following individuals were contacted for information gathering sessions Arline Eaton, Richard Hirata, Richard Oshiro, Kenneth Soma, Charles Nakamatsu and many other talk story sessions (see Section 7 Community Consultation). These sessions were conducted in-person or by telephone.

Cultural anthropologist Kēhaulani Souza, B.A. conducted information gathering sessions under the general supervision of Hallett H. Hammatt, Ph.D. (Principal Investigator).

Section 3 Mythological and Traditional Accounts

The traditions of Honouliuli Ahupua'a have been compiled by several authors, in studies by Sterling and Summers (1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), Maly (1992), and Tuggle and Tomonari-Tuggle (1997). Some of the traditional themes associated with this area include connections with Kahiki, the traditional homeland of Hawaiians in central Polynesia. There are several versions of the chief Kaha'i leaving from Kalaeloa for a trip to Kahiki; on his return to the Hawaiian Islands he brought back the first breadfruit (Kamakau 1991a:110) and planted it at Pu'uloa, near Pearl Harbor in 'Ewa (Beckwith 1940:97). Several stories associate places in Honouliuli to the gods Kāne and Kanaloa, with the Hawaiian pig god Kamapua'a and the Hina family, and with the sisters of Pele, the Hawaiian volcano goddess, all of who have strong connections with Kahiki (Kamakau 1991a:111; Pukui et al. 1974:200). The locations of traditional places names for Honouliuli are illustrated in Figure5.

3.1 The Naming of 'Ewa and Honouliuli

Honouliuli is the largest *ahupua'a* in the *moku* (district) of 'Ewa. One translation of the name for this district is given as "unequal" (*Saturday Press* Aug. 11, 1883). Others translate the word as "strayed" and associate it with the legends of the gods, Kāne and Kanaloa.

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of the land they would throw a stone and where the stone fell would be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Waianae range and it landed somewhere, in the Waimanalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

Honouliuli means "dark water," "dark bay," or "blue harbor" and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua'a*. The Hawaiians called Pearl Harbor, Pu'uloa (*lit.* long hill). Another explanation for the names comes from the "Legend of Lepeamoa", the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa (Thrum 1923:164-184). "Her grandfather gave his name, Honouliuli to a land district west of Honolulu . . ." (Thrum 1923:170). Westervelt (1963:209) gives an almost identical account.

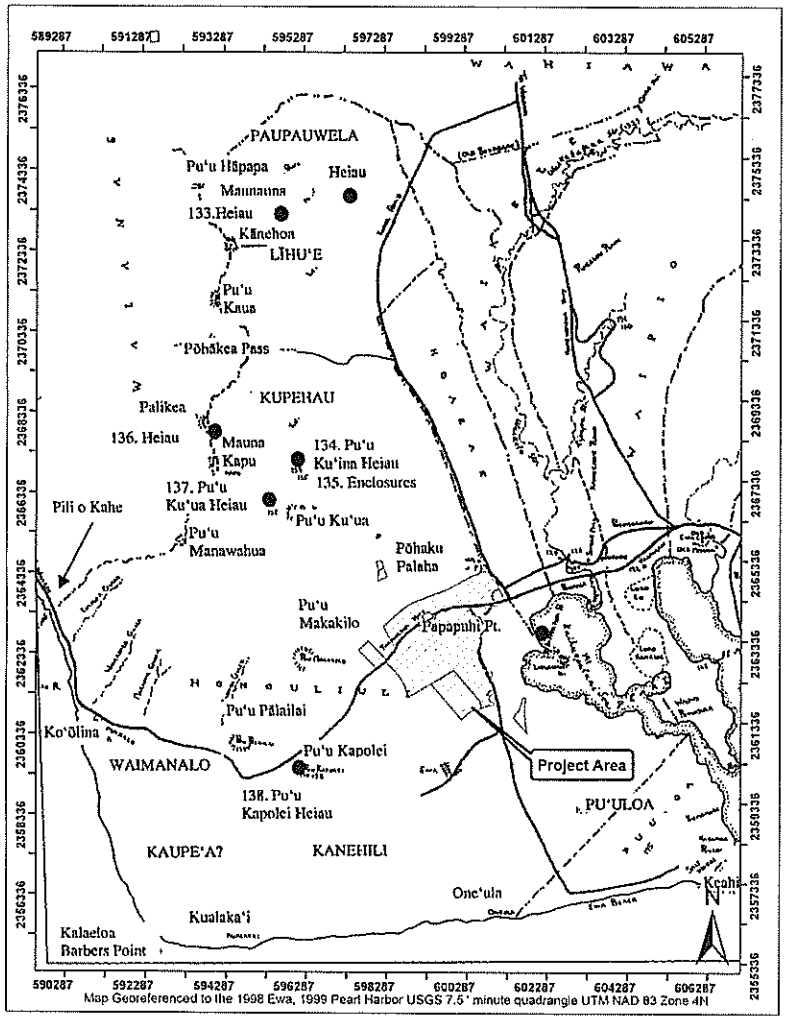

Figure 5. Place Names of Honouliuli (map adapted from Sterling and Summers 1978

It seems likely the boundaries of the western-most *ahupua'a* of 'Ewa were often contested with Wai'anae people. The 'Ewa people could cite divine sanction that the dividing point was between two hills at Pili o Kahe:

Eventually the stone was found at Pili o Kahe. This is a spot where two small hills of the Wai'anae Range come down parallel on the boundary between Honouliuli and Nānākuli ('Ewa and Wai'anae). The ancient Hawaiians said the hill on the 'Ewa side was the male and the hill on the Wai'anae side was female. The stone was found on the Waianae side hill and the place is known as Pili o Kahe.

> (Pili=cling to, Kahe=flow). The name refers, therefore, to the female or Waianae side hill. And that is where the boundary between the two districts runs [Told to E.S. by Simeon Nawaa, March 22, 1954; cited in Sterling and Summers 1978:1].

3.2 Legends and Place Name Meanings of the Upland Hills of Honouliuli

Honouliuli is divided from Wai'anae Ahupua'a on the west by a ridge with several prominent hills. From north (*mauka*) to south (*makai*) these peaks are: Hāpapa, which means "rock stratum (Pukui et al. 1974:42) or "shallow soil (Sterling and Summers 1978:1); Kānehoa (which will be discussed in more detail below); Pu'u Kaua, which means "war hill or fort hill" (Pukui et al. 1974:199); Palikea, which means "white cliff" (Pukui et al. 1974:177); Mount Kapu (meaning "tabu mountain"); and, Pu'u Manawahua, which means "great grief hill or nausea hill" (Pukui et al. 1974:203).

The central section of 'Ewa is divided by a series of northeast-southwest trending gulches that intermittently carry rainwater towards the coast. In this area there are several other notable hills; Pu'u Makakilo, which translates as "observing eyes hill" (Pukui et al. 1974:201); Pu'u Kapua'i, or "footprint hill" (Pukui et al. 1974:199); and, Pu'u Pālailai, probably meaning the young *lai* (*Scomberoides* sp.) fish (Pukui et al. 1974:205).

To the north (*mauka*) is Kānehoa, which can be translated as "companion of Kāne" (Pukui et al. 1974:84), "Kāne, the divine companion or friend," or Kāne, the divine fire-maker" (Westervelt 1999:64). This peak was named for a god (Kāne-hoa-lani), who was said to be the father of Pele (Emerson 1915:ix) in some versions, and the brother of Pele in others (Westervelt 1999:64). The hill Kānehoa is mentioned in the following hula chant.

Anklet Song	*Mele Ku-pe'e*
Fragrant the grasses of high Kanehoa.	*Aala kupukupu ka uka o Kane-hoa*
Bind on the anklets, bind!	*E ho-a!*
Bind with finger deft as the wind	*Hoa na lima o ka makani, he Wai- kaloa.*
That cools the air of this bower.	*He Wai-kaloa ka makani anu Lihue.*
Lehua blooms pale at my flower,	*Alina lehua i kau ka opua-*
O sweet heart of mine,	*Ku'u pua,*
Bud that I'd pluck and wear in my wreath.	*Ku'u puai'ini e ku-i a lei.*

If thou wert but a flower! *Ina ia oe ke lei 'a mai la.*

[Emerson 1998:49]

A similar chant is found in the Legend of Pamano, which mentions the *kupukupu* (fern), a fragrant flowering shrub.

The uplands of Kanehoa are scented with kupukupu.
Bind on, the hands of the Waikoloa wind are binding,
The Waikoloa wind is the cold wind of Lihue,
Withering the branches in the uplands of Waiopua,
My flower I said I would string into garlands. If you have it,
You would have worn it.

Aala kupukupu ka uka o Kanehoa la!
Hoa! Hoa na lima o ka makani Waikoloa,
He Waikoloa ka makani anu, o Lihue,
Weli no loha ka uka o Waiopua la,
Kuu pua i i ai e kui e lei, I na ia oe ke lei ia ala

[Fornander 1919, Vol. V, Part 2:310-311].

3.2.1 Pōhākea Pass

Pōhākea Pass lies between the peaks of Pu'u Kaua and Palikea along the Wai'anae Mountain range. Pōhākea means "white stone" (Pukui et al. 1974:185).

3.2.1.1 Hi'iaka at the summit of Pōhākea Pass (Pele and Hi'iaka)

Pōhākea Pass was one of the resting places of Pele's sister, Hi'iaka, as she was returning from Kaua'i with Pele's lover Lohiau (Fornander 1918 Vol. V, Part 1:188 note 6). Hi'iaka elected to travel overland, while her companions traveled by canoe. A considerable number of *mele* (songs) and *pule* (prayers) are ascribed to Hi'iaka as she stood at the summit of Pōhākea (*Aluna au a Pōhākea, Kū au, nānā ia Puna . . .*) (Emerson 1915:162-168). From this vantage point Hi'iaka could see through her powers of vision that her beloved *lehua* groves and friend Hōpoe at Puna, Hawai'i Island had been blasted by Pele. She could also see that in her canoe, off the coast of Wai'anae, Lohiau was seducing her traveling companion Wahine'ōma'o.

3.2.1.2 Keahumoa, Residence of Māui's Grandfather

In the Legend of Māui's Flying Expedition (Thrum 1923:252-259) Māui-kupua looked toward Pōhākea Pass and saw his wife, Kumulama, being carried away by chief Peapeamakawalu. After failing to recover her, Māui returned and told his problems to his mother, Hina. Hina instructed her son to go to Keahumoa and visit his grandfather, Kuolokele, who lived there in a large hut. The hump-backed Kuolokele returned home with a load of potato leaves, and Māui cured him by striking him in the back with a stone (which Kuolokele threw to Waipahu, where it remains). Kuolokele had Māui gather *kī* leaves, *'ie'ie* vines and bird feathers, from which the old man fabricated a "bird-ship" (*moku-manu*), which Māui used to defeat Peapeamakawalu and recover his wife. They returned to Kuolokele's house, where they feasted, and Māui ate Peapeamakawalu's eyeballs.

3.2.1.3 The Frightened Populace of Honouliuli

In the Legend of Palila (Fornander 1918, Vol. V, Part 1:136-153), the *kupua*, or demigod hero, of Kaua'i landed at Ka'ena Point with his fabulous war club (*lā'au pālau*), which required eighty men to carry, and crossed into Honouliuli through Pōhākea Pass. He traveled by throwing his supernatural war club and hanging on to one end. The first throw was to Ka'ena Point, Oahu.

> After leaving Kaena he came to Kalena, then on to Pohakea, then to Maunauna, then to Kanehoa, then to the plain of Keahumoa and looking toward Ewa. At this place he stood and looked at the dust as it ascended into the sky caused by the people who had gathered there; he then pushed his war club toward Honouliuli.
>
> *Haalele keia ia Kaena, hele mai la a Kalena, a Pohakea, maunauna, kanehoa, a ke kula o Keahumoa, nana ia Ewa. Ku keia I laila nana I ke ku a ka ea o ka lepo I na kanaka, e pahu aku ana keia I ka laau palau aia nei I kai o Honouliuli. . . .*
> [Fornander 1918, Vol. V, Part I:142-143]

He descended to the plain of Keahumoa:

> At this place he stood and looked at the dust as it ascended to the sky caused by the people who had gathered there; he then pushed his war club toward Honouliuli. When the people heard something roar like an earthquake they were afraid and they all ran to Waikele . . .
>
> *Kū kēia i laila nānā i ke kū ka ea o ka lepo i nā kānaka, e pahu aku ana kēia i ka lā'au pālau aia nei i kai o Honouliuli, kū ka ea o ka lepo o ka honua, me he ōla'i la, maka'u nā kānaka holo a hiki i Waikele.*
> [Fornander 1918, Vol. V, Part I:142-143]

3.2.1.4 Kahalaopuna at Pōhākea Pass

One of the most popular legends of O'ahu is that of Kahalaopuna (or Kaha), a young woman of Mānoa who was slandered by others and then killed by her betrothed, Kauhi, a chief from Ko'olau. While the numerous accounts (Day 1906:1-11, Fornander 1918 Vol. V, Part 1:188-193, Kalākaua 1888:511-522, Nakuina 1904:41-45, Patton 1932:41-49, Skinner 1971:220-223, Thrum 1907:118-132, Westervelt 1987 127-137, Westervelt 1998:84-93) vary in details, they typically have Kahalaopuna slain and then revived repeatedly with the aid of a protective owl. Kauhi forced her to hike west from Mānoa through the uplands until they got to Pōhākea Pass through the southern Wai'anae Range in north Honouliuli. At Pōhākea Pass, Kauhi beat her with a stick until she was dead (*Ia hahau ana a Kauhi i ka lā'au, make loa o Kahalaopuna*). Her spirit (*'uhane*) flew up into a *lehua* tree and chanted for someone to go notify her parents:

E hai aku oukou ua make o Kahalaopuna;	And tell them that Kahalaopuna is dead
Aia la i ka uka o Pohakea,	For she lies in the uplands of Pohakea
I ke kumu lehua la o lalo iho.	Beneath the lehua tree.

[Fornander 1918, Vol. V, part 1:192

Upon hearing the news, her parents fetched Kahalaopuna back to Mānoa, and she was restored.

3.2.2 Paupauwela and Līhu'e

Paupauwela, also spelled Popouwela (derivation unknown), is the name of the land area in the extreme *mauka* section of Honouliuli *Ahupua'a*. The land area of Līhu'e is just *makai* of this land, and extends into the *ahupua'a* of Waipi'o (adjacent to the eastern border of Honouliuli). Both place names are mentioned in a chant recorded by Abraham Fornander, which was composed as a *mele* for the O'ahu king, Kūali'i, as he was preparing to battle Kuiaia, the chief of Wai'anae:

Where? Where is the battle field	*Ihea, ihea la ke kahua,*
Where the warrior is to fight?	*Paio ai o ke koa-*a?
On the field of Kalena, I	*kai i kahua i Kalena,*
At Manini, at Hanini,	*I Manini, i Hanini*
Where was poured the water of the god	*I ninia i ka wai akua,*
By your work at Malamanui;	*I ko hana i Malamanui*
On the heights of Kapapa, at Paupauwela,	*Ka luna o Kapapa, i Paupauwela,*
Where they lean and rest;	*I ka hilinai i ke kalele,*
At the hala trees of indolent Halahalanui,	*Ka hala o Halahalanui maauea,*
At the ohia grove of Pule-e	*E kula ohia ke Pule-e,*
The god of Lono, of Makalii	*Ke 'kua o Lono o Makalii*
Thr fragrant branch of the Ukulonoku,	*Ka lala aalao Ukulonoku,*
Mayhap from Kona, from Lihue,	*No Kona paha, no Lihue.*
For the day at Maunauna	*No ka la i Maunauna,*
For the water at Paupauwela.	*No ka wai i Paupauwela.*

[Fornander 1917, Vol. IV, Part 2:384-386].

Red is the water of Paupauwela,	*Ula ka wai i Paupauwela,*
From the slain at Malamani,	*Ke kilau o Malamani,*
The slain on the ridge at Kapapa.	*Ka moo kilau I Kapapa.*

The derivation of the place name Līhu'e (meaning "cold chill") is illustrated in the following poem; all other places names mentioned in this poem are in Waipio:

The icy wind of Lihue plied its spurs,
Pulling up the bridle of Haleauau,
Speeding headlong over Kalena
And running over the plain of Kanoenoe

[*Ka Loea Kālai'āina*, July 22, 1899, translated in Sterling and Summers 1978:21].

This explains the meaning of a Hawaiian saying "*Hao na kēpā o Līhu'e i ke anu.* The spurs of Līhu'e dig in with cold" [Pukui 1983:#479].

The icy winds of Honouliuli are also noted in a *mele* for the high king Kūali'i. In this *mele*, the cold winds of Kumomoku and Leleiwe, near Pu'uloa in Honouliuli are compared unfavorably to the god Kū.

Not like these are thou,	*Ku Aole i like Ku.*
[Nor] the rain that brings the land breeze,	*Ia ua hoohali kehau,*
Like a vessel of water poured out.	*Mehe ipu wai ninia la,*
Nor to the mountain breeze of Kumomoku,	*Na hau o Kumomoku;*
[The] land breeze coming round to Leleiwi.	*Kekee na hau o Leleiwi,*
Truly, have you not known?	*Oi ole ka oe i ike*
The mountain breezes, that double up your back,	*I ka hau kuapuu.*
[That make you] sit crooked and cramped at Kaimohala,	*Kekee noho kee, o Kaimohala,*
The Kanehili at Kaupea?	*O Kanehili i Kaupea-la*
Not like these are thou, Ku.	*Aole i like Ku.*

[Fornander 1917, Vol. IV, Part II:390-391]

In the Legend of Halemano (Fornander 1919, Vol. V, Part II:252), the romantic O'ahu anti-hero chanted a love song with a reference to the winds of Līhu'e:

Search is made to the top of Ka'ala,	*Huli a'e la Ka'ala kau i luna,*
The lower end of Pōka'I is plainly seen.	*Waiho wale kai o Pōka'I,*
Love looks in from Honouliuli,	*Nānā wale ke aloha i Honouliuli,*
The dew comes creeping, it is like the wind of Līhu'e...	*Kokolo kēhau he makani no Līhu'e.*

The wind of Lihu'e and others in the region are also named by Moses K. Nakuina, as follows:

Moa'e-kū is of 'Ewaloa
Kēhau is of Waiopua
Waikōloa is of Līhu'e
Kona is of Pu'uokapolei
Maunuunu is of Pu'uloa

[Nakuina 1992:43]

The *ali'i* (chiefly class) were closely associated with Līhu'e, which had habitation areas and playing grounds set aside for their sports.

> Lolale was the father and Keleanohoapiapi the mother of Ka-lo-kaholi-a-Lale. He was born in the land of Lihue and there he was reared into manhood. He excelled in good looks and greatly resembled his mother.
>
> In the olden days the favorite occupation of Lihue chiefs was spear throwing and the best instructors hailed from this locality [*Ka Nūpepa Kū'oko'a*, Aug. 26, 1865, translation in Sterling and Summers 1978:23].

Līhu'e was also the home of a famous cannibal king-man, Kaupe, who overthrew the ruling chiefs to become the paramount power between Nu'uanu and the sea. He had a home and a *heiau* in Līhu'e. Kaupe was a *kapua*, a supernatural being who could take the form of a man or a dog; this type of dog man was known as an *'ōlohe*. Although he left the O'ahu *ali'i* alone, he killed many commoners in the area, and eventually sailed to the island of Hawai'i on a raid, where he captured a chief's son; he planned to sacrifice this boy at his *heiau* in Līhu'e. The father came to O'ahu, and with the help of the priests of the Hawaiian hero, Kahanaiakeakua, was able to free his son, escape back to Hawai'i, and eventually kill the dog-man, Kaupe (Westervelt 1963:90-96).

3.2.3 Hill of Maunauna

The hill Maunauna lies between the lands Paupauwela and Līhu'e. It was at Maunauna, according to one tradition, that the forces of the chiefs of Kūali'i and Kuiaia of Waianae met to do battle, but was averted when a *mele* honoring the god Kū was chanted (see previous section). (Fornander 1917, Vol IV, Part 2:348). In the Legend of Ke-ao-melemele, a woman named Paliuli traveled in this area.

> In a very short time she [Paliuli] walked over the plain of Ewa; Ewa that is known as the land of the silent fish [pearl oysters] . . . She went on to the plain of Punalu'u and turned to gaze at Maunauna point and the plain of Lihue [Manu 1885, translation in Sterling and Summers 1978:21].

According to the surveyor W. D. Alexander (1903:367-425), Maunauna means "waste."

Certain place names in the uplands, including Maunauna, are also mentioned in the story of Lo-lae's Lament. The place of Lolale's residence is given in King Kalākaua's version of this story. According to him (Kalākaua 1990:232): "There lived there at that time in Lihue, in the district of Ewa, on the island of Oahu, a chief named Lo-lale, son of Kalona-iki, and brother of Piliwale, the *alii-nui*, or nominal sovereign, of the island, whose court was established at Waialua."

In this story, Lolale was a chief of O'ahu who asked his friend Kalamakua to find him a bride (Kalākaua 1990:228-246; Skinner 1971:217-219). Kalamakua traveled to Maui and chose Kelea, the chief's sister, and returned with her to O'ahu; during this time the two grew close. Kelea lived with Lolale for a while, but he was a silent type that was often away from home playing sports and walking in the woodlands. Longing for Kalamakua, Kelea decided to leave her husband, Lolale voiced no "spoken bitterness;" however, after she left, he sang this lament:

Farewell, my partner of the lowland plains,
On the waters of Pohakeo, above Kanehoa,
On the dark mountain spur of Mauna-una!
O, Lihue, she is gone!
Sniff the sweet scent of the grass,
The sweet scent of the wild vines
That are twisted by Waikoloa,
By the winds of Waiopua,
My flower!

As if a mote were in my eye.
The pupil of my eye is troubled.
Dimness covers my eyes. Woe is me!

[Kalākaua 1990:244-245].

3.2.4 Pu'u Ku'ua

Makai of the land of Lihu'e was the land of Kupehau, which was itself *mauka* of Pu'u Ku'ua. Divine sanction was also given to social stratification and the designation of a land for *kauwā* (outcastes, pariahs), a low, slave caste of Hawai'i, in the vicinity of Pu'u Ku'ua:

> . . . If you are above Puuloa, you wil see Pu'u-o-Kapolei, a small hill. Lying below and back of that hill is the government road going to Waianae. Above that is also a small hill and back of that, is a big hill and above it is a large hollow. That is Pu'u-Kuua where the very dirty ones lived [*Ka Loea Kālai'āina* July 15, 1899, translation in Sterling and Summers 1978:32].

The creation of the *kauwā* class is told in a tradition of the gods Kāne and Kanaloa:

> *A penei na'e i kauwā loa [sic. "loa'a"] ai. Aia a mana'o ke Ali'i Nui (Mō'ī) e 'au'au kai i Waikīkī. Eia ka nīnau a ke Ali'i Nui i ke ali'i ma lalo iho ona, "Pehea āu mau wahi lepo kanu o Pu'u Ku'ua? 'A'ole paha he mau wahi pōhuli?" Eia ka pane a ke ali'i ma lalo iho ona, "He Pōhuli nō. 'O ke kauoha ia akula nō ia e ki'i. 'Oiai ko kāne me ka wahine e nanea ana me nā keiki, a hiki 'ana ke ki'i i mau keiki. 'O ke kū a'ela nō ia o ka makuakāne a lawe 'ana i kāna mau keiki a hiki i Waikīkī. Aia ho'i a hiki i ka wā a ke Ali'i e hele ai i ka 'au'au kai, a laila, hoouna 'ia mai ke kahu e ki'i mai i ua keiki a lawe aku ia ma kahi pāpa'u o ke kai, ma kahi a ke Ali'i nui e hele kū 'ana, a laila kau nā lima o ka Mō'ī i luna o kahi keiki a me kahi keiki, ma nā 'ā'ī o nā keiki a pa'a ai. 'O ka hua 'ōlelo ma ka waha o ke Ali'i nui e 'ōlelo ai, "'A'ole pau ku'u loa! 'A'ole pau ku'u loa!" 'Oiai 'o ia e 'au ana me ka pa'a nō o nā lima i nā keiki a hiki i ka umauma ke kai o ke ali'i. Ua lana a'ela nā keiki i luna o ka 'ilikai, aia ke alo i lalo. Eia ho'i ka 'ōlelo a ka makuakāne ma kula aku nei, "Moe mālie i ke kai o ko Haku," a pēlā aku.*

> *'O ke kai o Waikīkī ke kai i 'ōlelo 'ia he kai lumaluma'i kanaka o ka lua, aia i Kualoa* [*Ka Loea Kālai'āina*, July 8, 1899].

Translation:

> The chiefs of old, who lived at that time, were of divine descent. The two gods [Kāne and Kanaloa] looked down on the hollow [vicinity of Pu'u Ku'ua] and saw how thickly populated it was. The mode of living here was so that chiefs and commoners mixed freely and they were so like the lowest of people (*kauwā*). That is what these gods said and that was the time when the term *kauwā* was first used, and was used for many years afterwards. . . . This was how they were made to be *kauwā*. When the ruling chief wished to go to Waikīkī for sea bathing he asked the chief just below him in rank, "How are my planting places at Pu'u Ku'ua,

have they not produced young suckers?" The chief next to him answered, "There are some suckers," and sent someone for them. When the men, women and children least expected it, the messenger came to get some of the children. The father stood up and took his sons to Waikīkī. Then, when the ruling chief went sea bathing, he sent an attendant to get the boys and take them to a shallow place where the ruling chief would come. Then the ruler placed a hand on each of the boys, holding them by the necks. The words he uttered were, "My height has not been reached! My height has not been reached!" He advanced and held onto the boys until the sea was up to his chest. The boys floated on the water face down. The father on shore called out, "Lie still in the sea of your Lord," and so on.

The Sea of Waikīkī is said to have been used to kill men in and the other place is Kualoa. The inhabitants of Pu'u-Kuua were so mixed, like taro beside an imu [translation in Sterling and Summers 1978:32-33].

A Hawaiian saying concerning 'Ewa suggests that this drowning also took place in this *ahupua'a*.

'Ewa of the drowning sea '*Ewa kai lumaluma'i*

An epithet applied to 'Ewa, where *kauwā* were drowned prior to offering their bodies in sacrifice [Pukui 1983:#385].

On Hi'iaka's journey as she leaves 'Ewa and descends to the coast, she sees some women stringing *lei* and offered a chant, naming several place names in the area:

Rising in the presence of the cliff of Pu'uku'ua	*Ke ku no i ke alo o pali o Pu'uku'ua*
The land is indeed a chief	*He ali'i nona'e ka 'āina*
Man is indeed a slave	*He kauwā no na'e kanaka*
I am indeed a slave to aloha – love	*I kauwā no na'e wau i ke aloha*

[*Ka hōkū o Hawai'i* February 22, 1927, translation in Maly 1997:17]

The great fisherman, Nihookeki, was born in Keauhou, Kona, but traveled to O'ahu and lived in Wai'anae and became a great chief. Fornander (1917, Vol. IV, Part 3:488) places his home at Pu'u ku'ua, in Pu'u o Kapolei in Wai'anae, possibly during one of the times that both Wai'anae and 'Ewa were ruled by one chief.

O Keauhou, i Kona, Hawaii, ka aina hanau o Nihooleki, a malaila mai ka hele ana a noho i Kuukuua, i Puuokapolei ma Waianae, no laila ka wahine.

Keauhou in Kona, Hawaii, was the birthplace of Nihooleki and it was from this place that he moved to Kuukuua, in Puuokapolei at Waianae, where he took unto himself a wife [Fornander 1917, Vol. IV, Part 3:488-489].

Keahaikiaholeha, the paramount chief of Wai'anae, owned a famous mother-of-pearl fishhook, called Pahuhu, which he used to catch many *aku* (bonito, *Katsuwonus pelamis*). He later sailed to Waimea, Kaua'i, where his wife had been born, and there also became the ruling

chief of Kaua'i. When Keahaikiaholeha died, his body was brought back to Kuukuua and placed in a *pu'āo* (*A make o Kaehaikiaholeha, hoihoi ia mai a Kuukuua, i Waianae, waiho ia kona kino kupapau; i loko o ka hale, puoa . . .*). A *pu'āo* is an open, small, temporary cone-shaped structure, of poles; in this case, this *pu'āo* was used as his tomb. The parents of the chief worshiped the spirit (*'uhane*) of their son, until it became strong enough to go about in the form of a live person. The spirit took the name of Nihooleki, traveled to Kaua'i, and married his wife, although she was unaware that this was the spirit of her dead husband. Nihooleki used his magic fishhook to catch canoes full of *aku* until it became the wonder of the islands. The piles of fish that he caught and gave away came to the ears of Kamapua'a, who was then living at Waiohuli, sick with dropsy.

Nihooleki told his wife that if a man with dropsy came to the door, to ask him in because he was a friend. But when Kamapua'a arrived, the wife would not let him in since he was so dirty. Kamapua'a had to wait in the pig pen for the return of his friend. Nihooleki was angry about the treatment of his friend when he returned and left the island with Kamapua'a.

Lohe aku la na 'lii, a me na kaikoeke, o ke 'lii no keia, alualu mai la lakou, luu laua nei i ke kai, a ea ana i Kuukuua, ma Waianae. . . .

A kokoke laua i ka hale o na mauka a me ke kaikuahine, a e ku ana hoi ka puoa hale o ke kino kupapau ona. ". . . A o ke kaikuahine o kaua, o kau wahine no ia, no ka mea, he wahine maikai, ua nui no ke kino."

O Kaehaikiaholeha, oia o Nihooleki, komo aku la ia i kona puoa kupapau a nalo iho la, oia ka pau o kona kaao ana.

He [Nihooleki] and his friend [Kamapua'a] then dove into the sea and swam under water until they came up at Kuukuua, at Waianae. . .. As they drew near to the house where the parents and sister of Nihooleki were living and near to the tomb where his dead body was laid, Nihooleki then turned to his friend. " . . . Take our sister and make her your wife as she is fair to look upon and is also of proper age." . . . Keahaikiaholeha, who was Nihooleki, entered the tomb and disappeared. Thus ends the story [Fornander 1917, Vol. IV, Part 3:496].

This legend suggests associations with Pu'u ku'ua to Pu'uokapolei , worship of the dead, and wandering souls, all of which are prominent themes associated with Pu'u Kapolei, as seen in the next section. It also ties the pig god Kamapua'a to Pu'uokapolei in 'Ewa.

3.3 Pu'uokapolei and the Plains of Kaupe'a

Pu'uokapolei is a prominent hill at the *mauka* edge of the coastal 'Ewa Plains and was the primary landmark for travelers on the trail that ran from Pearl Harbor west to Wai'anae ('I'i 1959:27, 29; Nakuina 1992:54; E.M. Nakuina 1904, in Sterling and Summers 1978:34).

3.3.1 Pu'uokapolei , Astronomical Marker and Heiau

Pu'u means hill and Kapolei means "beloved Kapo," a reference to the sister of the Hawaiian volcano goddess, Pele. Samuel Kamakau (1976:14) says that ancient Hawaiians used Pu'u o

Kapolei as an astronomical marker to designate the seasons. Samuel Kamakau (1870 *Mo'olelo Hawai'i* Vol. I, Chap. 2, p. 23) relates:

> . . . the people of O'ahu reckoned from the time when the sun set over Pu'uokapolei until it set in the hollow of Mahinaona and called this period Kau [summer], and when it moved south again from Pu'uokapolei and it grew cold and the time came when young sprouts started, the season was called from their germination (*'ōilo*) the season of Ho'oilo [winter, rainy, season].

A *heiau* was once on Pu'u o Kapolei, but had been destroyed by McAllister's (1933:108) survey of the island in the early 1930s. The hill was used as a point of solar reference or as an observation place for such observations (Fornander 1919, Vol. VI, Part 2:292). Pu'uokapolei may have been regarded as the gate of the setting sun, just as the eastern gate of Kumukahi in Puna is regarded as the rising sun; both places are associated with the Hawaiian goddess Kapo (Emerson 1915:41). This somewhat contradicts some Hawaiian cosmologies, in which Kū was the god of the rising sun, and Hina, the mother of Kamapua'a was associated with the setting sun. Fornander (Fornander 1919, Vol. VI, Part 2:292) states that Pu'uokapolei may have been a jumping off place (also connected with the setting sun) and associated with the wandering souls who roamed the plains of Kaupe'a and Kāne-hili, *makai* of the hill.

3.3.2 Pu'uokapolei and the Plains of Kaupe'a and Kāne-hili

Hi'iaka sang this bitter chant addressed to Lohiau and Wahine-oma'o, which uses the association of the Plains of Kaupe'a as a place for the wandering of lost souls:

Ku'u aikana i ke awa lau o Pu'uloa,
Mai ke kula o Pe'e-kaua, ke noho oe,
E noho kaua e kui, e lei i ka pua o ke kauno'a,
I ka pua o ke akuli-kuli, o ka wili-wili;
O ka iho'na o Kau-pe'e i Kane-hili,
Ua hili au; akahi no ka hili o ka la pomaika'i;
E Lohiau ipo, e Wahine-oma'o,
Hoe 'a mai ka wa'a i a'e aku au.

We meet at Ewa's leaf-shaped lagoon, friends;
Let us sit, if you will on this lea
And bedeck us with wreaths of Kauno'a,
Of akuli-kuli and wili-wili,
My soul went astray in this solitude;
It lost the track for once, in spite of luck,
As I came down the road to Kau-pe'a.
No nightmare dream was that which tricked my soul.
This way, dear friends; turn the canoe this way;
Paddle hither and let me embark

[Emerson 1915:162-163].

Several other Honouliuli places are mentioned in this chant, including Pe'e-kaua, which may be a variation of Kau-pe'e or Kaupe'a, and the plains of Kānehili, the last of which again refers to wandering, as the word *hili* means "to go astray" (Emerson 1915:162). In the chant, Hi'iaka is moving downhill from Kaupe'a, probably the plains adjacent to Pu'uokapolei , toward the coast, the plain of Kānehili.

3.3.3 The plains of Kaupe'a and Pu'uokapolei and the Realm of Homeless Souls

There are several places on the 'Ewa coastal plain that are associated with *ao kuewa*, the realm of the homeless souls. Samuel Kamakau (1991b:47-49) explains the Hawaiian beliefs in the afterlife:

> . . . There were three realms (*ao*) for the spirits of the dead. . . There were, first, the realm of the homeless souls, the *ao kuewa*; second, the realm of the ancestral spirits, the *ao 'aumakua*; and third, the ream of Milu, *ke ao o Milu* . . .
>
> The *ao kuewa*, the realm of homeless souls, was also called the *ao 'auwana*, the realm of wandering souls. When a man who had no rightful place in the *'aumakua* realm (*kanaka kuleana 'ole*) died, his soul would wander about and stray amongst the underbrush on the plain of Kama'oma'o on Maui, or in the *wiliwili* grove of Kaupe'a on Oahu. If his soul came to Leilono [in Halawa, 'Ewa near Red Hill], there he would find the breadfruit tree of Leiwalo, *ka'ulu o Leiwalo*. If it was not found by an *'aumakua* soul who knew it (*i ma'a mau iaia*), or one who would help it, the soul would leap upon the decayed branch of the breadfruit tree and fall down into endless night, *the pō pau 'olo o Milu*. Or, a soul that had no rightful place in the *'aumakua* realm, or who had no relative or friend (*makamaka*) there who would watch out for it and welcome it, would slip over the flat lands like a wind, until it came to a leaping place of souls, a *leina a ka 'uhane*. . . [Kamakau 1991b:47].
>
> On the plain of Kaupe'a beside Pu'uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by 'aumakua souls, and be helped to escape. . . . [Kamakau 1991b:49].

The breadfruit tree Leilono was said to have been located on the 'Ewa-Kona border, above Āliamanu. In another section of his account of the dead, Kamakau calls the plain of wandering souls the "plain at Pu'uokapolei."

> There are many who have died and have returned to say that they had no claim to an 'aumakua [realm] (*kuleana'ole*). These are the souls, it is said, who only wander upon the plain of Kama'oma'o on Maui or on the plain at Pu'uokapolei on Oahu. Spiders and moths are their food [Kamakau 1991b:29].

This association of Pu'uokapolei and Kanehili with wandering souls is also illustrated in a lament on the death of Kahahana, the paramount chief of O'ahu, who was killed by his father, Kahekili, after Kahahana became treacherous and killed the high priest Kaopulupulu.

Go carefully lest you fall dead in the sun,	*E newa ai o hea make i ka la,*
The god that dwells on Kapolei hill.	*Akua noho la i Puuokapolei.*
The sun is wailing on account of the women of Kamao,	*E hanehane mai ana ka la i na wahine o Kamao,*
A hiding god, blossoming ohai of the banks,	*Akua pee, pua ohai o ke kaha,*
Contented among the stones-	*I walea wale i ke a-*
Among the breadfruit planted by Kahai.	*I ka ulu kanu a Kahai.*
Thou wast spoken of by the oo-	*Haina oe e ka oo-*
By the bird of Kanehili.	*E ka manu o Kanehili.*

[Fornander 1919, Vol. VI, Part 2:297]

Fornander provides some notes on this lament. The god dwelling at Kapolei is the god Kahahana, stating that this is where his soul has gone. Kamao is one of the names of the door to the underworld. This lament draws an association with wandering souls and the place where the first breadfruit tree was planted by Kahai at Pu'uloa (Fornander 1919, Vol. VI, Part 2:304).

Pukui (1983:180) offers this Hawaiian saying, which places the wandering souls in a *wiliwili* grove at Kaupe'a.

The wiliwili grove of Kaupe'a *Ka wiliwili of Kaupe'a.*
In 'Ewa, O'ahu. Said to be where homeless ghosts wander among the trees.

[Pukui 1983:#1666].

Beckwith (1940:154) has stressed that "the worst fate that could befall a soul was to be abandoned by its '*aumakua* and left to stray, a wandering spirit (*kuewa*) in some barren and desolate place." These wandering spirits were often malicious, so the places that they wandered were avoided.

3.3.4 The Plain of Pukaua

The Hawaiian language newspaper *Ka Loea Kālai'āina*, (January 13, 1900) relates that near Pu'uokapolei , on the plain of Pukaua, on the *mauka* side of the road, there was a large rock. This legend suggests that the plain around Pu'uokapolei was called Pukaua. The legend is as follows:

> If a traveler should go by the government road to Waianae, after leaving the village of gold, Honouliuli, he will first come to the plain of Puu-ainako and when that is passed, Ke-one-ae. Then there is a straight climb up to Puu-o-Kapolei and there look seaward from the government road to a small hill, That is Puu-o-Kapolei. . . . You go down some small inclines, then to a plain. This plain is Pukaua and on the mauka side of the road, you will see a large rock standing on the plain. . . . There were two supernatural old women or rather peculiar women with strange powers and Puukaua belonged to them. While they were down fishing at Kualaka'i [near BarbersPoint] in the evening, they caught these things, *'a'ama* crabs, *pipipi* shellfish, and whatever they could get with their hands. As they were returning to the plain from the shore and thinking of getting home while it was yet dark, they failed for they met a one-eyed person [bad omen]. It became light as they came near to the plain, so that passing people were distinguishable. They were still below the road and became frightened lest they be seen by men. They began to run - running, leaping, falling, sprawling, rising up and running on, without a thought of the *'a'ama* crabs and seaweeds that dropped on the way, so long as they would reach the upper side of the road. They did not go far for by then it was broad daylight. One woman said to the other, "Let us hide lest people see us," and so they hid. Their bodies turned into stone and that is one of the famous things on this plain to this day, the stone body. This is the end of these strange women. When one visits the plain, it will do no harm to glance on the upper side of the road and see them standing on the plain [*Ka Loea Kālai'āina*, January 13, 1900, translation in Sterling and Summers 1978:39].

In another version of this story, the two women met Hi'iaka as she journeyed toward the 'Ewa coast. The women were *mo'o* (supernatural beings) and were afraid that Hi'iaka would kill them, so they changed into their lizard form. One of the lizards hid in a little space on a stone beside the coastal trail, and the other hid nearby (*Ka Hōkū o Hawai'i*, February 15, 1927, translated in Maly 1997:19). From that time on the stone was known as *pe'e-kāua*, meaning "we two hidden." Hi'iaka greeted the two women but did not harm them, and passed on.

When she reached Pu'uokapolei , she also greeted two old women who lived at an '*ohai* grove on the hill. These women were named Pu'uokapolei and Nāwaineokama'oma'o (*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:19). As she continued her travels, she looked to the ocean and saw the canoe carrying Lohi'au.

My man on the many harbored sea of Pu'uloa	*Ku'u kāne i ke awa lau o Pu'uloa*
As seen from the plain of Pe'ekāua	*Mai ke kula o Pe'ekāua ke noho*
Let us dwell upon the 'ōhai covered shore	*E noho kāua i ke kaha o ka 'ōhai*
Where the noni blossoms are twisted together	*I ka wiliwili i ka pua o ka lau noni*
Descending along Kānehili	*O ka ihona i Kānehili la*
I am winding along	*Ua hili ho'i au-e*

[*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:20].

3.3.5 Pu'uokapolei and Kamapua'a

Pu'uokapolei was the home of Kamapua'a's grandmother, Kamaunuaniho, who was one of the three migrants from Kahiki that were ancestors to the people of O'ahu (Fornander 1919, Vol. V, Part 2:318; Kahiolo 1978:81, 107). Kamapua'a, the Hawaiian pig god once lived in Kaluanui on the windward side, but escaped to 'Ewa when he was pursued by the chief Olopana.

> Kamapua'a subsequently conquered most of the island of O'ahu, and, installing his grandmother [Kamaunuaniho] as queen, took her to Pu'uokapolei, the lesser of the two hillocks forming the southeastern spur of the Wai'anae Mountain Range, and made her establish her court there. This was to compel the people who were to pay tribute to bring all the necessities of life from a distance, to show his absolute power over all [Nakuina 1904:50-51].

Emma Nakuina goes on to note: "A very short time ago [prior to 1904] the foundations of Kamaunuaniho's house could still be seen at Pu'uokapolei." Another account (*Ka Loea Kālai'āina* January 13, 1900, from Sterling and Summers 1978:34) speaks of Kekeleaiku, the older brother of Kamapua'a, who also lived on Pu'uokapolei .

3.3.6 The Strife at Honouliuli; Kūali'i unites Hawai'i *nei* (*Mo'olelo o Kūali'i*)

The celebrated chief, Kūali'i, is said to have led an army of twelve thousand (*'ekolu mano*) against the chiefs of Ko'olauloa with an army of twelve hundred (*'ekolu lau*) upon the plains of Keahumoa (Fornander 1917 Vol. IV, Part 2:364-401). Perhaps because the odds were so skewed the battle was called off and the *ali'i* of Ko'olau ceded (*ha'awi a'e*) the districts of Ko'olauloa, Ko'olaupoko, Waialua and Wai'anae to Kūali'i. When the *ali'i* of Kaua'i heard of this victory at Honouliuli they gave Kaua'i to Kūali'i as well and thus he became possessed of all the islands (*a lilo a'e la nā moku a pau ia Kūali'i mai Hawai'i a Ni'ihau*). The strife at Honouliuli was the occasion of the recitation of a song for Kūali'i by a certain Kapa'ahulani (*Ka Pule Ana a Kapa'ahulani*). This *mele* compares the king to certain places and objects in the islands, in this instance to the first breadfruit planted by Kahai at Pu'uloa, and a pig and a woman on Pu'uokapolei, possibly a reference to Kamapua'a and his grandmother.

Not like these art thou, Ku.	*Aole I like Ku.*
Not like the pig	*Aole I like i ka puaa,*
Discerning the progeny of the god;	*I ka weke lao a ke akua,*
[Or] The breadfruit planted by Kahai.	*Ka ulu kanu a Kahai;*
Truly, have you not known	*Oi ole ka oe i ike,*
The woman with the dyed garment,	*Ka wahine pau mao*
On the top of Puuokapolei?	*I ka luna o Puuokapolei-la?*

[Fornander 1917, Vol. IV, Part 2:392-393].

A later section of this *mele* also refers to Pu'uokapolei and makes mention of the famous blue poi of Honouliuli.

O Kawelo! Say, Kawelo!	*O Kawelo-e, e Kawelo-e,*
Kawelokiki, the sharp-pointed hill,	*O Kaweloiki puu oioi,*
Hill of Kapolei.	*Puu of Kapolei-e-*
Blue is the poi which appeases	*Uliuli ka poi e piha nei-o Honouliuli;*
[the hunger] of Honouliuli.	

[Fornander 1917, Vol. IV, Part 2:400-401].

3.4 Pearl Harbor (Pu'uloa) and West Loch (Kaihu o pala'ai)

3.4.1 The "Silent Fish" of Pearl Harbor

Pearl Harbor was called Pu'uloa or *ke-awa-lau-o-Pu'uloa*, the many harbored-sea of Pu'uloa (Pukui 1983:#1686) by the Hawaiians. An alternate name was Awawa-lei, or "garland (*lei*) of harbors" (Handy and Handy 1972:469). Pukui (1983:#1126] also uses the name *Awalua* for Pearl Harbor, as in the saying "*Huhui na 'ōpua i Awalau*, The clouds met at Pearl Harbor. Said of the mating of two people." Emerson (1915:167) interprets Awalau as "leaf-shaped lagoon."

John Clark (1977:70) says that its English name came from the name Waimomi, or "water of the pearl," an alternate name for the Pearl River (Pearl Harbor). The harbor was named Pearl Harbor after the pearl oysters of the family Pteriidae (mainly *Pinctada radiata*), which were once abundant on the harbor reefs, but were later decimated by over-harvesting. This oyster was supposedly brought from Kahiki, the Hawaiian ancestral lands, by a *mo'o* (lizard or water spirit) named Kane-kua'ana (Handy and Handy 1972:470).

Kanekua'ana was the *kia'i* (food guardian) for 'Ewa. When food was scarce, the descendants of Kanekua'ana built *waihau heiau* (a *heiau* for *mo'o*) for her and lit fires to plead for her blessings. For 'Ewa the chief *i'a* (marine food) blessing was the famous *pipi*, or pearl oyster. Samuel Kamakau describes the *pipi* of Honouliuli.

> That was the oyster that came in from deep water to the mussel beds near shore, from the channel entrance of Pu'uloa to the rocks along the edges of the fishponds. They grew right on the *nahawele* mussels and thus was this *i'a* obtained. Not six months after the *hau* branches [that placed a *kapu* on these waters until the *pipi* should come up] were set up, the *pipi* were found in abundance-enough for all 'Ewa-and fat with flesh. Within the oyster was a jewel (*daimana*) called a pearl (*momi*), beautiful as the eyeball of a fish, white and shining; white as the cuttle fish, and shining with the colors of the rainbow-reds and yellow and blues, and some pinkish white, ranging in size from small to large. They were of great bargaining value (*he waiwai kumuku'ai nui*) in the ancient days, but were just "rubbish" (*'opala*) in 'Ewa [Kamakau 1991b:83].

This oyster, the *pipi*, was sometimes called "the silent fish," or *i'a hamau leo o 'Ewa*, 'Ewa's silent sea creature (Handy and Handy 1972:471), since the collectors were supposed to stay quiet while harvesting the shells, as in the sayings:

The fish of 'Ewa that silences the voice. *Ka ka'a hāmau leo o 'Ewa.*
The pearl oyster, which has to be gathered in silence [Pukui 1983:#1331].

'Ewa is disturbed by the Moa'e wind. *Haunāele 'Ewa i ka Moa'e.*

> Used about something disturbing, like a violet argument. When the people of 'Ewa went to gather the *pipi* (pearl oyster), they did so in silence, for if they spoke, a Moa'e breeze would suddenly blow across the water, rippling it, and the oysters would disappear [Pukui 1983:5#493].

Hush, lest the wind rise. *E hāmau o makani mai auane'i.*

> Hold your silence or trouble will come to us. When the people went to gather pearl oysters at Pu'uloa, they did so in silence, for they believed that if they spoke, a gust of wind would ripple the water and the oysters would vanish [Pukui 1983:#274].

The gesturing fish of 'Ewa. *Ka i'a kuhi lima o 'Ewa.*

> The *pipi*, or pearl oyster. Fishermen did not speak when fishing for them but gestured to each other like deaf-mutes [Pukui 1983:#1357].

Sereno Bishop, an early resident of O'ahu, wrote, of his time in the area around 1836, of the pearl oyster, the *pipi*, and another edible clam, identified by Margaret Titcomb (1979:351) as probably *Lioconcha heiroglyphica.*

> The lochs or lagoons of Pearl River were not then as shoal as now. The subsequent occupation of the uplands by cattle denuded the country of herbage, and caused vast quantities of earth to be washed down by storms into the lagoons, shoaling the water for a long distance seaward. No doubt the area of deepwater and anchorage has been greatly diminished. In the thirties, the small oyster was quite abundant, and common on our table. Small pearls were frequently found in them. No doubt the copious inflow of fresh water favored their presence. I think they have become almost entire extinct, drowned out by the mud. There was also at Pearl River a handsome speckled clam, of a delicate flavor which contained milk white pearls of exquisite luster and perfectly spherical. I think the clam is still found in the Ewa Lochs [Bishop 1901:87].

Older Hawaiians believed that the *pipi* disappeared around the time of the smallpox epidemic of 1850-1853, because Kanekua'ana became displeased at the greed of some *konohiki* (overseer).

> The people of the place believe that the lizard was angry because the konohikis imposed kapus [bans], were cross with the women and seized their catch of oysters. So this "fish" was removed to Tahiti and other lands. When it vanished a white, toothed thing grew everywhere in the sea, of Ewa, which the natives of Ewa had named the pahikaua (sword). It is sharp edged and had come from Kauai-helanai, according to this legend [Manu 1885:50].

Pahikaua is the Hawaiian name for the mussel, *Brachidontes crebristriatus* (Mytilidae), which was also a popular clam eaten by the residents of Pearl Harbor.

A clarification of the story of Kanekua'ana and the pearl oysters of Pearl Harbor is given, in which it seems an overseer had set a ban on the *pipi* for several months a year so that they could increase. A poor widow, a relation of the *mo'o*, took some of the *pipi* and hid them in a basket. The *konohiki* found the hidden shells, and took them from her, emptying them back into the sea, which was proper. However, after this he followed the woman home and also demanded that she pay a stiff fine in cash, which she did not have. The *mo'o* thought this was unjust and the next night she took possession of a neighbor who was a medium.

> . . . After the overseer had gone back to Palea the lizard goddess possessed her aged keeper [a woman of Ewa] and said to those in the house, "I am taking the

> pipi back to Kahiki and they will not return until all the descendants of this man are dead. I go to sleep. Do not awaken my medium until she wakes of her own accord." The command was obeyed and she slept four days and four nights before she awoke. During the time that she slept the pearl oysters vanished from the places where they were found in great numbers, as far as the shore . . . .The few found today are merely nothing . . .[*Ka Loea Kālai'āina*, June 3, 1899, translation in Sterling and Summers 1978:49-50].

3.4.2 Ka'ahupāhau, the Queen Shark of O'ahu

Pearl Harbor in legendary traditions is closely associated with shark *'aumakua*, guardian spirits for specific Hawaiian families or clans. Pukui (1943:56) and others (Sheldon 1883) claim that the sharks of Pearl Harbor were so tame that people used to ride on their backs, and that their human relatives would feed them with *awa*. The most famous guardian shark was Ka'ahupāhau, the queen shark of O'ahu, who lived in Pu'uloa, now called Pearl Harbor. Her name means "cloak well cared for" (Pukui 1943:56), or "well cared-for feather cloak;" the feather cloak was a symbol of royalty.

Ka'ahupāhau and her brother, Kahi'uka, had been born as humans and were turned into sharks (Mary Kawena Pukui, March 29, 1954, from Sterling and Summers 1978:56).

> The mother, who was a chiefess, of Ka'ahupahau was gathering limu [seaweed] in the waters of Pearl Harbor when she had a miscarriage. Thinking the baby dead she left it in the water to be washed away. Later she went again to gather limu and was bitten by a shark. She went to a kahuna [priest] who told her that the shark was Ka'ahupahau who was her own daughter, the baby she thought was dead. The kahuna advised her to go to the place and build and ahu (heap) of hau a sort of landing from which she could feed the shark and care for it. It was from that time by command of the mother that all people of Ewa were to be always be protected from sharks whether in Pearl Harbor or outside [E.S. as told by Simeon Nawaa, Mar. 22, 1954, from Sterling and Summers 1978:56].

This explains the meaning of the shark's name Ka'ahupāhau, "the mound (*ahu*) of *hau*" (*Hibiscus tiliaceus*). The grandmother of Ka'ahupāhau and her brother, Koihala, lived in Honouliuli and one day was making *lei* for her shark grandchildren. A young girl named Pāpio rudely begged for one of the *lei*, but Koihala refused. On her way to her favorite surfing spot at Keahi Point, Pāpio snatched up one of the *lei*, and laughingly went surfing. Koihala angrily told Ka'ahupāhua about the stolen *lei*, and the shark killed the girl, grabbing her from a rock in the sea where she was resting.

> Ka'ahupahau soon recovered from her anger and became very sorry. She declared that from hence forth all sharks in her domain should not destroy, but protect the people round about. As flowers were the cause of the trouble she forbade their being carried or worn on the water of Pu'uloa. From that time all the people of that locality and the sharks in the lochs were the best of friends . . . . [Pukui 1943:56].

In a second version of this story, the shark gods Kanehunamoku and Kamohoali'i were the ones that had placed a *kanawai* (decree) against the attack of men by all sharks around O'ahu. As the result of the attack of the chiefess Pāpio, Ka'ahupāhau was put on trial and tried at Uluka'a [the realm of the gods]. She escaped the punishment of death, but was placed in confinement. In his writing of 1870 (*Ke Au 'Oko'a* April 7, 1870), Samuel Kamakau asserted:

> After her confinement ended several years later Ka'ahupahau was very weak. She went on a sightseeing trip, got into trouble, and was almost killed. But she received great help from Kupiapia and Laukahi'u, sons of Kuhaimoana, when their enemies were all slain the *kanawai* was firmly established. This law-that no shark must bite or attempt to eat a person in Oahu waters-is well known from Pu'uloa to the Ewas. Anyone who doubts my work must be a *malihini* [recent resident] there. Only in recent times have sharks been known to bite people in Oahu waters or to have devoured them; it was not so in old times [Kamakau 1991b:73].

This information on the protective nature of Ka'ahupāhau is somewhat contradicted by the writings of the Russian explorer Otto Von Kotzebue, who walked to Pearl Harbor in 1821, but was unable to actually sail on the waters. He was told that people were thrown into the water as sacrifices to the sharks; however, it is uncertain if the person who told him this was an actual resident of 'Ewa, who would know the real truth. Kotzebue's account is:

> In the Pearl River there are sharks of remarkable size, and there have made on the banks an artificial pond of coral stones, in which a large shark is kept, to which, I was told, they often threw grown-up people, but more frequently children, as victims [Kotzebue 1821:338-348].

The protection of Ka'ahupāhau is emphasized in many other Hawaiian traditions. One time a man-eating shark called Mikololou from the Ka'ū district of the island of Hawai'i, came visiting at Pearl Harbor with other sharks, some man-eating, some not. Mikololou remarked "What fine, fat crabs you have here," from which Ka'ahupāhau knew that some of the sharks were man-eaters, since they referred to fishermen as "fat crabs." She directed the fishermen to place a barrier of nets across the entrance to the harbor, and when the sharks left her home, they could not get back out to the ocean.

> The sharks of the lochs attacked the man-eaters from outside and beat them unmercifully. A shark from Ka'u, Hawaii, who was not a man-eater, threw his weight over the nets and pressed them down. His sons changed themselves into pao'o [blennies] fishes and leaped where the net was forced down, thus escaping from the place where the battle of sharks was raging. Mikololou was caught fast in the nets and dragged ashore where his head was cut off and his body burned [Pukui 1943:56].

In another version of this story, Mikololou is accompanied to Pearl Harbor with his shark friends Kua, Keali'ikauaoka'ū, Pākaiea, and Kalani; Mikololou was the only man-eater. To escape the nets:

> Keali'ikauaoka'ū changed himself into a pao'o fish, which lives among the rocks, and leapt out of the net. Kua changed into a lupe, as the spotted stingray is called, and weighted down the net on one side, helping his son Kalani and nephew Pākaiea, who were half human, to escape [Pukui and Green 1995:40].

Only Mikololou was caught in the nets, and his body was tossed on shore to rot, until only the tongue was left. In some versions of this story, the tongue immediately jumps into the water and then becomes a shark again (Pukui and Green 1995:41); in other versions (Pukui 1943:56), the tongue is eaten by a dog, which then jumps into the water, turns into a shark, and escapes. In both versions, Mikololou returns to Ka'ū, never to bother Ka'ahupāhau again.

In Thrum's (1923:308) version, Mikololou went back to his home island of Hawai'i and organized an army of sharks to return to Pearl Harbor, but he was again defeated by the fishermen of 'Ewa under the command of Ka'ahupāhau, who slaughtered so many of the sharks that from then on "the sea of Pu'uloa is safe and peaceful through her law that sharks shall not attack man. That is why these waters are safe for people to swim from shore to shore without fear" (Thrum 1923:308). The watchful eye of Ka'ahupāhau led to these Hawaiian sayings:

Everywhere in Pu'uloa is the trail...of Ka'ahupāhau — *Alahula Pu'uloa, he alahelena Ka'ahupāhau*

Said of a person who goes everywhere, looking, peering, seeing all, or of a person familiar with every nook and corner of a place. Ka'ahupāhau is the shark goddess of Pu'uloa (Pearl Harbor) who guarded the people from being molested by sharks. She moved about, constantly watching [Pukui 1983:#105].

The man-eating sharks blamed Ka'ahupāhau. — *Ho'ahewa na niuhi ia Ka'ahupāhau.*

Evil-doers blame the person who safeguards the rights of others. Ka'ahupāhau was the guardian shark goddess of Pu'uloa (Pearl Harbor) who drove out or destroyed all the man-eating sharks [Pukui 1983:#1014].

Pu'uloa became lonely when Ka'ahupāhau went away. — *Mehameha wale no o Pu'uloa, i ka hele a Ka'ahupāhau.*

The home is lonely when a loved one has gone. Ka'ahupāhau, guardian shark of Pu'uloa (Pearl Harbor), was dearly loved by the people [Pukui 1983:#2152].

Mikololou died and came to life again... through his tongue. — *Make o Mikololou a ola i ke ale lo.*

Said of one who talks himself out of a predicament [Pukui 1983:#2111].

There were other guardian sharks in Pearl Harbor, including a brother of Ka'ahupāhau's named Kahi'ukā (the smiting tail), and a son name Kūpīpī (Pukui 1943:57), or, in some versions, twin sons, named Kūpīpī and Kūmaninini (Pukui and Green 1995:41). In one version of the

Story of Pāpio, recounted above, it is said the Ka'ahupāhau later turned into a stone, although the people of Pu'uloa continued to feed her (Martha Beckwith notes to Samuel Kamakau n.d., *Mo'olelo Hawaii*, vol. II:23, from Sterling and Summers 1978:56).

> Kahi'ukā was the brother of Ka'ahupahau. The name means "smiting tail." This shark was called by this name because it was his duty to warn the people of Ewa of the presence of strange and unfriendly sharks in these waters and he did so by nudging them or striking at them with his tail When ever anyone was fishing and felt a nudge they would know it was Kahi'uka, warning them and they would leave the water immediately [E.S. as told by Simeon Nawaa, Mar. 22, 1954, from Sterling and Summers 1978:56].

There are two different accounts of the home of this shark brother. The above reference says that Kahi'uka lived at the site of the old dry dock. Mary Pukui disagrees, and says the site of the old dry dock was the home of the son, not the brother of Ka'ahupāhau. Mary Pukui says Kahi'ukā lived in a cavern under water off Moku'ume'ume (Ford Island) near Keanapua'a Point; he had a stone form in deep water some distance from the cave that could be seen from the surface (Mary Kawena Pukui, Mar. 29, 1954, from Sterling and Summers 1978:56). J. S. Emerson (1892) wrote in the late nineteenth century that Kahi'uka's keeper, Kimona, would often find fish nets missing and knew that Kahi'ukā had carried them upshore to a place of safety. Pukui also relates that the shark was named "smiting tail" because one side was longer than the other, and the shark would use his tail to smite unfriendly sharks.

3.4.3 Story of Ka'ehu-iki-manō-o-Pu'uloa, the Little Yellow Shark

One of the shark *'aumakua* associated with Pearl Harbor, was the little yellow shark called Ka'ehu, who was born on the Big Island, but later traveled to O'ahu and settled at Pu'uloa. His ancestor was Kama'ili'ili, the Hawaiian shark god, brother of the Hawaiian volcano goddess, Pele. Ka'ehu was a guardian of the Hawaiian people and once saved several surf riders at Waikīkī from a man-eating shark called Pehu (Knudsen 1946:9-13; Westervelt 1963:55-58).

In Thrum's version of this legend, the shark's name is Ka-ehu-iki-mano-o-Puuloa, meaning "the small, blonde shark of Pu'uloa." He was born in Puna, Hawai'i, but soon left on a tour of all of the islands, so that he could call and pay respects to all of the king-sharks of Hawai'i.

> . . . Puuloa, Oahu, was the next objective. Reaching its entrance they visited the pit of Komoawa, where Kaahupahua's watcher lived. Here the young shark made himself known, as usual; the object of the journey, and the desire to meet the famous queen-shark protector of Oahu's waters. . . . Welcome greetings were sent by the messenger, who was bid entertain the visitors in the outer cave, and on the morrow the party could come up the lochs to meet the queen. . . .The company then repaired to the royal cave at Honouliuli, where the visitors were supplied with soft coconut and *awa*, their home food and beverage [Thrum 1923:301-302].

The cave of Komoawa may be the Hawaiian words for "channel" or harbor" entrance (Pukui and Elbert 1986). In another version of this story, the shark watcher himself is named Komoawa and the cave that he lives in is called Keaali'i. Keaali'i guards the entrance to Pearl Harbor,

while the home of Ka'ahupāhau is deeper into Honouliuli lagoon (*Saturday Press*, Dec. 29, 1883).

In 1823, the missionary Hiram Bingham accompanied Liholiho (King Kamehameha II) and his company to the royal compound at Pu'uloa, where he was shown a cave that was home to a shark god.

> I one day accompanied the king and others by boat to see the reputed habitation of an Hawaiian deity, on the bank of the lagoon of Ewa. It was a cavern or fissure in a rock, chiefly under water, where, as the traditions teach, and as some then affirmed, a god, once in human form, taking the form of a shark, had his subterraqueous abode. Sharks were regarded by the Hawaiians as gods capable of being influenced by prayers and sacrifices, either to kill those who hate and despise them, or to spare those who respect and worship them . . . [Bingham 1847:177].

Although Bingham stated in this year that no one any longer believed these stories, there were some who kept the beliefs of the guardian sharks alive. In 1912, dredging in Pearl Harbor was completed and a large drydock was completed, but collapsed the very next year. The native Hawaiians believed that the dock had collapsed because it had been built over the home of Kūpipi the shark son of Ka'ahupāhau's, who lived in a cavern near the harbor entrance at Pu'uloa. "Angered by the violation of his home, the shark prince destroyed the imposing structure" (Clark 1977:69-70). The dock was rebuilt in the same year, but this time only after a blessing on the construction was made by Hawaiian traditional practioners.

In other versions of this story, the name of the shark is interpreted as "the little ruddy shark" (Emerson n.d.), or the "little reddish-haired shark," named for the reddish (*'ehu*) hair of Ka'ahupāhau. In this version, the cave of Ka'ehu is called Pānau, and the human mother and father of the little shark are Kapukapu and Holei of Pānau, in Puna, Hawai'i (Emory et al. 1959:63).

3.4.4 Kāne and Kanalao and the Fish Ponds of West Loch

According to an account in the Hawaiian newspaper *Ka Loea Kālai'āina* (June 10, 1899), several of the fishponds in the Pu'uloa area were made by the brother gods, Kāne and Kanaloa. A fisherman living in Pu'uloa, named Hanakahi, prayed to unknown gods, until one day two men came to his house. They revealed to him that they were the gods to whom he should pray. Kāne and Kanaloa then built fishponds at Ke'ana-pua'a, but were not satisfied. Then they built the fishpond, Kepo'okala, but were still not satisfied. Finally they made the pond Kapākule, which they stocked with all manner of fish. They gifted all of these fishponds to Hanakahi and his descendants (Handy and Handy 1972:473; *Ka Loea Kālai'āina*, July 8, 1899).

According to Mary Pukui (1943:56-57), who visited Kapākule fishpond when she was young, the pond was built by the legendary little people of Hawai'i, the *menehune*, under the direction of the gods Kāne and Kanaloa. Pukui describes several unique aspects of this pond:

> On the left side of the pond stood the stone called Hina, which represented a goddess of the sea by that by that name. Each time the sea ebbed, the rock became

> gradually visible, vanishing again under water at high tide. Ku, another stone on the right, was never seen above sea level. This stone represented Ku'ula, Red Ku, a god for fish and fishermen. From one side of the pond a long wall composed of driven stakes of hard wood, ran toward the island [Laulaunui] in the lochs. When the fish swam up the channel and then inside of this wall, they invariably found themselves in the pond. A short distance from the spot where the pond touched the shore was a small koa or altar composed of coral rock. It was here that the first fish caught in the pond was laid as an offering to the gods [Pukui 1943:56].

The fishpond contained many fish, especially the *akule* (scad fish, *Trachurops crumenophthalmus*), thus its name, "the enclosure for *akule* fish" (Pukui 1943:56-57). The pond was destroyed when the channel to Pearl Harbor was dredged in the early twentieth century. The caretaker of the pond took the stones Kū and Hina to a deep place in the ocean and sunk them so "none would harm or defile them." Cobb (1903:733) says it was used to catch the larger *akule* (goggler), *opelu* (mackeral scad), *weke* (goat fish), *kawakawa* (bonito), and sharks; it was unusual for having walls made of coral. This contradicts much of the legendary material that says that sharks were not killed within Pearl Harbor; however, Kamakau does relate that Kekuamanoha and Kauhiwawaeono, two conspirators against Kamehameha I, lived at Pu'uloa. The chief Kauhiwawaeono was known to murder people and use their bodies as shark bait (Kamakau 1961:182, 232).

Samuel Kamakau adds more information on the pond Kapākule, and a second one called Kepo'okala.

> At Pu'uloa on Oahu were two unusual ponds [fish traps]—Kapakule and Kepoolala. Kapakule was the better one. The rocks of its walls, *kuapa*, could be seen protruding at high tide, but the interlocking stone walls (*pae niho pohaku*) of the other pond were still under water at high tide. . . . It [Kapakule] was said to have been built by the *'e'epa* people [mysterious people] at the command of Kane....This is how the fish entered the pond. At high tide many fish would go past the mauka side of the pond, and when they returned they would become frightened by the projecting shadows of the trunks, and would go into the opening. The fish that went along the edge of the sand reached the seaward wall, then turned back toward the middle and entered the *anapuna* (the arched portion of the trap) A man ran out and placed a "cut-off" seine net (*'omuku lau*) in the opening, and the fish shoved and crowded into it. The fish that were caught in the net were dumped out, and those not caught in the net were attacked with sharp sticks and tossed out, or were seized by those who were strong [Kamakau 1976:88].

3.4.5 The Story of Kaihuopala'ai Pond, Honouliuli (*Ka'ao no Maikohā*)

In the Legend of Maikohā (Fornander 1917, Vol. V, Part 2:270-271), a sister of Maikohā, a deified hairy man who became the god of *tapa* makers, named Kaihuopala'ai, journeys to O'ahu:

> Kaihuopala'ai saw a goodly man by the name of Kapapaapuhi who was living at Honouliuli, 'Ewa; she fell in love with him and they were united, so

> Kaihuopala'ai has remained in 'Ewa to this day. She was changed into that fishpond in which mullet are kept and fattened, and that fish pond is used for that purpose to this day,
>
> *'Ike aku la o Kaihuopala'ai i ka maikai o Kapapaapuhi, he kāne e noho ana ma Honouliuli ma 'Ewa. Moe iho la lāua, a noho iho la o Kaihuopala'ai i laila a hiki i kēia lā. 'Oia kēlā loko kai e ho'opuni ia nei i ka 'anae, nona nā i'a he nui loa, a hiki i kēia kākau ana* [Fornander 1919, Vol. V, Part 2:270].

The name of Maikohā's sister, Kaihuopala'ai, which means "the nose of Pala'ai" (Pukui et al. 1974:68) is also the name the Hawaiians used for the west loch of Pearl Harbor, adjacent to the Project Area. McAllister recorded that other Hawaiians say there never was a fishpond by that name Beckwith (1918) says that Kaihuopala'ai changed into the fishpond near Kapapapuhi, which means "the eel flats." This is identified on old maps as the point north of the Project Area (sometimes spelled Kapapa'apuhi) that juts into the loch; early Hawaiian settlement was focused on this area.

There is also a famous *pōhaku*, or rock, associated with the traveling mullet of Pearl Harbor.

> . . .I . . .asked the person sitting on my left, "What place is this?" Answer – "This is Pearl City." It was here that mullets were bred in the ancient times and that flat stone there was called Mullet Rock or Pōhaku Anae. It lies near the beach by Ewa mill [*Ka Nūpepa Kū'oko'a*, Oct. 2, 1908, from Sterling and Summers 1978:53].

3.4.6 The Traveling Mullet of Honouliuli (Fish Stories and Superstitions)

The story of Kaihuopala'ai, or Ihuopala'ai, is also associated with the tradition of the *anae-holo*, the traveling mullet of Pearl Harbor (Thrum 1998:270-272):

> The home of the *'anae-holo* is at Honouliuli, Pearl Harbor, at a place called Ihuopala'ai. They make periodical journeys around to the opposite side of the island, starting from Pu'uloa and going to windward, passing successively Kumumanu, Kalihi, Kou, Kālia, Waikīkī, Ka'alāwai, and so on, around to the Ko'olau side, ending at Lā'ie, and then returning by the same course to their starting point [Thrum 1998:271].

In Thrum's account, Ihuopala'ai is a male who possesses a Kū'ula or fish god that supplied the large mullet known as "*anae*." His sister lived in Lā'ie, and there came a time there were no fish to be had. She sent her husband to visit Ihuopala'ai, who was kind enough to send the fish following his brother-in-law on his trip back to Lā'ie.

This story is associated with a proverb or poetical saying identified with Honouliuli:

The fish fetched by the wind. *Ka I'a hali a ka makani*

> The *'anaeholo*, a fish that travels from Honouliuli, where it breeds, to Kaipāpa'u, on the windward side of O'ahu. It then turns about and returns to its original home. It is driven closer to shore when the wind is strong [Pukui 1983:#1330].

Pukui et al. (1974:68) gives the name of the husband in this story as Lā'ie and the name of the wife as Pala'ai, which ties into the name of the west loch of Pearl Harbor, called Ka-ihu o Pala'ai, "the nose of Pala'ai." Another version has a woman named Awawalei (an alternate version for the name of Pearl Harbor), who had a brother named Laniloa (the point on Lā'ie at which the mullet stops its migration and makes its way back to Pearl Harbor), and another brother (a mullet) who lived with an eel named Papa-puhi, which relates to the name of the fishpond in the tale called Kapapapuhi (*Ka Loea Kālai'āina*, Oct. 21, 1899). On historic maps, Kapapapuhi is a point of land that juts into West Loch and was a focus for habitation, taro cultivation, and fishpond maintenance in the early post-Contact (and probably earlier) period.

3.4.7 The Caves of Pu'uloa

'Ewa was famous for the many limestone caves formed in the uplifted coral. Some of these caves, called *ka-lua-ōlohe* were inhabited by the *ōlohe*, a type of people that looked like other humans but had tails like dogs (Beckwith 1940:343). These people were skilled in wrestling and bone-breaking and often hid along narrow passes to rob travelers; they were also reputed to be cannibals. As mentioned in a previous section of this report, the famous cannibal king, Kaupe, who lived in Līhu'e in upland Honouliuli, was an *ōlohe*.

There was once a cave named Kapuna on Waipi'o peninsula that was associated with a famous riddle. *No Kapuna kane hale noho ia e ke kai*, or "To Kapuna belongs the house, the sea dwells in it."

> This cave is on the Waipio side and a sea passage separates Waipio and Waikele and Waikele and Honouliuli. The passage is obstructed by three small islands, a middle one and Manana and Laulaunui. These small islands in the middle of the passage to Honouliuli and inside and outside of these small islands is the sea of Kaihuopalaai [Hawaiian name for West Loch] where mullet lived till they whitened with age [*Ka Loea Kālai'āina*, Oct. 7, 1899, translation in Sterling and Summers 1978:24].

Another famous cave of the area was Keanapua'a [in Halawa opposite Waipi'o peninsula], which means "the pig's cave," so named because Kamapua'a once slept there (Pukui et al. 1974:103). This cave was one of the places that the high king of O'ahu, Kahahana, hid after he had killed the priest Kaopulupulu, thus angering the high chief of Maui, Kahekili (Kahahana's father).

> Upon the arrival here at Oahu of Kahekili, Kahahana fled, with his wife Kekuapoi, and friend Alapai, and hid in the shrubbery of the hills. They went to Aliomanu, Moanalua, to a place called Kinimakalehua; then moved along to Keanapuaa and Kepookala, at the lochs of Puuloa, and then from there to upper Waipio; thence to Wahiawa, Helemano, and on to Lihue; thence they came to Poohilo, at Honouliuli, where they first showed themselves to the people and submitted themselves to their care.
>
> Through treachery, Kahahana was induced to leave Po'ohilo, Honouliuli and was killed on the plains of Hō'ae'ae [Thrum 1906:213-214].

The place Pō'o Hilo was somewhere on the border between Honouliuli and Hō'ae'ae (north of the Project Area). In the "Legend of the Sacred Spear-point" (Kalākaua 1990:209-225) is a reference to the Hawai'i Island chief, Hilo-a-Lakapu. Following his unsuccessful raid against O'ahu "he was slain at Waimano, and his head was placed upon a pole near Honouliuli for the birds to feed upon"(Kalākaua 1990:224). This place was called Pō'o Hilo, which literally means "the head of Hilo."

The caves of Pu'uloa were sometimes used as burial caves. In 1849, Keali'iahonui, son of Kaua'i's last king, Kaumuali'i, died. He had once been married to the chiefess Kekau'ōnohi, who had stayed with him until 1849. She wanted to bury her ex-husband at sea.

> It seems that by Kekauonohi's orders, the coffin containing her late husband's remains was removed to Puuloa, Ewa, with the view of having it afterwards taken out to sea and there sunk. It was temporarily deposited in a cavern in the coral limestone back of Puuloa, which has long been used for a burial place, and has lately been closed up [Alexander 1907:27].

After some initial objections by the niece of Kealai'iahonui, the body was removed from the outer coffin, the rest was sunk, and the coffin was later buried somewhere in Pu'uloa.

3.4.8 Coastal Honouliuli

The coastal area of Honouliuli is a triangular area that stretches from Pili o Kahe on the northwestern corner that marks the boundary with the Wai'anae District to Kalaeloa (now Barbers Point) on the southwestern corner, to Keahi Point on the southeastern corner at the mouth of Pearl Harbor. There were likely Hawaiian settlements at Ko'ōlina on the west side, at Kualaka'i on the south, at the royal residence in Pu'uloa near the mouth of the harbor, and at Honouliuli town at the upper end of West Loch, surrounding Kapapapuhi Point, north of the Project Area.

Kalaeloa literally means "the long point" (Pukui et al. 1974:72), but Raphaelson (1925) has a different translation. He says the name of the point is Kalaiekao, meaning "sky rocket cape," because it was on this point that signal fires were set to signal canoes to go out to meet European boats during the early historic period. Kalaeloa Point was the home of Uhu makaikai, a *kupua* (supernatural being) who could take the form of a man or a giant parrotfish (*uhu*). He is mentioned in several legends concerning the hero Kawelo and his struggles with the ruling chief of Kaua'i, Aikanaka.

> This friend was Kauahoa also an alii of Waiłua (Kauai). Their king, Aikanaka, in the time of Kākuhihewa of Oahu and Lonoikamakahiki of Hawaii. Aikanaka got offended with Kawelo and sent him to live at Waikiki. The king at a surf bathing told Kawelo to get a calabash of water for him to wash off with, but on Kawelo's failing to do it, he took a calabash of soft poi and threw it over Kawelo and sent him off as already stated. At Waikiki, Kawelo studied the art of fighting to be revenged on Aikanaka. A *kupua*, Uhu makaikai, a fish was his teacher. Makuakeke was his helper in the canoe. The fish lived at Pōhaku o Kawai near Kalailoa (Kalaeloa), Oahu (BarbersPoint) . . . . [Hawaiian Ethnological Notes, Bishop Museum Vol. II:114, translation in Sterling and Summers 1978:41].

One historical account of particular interest refers to an *ali'i* residing in Ko'ōlina, within Waimanalo (meaning "brackish water").

> Ko'ōlina is in Waimānalo near the boundary of 'Ewa and Wai'anae. This was a vacationing place for chief Kākuhihewa and the priest Napuaikamao was the caretaker of the place. Remember reader, this Ko'ōlina is not situated in the Waimānalo on the Ko'olau side of the island but the Waimānalo in 'Ewa. It is a lovely and delightful place and the chief, Kākuhihewa loved this home of his [*Ke Au Hou* July 13, 1910, from Sterling and Summers 1978:41].

Between Pili o Kahe and Kalaeloa there is Kahe Point, which was formerly marked by two drainage ditches called Keone'ō'io and Limaloa, which may explain the name Kahe, which means "flow" (Pukui et al. 1974:64). Keone'ō'io means "the *'ō'io* sand; this area once had large schools of *'ō'io* (bonefish; Albulidae), a fish usually found on sandy-bottom areas (Clark 1977:77). Kalaeloa, meaning "the long point", got its present name Barbers Point from Captain Henry Barber of the brig *Arthur*, who ran aground on October 31, 1796 on a shoal west of the entrance to Pearl Harbor. Hawaiians, under the command of Kamehameha I, salvaged the cannon from the ship and used them to man a new fort on Lahaina, Maui (Clark 1977:75-76).

Kualaka'i is the name of the beach area on the south ocean coast of Honouliuli. Clark (1977:74) says it is named for a type of sea cucumber that squirts a purple fluid when squeezed, but, the book *Hawaiian Place Names* (Pukui et al. 1974:119) identifies the sea creature as 'tethys," a member of the invertebrate family Aplysiidae, commonly called sea hares. In the legend of Hi'iaka, there was a spring located at Kualaka'i named Hoaka-lei (*lei* reflection) where Hi'iaka picked *lehua* flowers to make a *lei* and saw her reflection in the water (*Ka Hōkū o Hawai'i*, February 22, 1927, translated in Maly 1997:20).

Keahi Point, at the entrance to Pearl Harbor, has already been noted as the surf spot for the chiefess Pāpio who was killed by the queen shark of Pearl Harbor, Ka'ahupāhau. It was also known as a good fishing spot for the *'ō'io* (bonefish, *Albula vulpes*). The *'ō'io* from Keahi were famed for their fragrance, like that of the *lipoa* (*Dictyopteris* spp.) seaweed (Pukui 1943:56).

In pre-Contact times, Pu'uloa was an *'ili* of Honouliuli, but sometime after 1868, it was designated as a separate *ahupua'a* (Maly 1997:9). Pu'uloa was a royal habitation area, and according to one tradition, was the first place that "human beings" landed on O'ahu (Beckwith 1940:343). Within Pu'uloa (meaning "long hill') on the seashore side was a beach area called One'ula, which means "red sand," possibly named for a large drainage ditch which carried red dirt from the inlands to the seashore (Clark 1977:73).

3.4.8.1 The Strife of Nāmakaokapāo'o and Puali'i (*Ka'ao no Nāmakaokapāo'o*)

In the Legend of Nāmakaokapāo'o (Fornander 1919, Vol. V, Part 2:274-277), the brave boy, Nāmakaokapāo'o, and his mother, Pokai, appear to have been living near the coast but were quite destitute (*'ilihune loa*). His mother met Puali'i when he came from Līhu'e to fish at Honouliuli, the two married, and the new family went to live on the plains of Keahumoa (*ke kula o Keahumoa*). Puali'i kept sweet potato patches (*māla uala*) and fished for *ulua*. Following a dispute over sweet potatoes, Nāmakaokapāo'o defeated his step-father, Puali'i and:

> Nāmakaokapāo'o picked up Puali'i's head and threw it towards Waipouli, a cave situated on the beach at Honouliuli (a distance of about five miles).
>
> *Lālau aku la o Nāmakaokapāo'o i ke po'o o Puali'i a kiola aku la i kai o Waipouli, he ana ma kahakai o Honouliuli, o kona loa, 'elima mile ka loa* [Fornander 1919, Vol. V, Part 2:276-277].

3.4.8.2 Coastal Village of Kualaka'i

In the Legend of the Children, is a tale that foretold the later breaking of the eating *kapu* by the *ali'i*. A young brother and sister always fished at Kualaka'i, a beach area on the southern coast of Honouliuli. One day they laid out their nets, but all they caught was one *palani* (surgeonfish), a fish that was *kapu* (tabu) for men; only women could eat it.

> . . . They fished again and again until the afternoon and nothing was caught. The children were weary and went home without fish. When they came as far as Pu'u-o-Kapolei where the blossoms of the ma'o looked golden in the sunlight, the sister sat down to make ma'o leis for themselves. When the leis were made they went across the breadth of Kaupe'a to Waipio [*Ka Loea Kālai'āina*, July 22, 1899:15; translation in Sterling and Summers 1978:7].

They stopped at the stream of Ka'aimalu on the way to their home, and the sister convinced her brother to share the fish between the two, thus breaking the *kapu*. "Because these children ate fish secretly, the spot is called Ka'ai-malu (Secret eating) to this day" (Sterling and Summers 1978:7). This legend also shows the relation of several landmarks on the coastal plain, as the children travel from the coast at Kualaka'i, across the plain of Kaupe'a to Waipi'o, passing next to Pu'uokapolei .

3.4.8.3 Pu'uloa and the Breadfruit

Pu'uloa was noted as one of the first places to have breadfruit. It was brought to the islands by Kaha'i, son of Ho'okamali'i and grandson of Moikehā, who brought the plant from Upolu (central Polynesia) to Hawai'i and planted it at Pu'uloa (Beckwith 1940:97).

Two other versions can be found in Fornander. In the first, the location of the first planting is in Pu'uloa, but does not mention Kaha'i (Fornander 1919, Vol. V, Part 3:678):

> At Puuloa, Oahu. Its breadfruit plant came from Kanehunaamoku [a mythical land supposed to have been hidden by the god Kāne], brought by two men at Puuloa who were out fishing and were blown off by a heavy wind and rainstorm and landed at the uninhabited land, save gods only. Therefore by them it was introduced at Puuloa and planted in a large excavation where it grew and bore fruit, which they ate.
>
> *Ma Puuloa i Oahu. Ko laila ulu no Kanehunamoku mai, na kekahi mau kanaka o Puuloa i hele i ka lawaia a puhia e ka ino nui, makani a me ka ua, a pae i keia aina kanaka ole, he akua wale no; nolaila mai ka laua lawe ana mai i keia ulu a hiki i Puuloa, kanu a ulu i kekahi lua niu a hua, ai keia mau kanaka.*

[Fornander 1919, Vol. V, Part 3:678-679].

A second version associates the breadfruit tree in 'Ewa to the chief Namaka-o-ka-paoo, the Hawaiian born son of Ka-ulu-o-kaha'i, which means "Breadfruit of Kaha'i." Kauluokaha'i had left O'ahu to return to his ancestral lands of Kahiki (Hawaiian ancestral land). Once Namakaokapa'o had conquered the island of O'ahu, he wanted to travel to Hawai'i in secret to spy on the land.

> . . . He [Namakaokapaoo] then went and got a small gourd wherein to place his garments which his father had left him. This gourd was deposited at Kualakai, where a breadfruit tree is standing to this day. This is the breadfruit impersonation of his father, Kahaiulu. When the real person went home the breadfruit tree remained, being in the supernatural state.
>
> *. . Alaila, kii aku la ia he wahi hokeo waiho kapa nona, na kona makuakane i waiho nona. O kahi i waiho ai ua wahi hokeo la, makai o Kualakai, oia kela ulu e ku nei a hiki i keia la ma Kualakai. Oia ke kino ulu o kona makuakane o Kahaiulu. Hoi ke kino maoli, koe ke kino ulu, ma ke ano akua keia kino* [Fornander 1919, Vol. V, Part 2:279-280].

Section 4 Historic Background

4.1 Pre-Contact and Early Post-Contact Period

By ca. A.D. 1320, 'Ewa, along with Kona, and Ko'olaupoko were the dominant polities, ruled by the sons of a chief named Māweke (Cordy 2002:21). 'Ewa at this time included the traditional districts of 'Ewa, Wai'anae, and Waialua (Fornander 1880:48). Around A.D. 1400, the entire island was ruled by King La'akona; chiefs within his line, the Māweke-Kumuhonua line, reigned until about A.D. 1520-1540, with their major royal center in Līhu'e, in 'Ewa. (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line; he was slain by his men at the fortress of Waewae near Līhu'e (Kamakau 1991a:54-54; Fornander 1880:88). Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūali'i achieved control of all of O'ahu by defeating the Kona chiefs, then the 'Ewa chiefs, and then expanding his control on windward Kaua'i. Peleiholani, the heir of Kūali'i, gained control of O'ahu ca. 1740, and later conquered parts of Moloka'i. He was ruler of O'ahu until his death in ca. 1778 when Kahahana, of the 'Ewa line of chiefs was selected as the ruler of O'ahu (Cordy 2002:24-41).

After Kamehameha's O'ahu victory, he gave the *ahupua'a* of Honouliuli to Kalanimōkū as part of the *panalā'au*, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kame'eleihiwa 1992:58, 112). Kalanimōkū subsequently gave the *ahupua'a* to his sister, Wahinepi'o.

Various Hawaiian legends and early historical accounts indicate that the *ahupua'a* (land division) of Honouliuli was once widely inhabited by pre-contact populations, including the Hawaiian *ali'i* (chiefly class). This would be attributable for the most part to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the *ahupua'a* include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy report:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko'olau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the 'awa for which the area was famous. [1972:429]

In addition, breadfruit, coconuts, *wauke*, bananas, and *olona* and other plants were grown in the interior. 'Ewa was known as one of the best areas to grow gourds and was famous for its *mamaki*. It was also famous for a rare taro called the *kai o 'Ewa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

He has eaten the Kāī-koi taro of 'Ewa. *Ua 'ai i ke kāī-koi o 'Ewa.*

> Kāī is O'ahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of 'Ewa, who, like the Kāī taro, is not easily forgotten [Pukui 1983:#2770].

The lochs of Pearl Harbor were ideal for the construction fishponds and fishtraps. Forest resources along the slopes of the Wai'anae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469-470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP site 50-80-12-4322) is present in Maka'īwa Gulch at 152 m (500 ft) above mean sea level (Hammatt, Robins, et al. 1990).

John Papa 'Ī'ī describes a network of Leeward O'ahu trails (Figure 6), which in historic times encircled and crossed the Wai'anae Range, allowing passage from Lualualei to Honouliuli by three different trails ('Ī'ī 1959:96-98). The coastal trail skirted Pearl Harbor, passing by Pu'uokapolei ; this would have been the nearest of three Honouliuli trails to the current Project Area. Following 'Ī'ī's description, a portion of this trail network, would have passed close to the existing Farrington Highway, near the northern border of the Project Area, as seen in an 1825 map

The trail is described by 'Ī'ī as:

> The trail went down to the stream and up again, then went above the taro patches of Waiau, up to a *makai* field, to Waimano, to Manana, and to Waiawa; then to the stream of Kukehi and up to two other *maika* fields, Pueohulunui and Haupuu. At Pueohulunui was the place where a trail branched off to go Waialua and down to Honouliuli and on to Waianae. As mentioned before, there were three trails to Waianae, one by way of Pu'u o Kapolei, another by way of Pohakea, and the third by way of Kolekole ['Ī'ī 1959:97].

Early historical accounts of the general region typically refer to the more populated areas of the 'Ewa district, where missions and schools were established and subsistence resources were perceived to be greater. However, the presence of archaeological sites along the barren coral plains and coast of southwest Honouliuli Ahupua'a, indicate that prehistoric and early historic populations also adapted to less inviting areas, despite the environmental hardships.

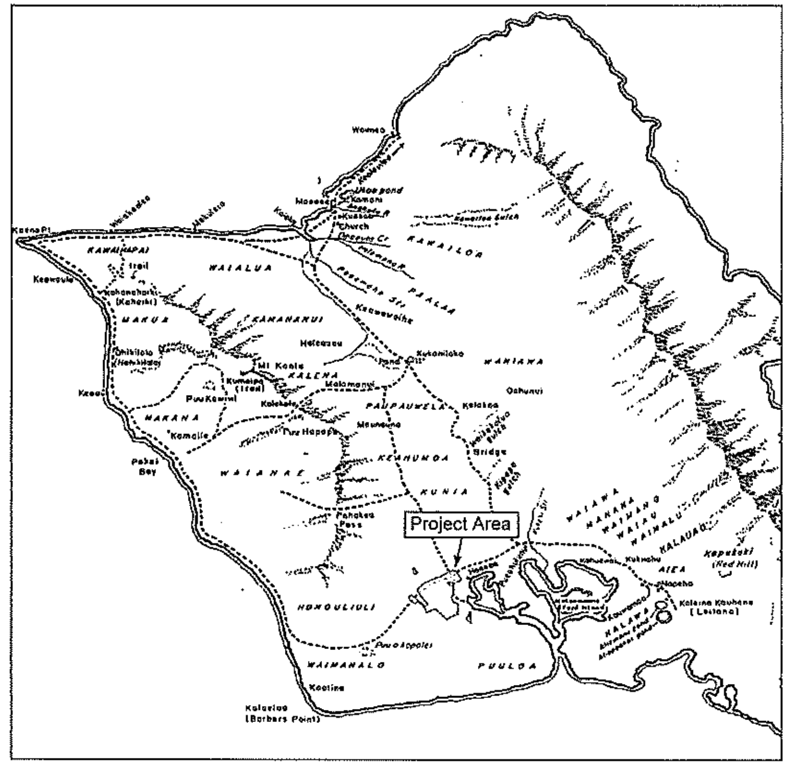

Figure 6. Trails of Leeward Oahu. Map by Paul Rockwood. ('Ī'ī 1959:96) Mid- to late-1800s

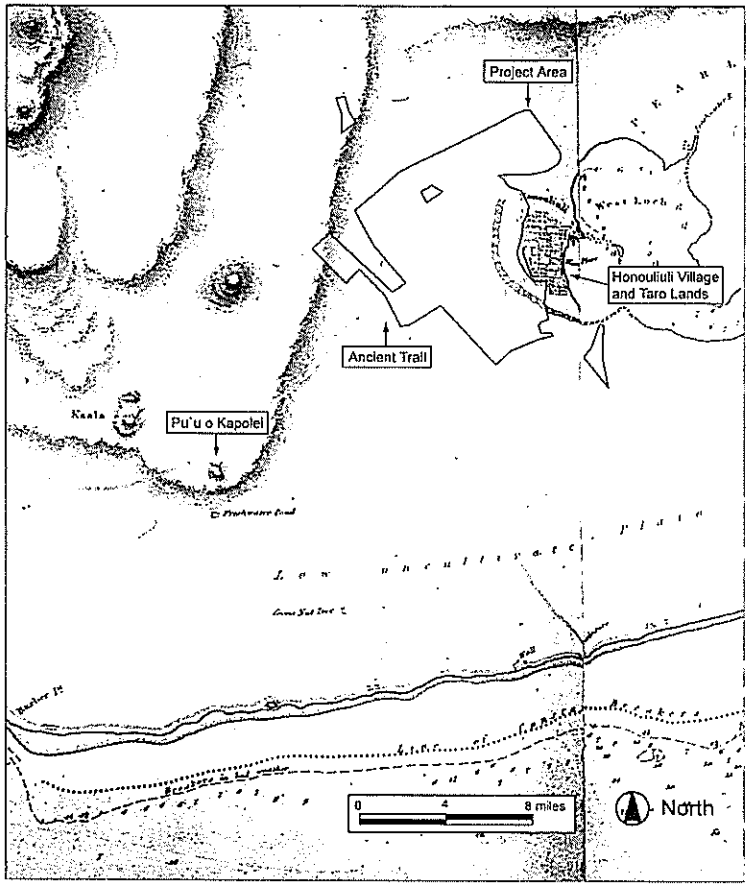

Figure 7. Portion of 1825 Map of the South Coast of Woahoo (O'ahu) and Honolulu by Lieut. C.R. Malden from the British ship the *Blonde* showing Honouliuli, the ancient trail, Pu'uokapolei, and the Project Area

4.1.1 Observations of Early Explorers and Foreign Residents

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka'i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it. . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen's huts [Vancouver 1798, Vol. I:167].
>
> . . .from the commencement of the high land to the westward of Opooroah [Pu'uloa], was composed of one very barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island . . .[Vancouver 1798, Vol. II:217].
>
> . . .This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced . . . [Vancouver 1798, Vol. III:361-363].

Archibald Campbell, an English seamen who was given some land in Waimano Ahupua'a by King Kamehameha in 1809, described his land around Pearl Harbor:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. . . .We passed by footpaths, winding through an extensive and fertile plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for the taro beds. Where there was not water, the land was under crops of yams and sweet potatoes [Campbell 1967:103-104].
>
> Pearl and mother of-pearl shells are found here in considerable quantity. Since the king has learned of their value, he has kept the fishing to himself, and employs divers for the purpose [Campbell 1967:114-115].

Subsequent to western contact in the area, the landscape of the 'Ewa plains and Wai'anae slopes was adversely affected by the removal of the sandalwood forest, and the introduction of domesticated animals and new vegetation species. Domesticated animals, including goats, sheep and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. It is unclear when the domesticated animals were brought to O'ahu; however, L.A. Henke reports the existence of a longhorn cattle ranch in Wai'anae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. Within the current Project Area, the majority of the vegetation is comprised of introduced species, mainly grasses.

At contact, the most populous *ahupua'a* on the island was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the

population as 1,026. Within four years the population was down to 870 (Schmitt 1973:19, 22). In 1835, there were eight to ten deaths for every birth (Kelly 1991:157-158). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of 'Ewa and Wai'anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of 'Ewa was probably abandoned by the mid-nineteenth, due to population decline and consolidation of the remaining people in the town of Honouliuli (at Papapuhi Point, east of the Project Area). A detailed discussion of the historic population counts in the 'Ewa District has been presented by Charvet-Pond and Davis (1992).

The first mission station in 'Ewa was established in 1834 at Kalua'aha near Pearl Harbor. Charles Wilkes, of the U.S. Exploring Expedition visited the missionary enclave at Honouliuli town in 1840.

> At Ewa, Mr Bishop has a large congregation. The village comprises about fifty houses, and the country around is dotted with them. . . . The natives have made some advance in the arts of civilized life; there is a sugar-mill which, in the season, makes two hundred pounds of sugar a day. . . . In 1840, the church contained nine hundred members, seven hundred and sixty of whom belonged to Ewa, the remainder to Waianae; but the Catholics have now established themselves at both these places, and it is understood are drawing off many from their attendance on Mr. Bishop's church [Wilkes 1970:80-81].

The earliest detailed map of the area (Alexander 1873 Figure 8) shows no habitation closer than the western edge of West Loch in the vicinity of Pāpapuhi Point. A Monsarrat survey map of 1878 documents substantial settlement at the "Honouliuli Taro Land" in the Pāpapuhi Point area, and it seems clear that in early historic times, this was the focus of the population of Honouliuli. The amenities of the area - including fishponds, taro *lo'i*, abundant shellfish, and salt pans - would have focused population there in pre-Contact times as well.

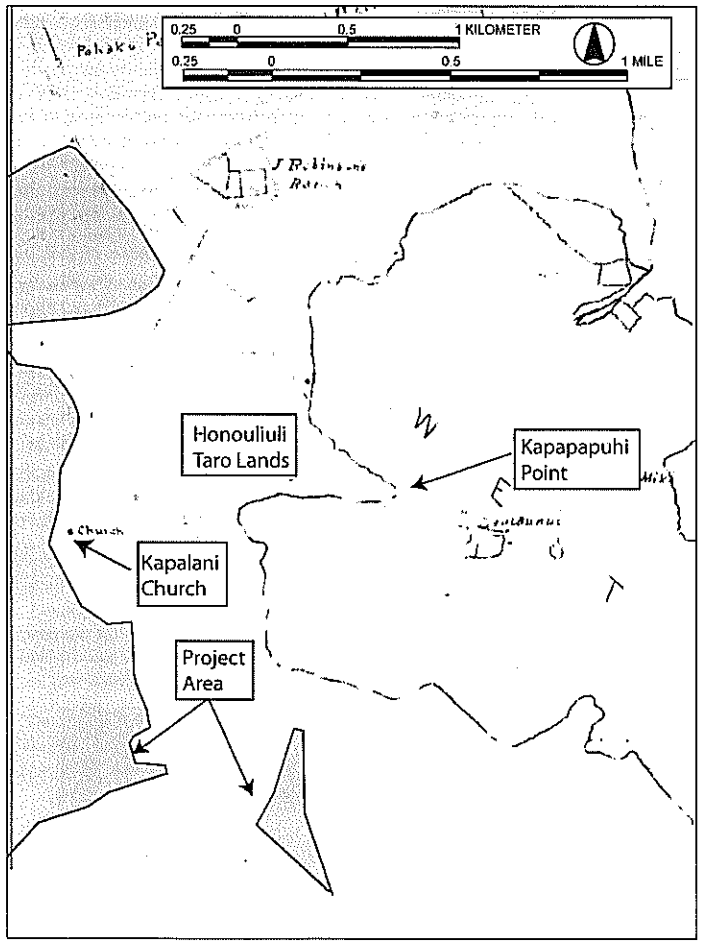

Figure 8. Portion of 1873 W.D. Alexander map of Honouliuli, showing location of Papapuhi Point (habitation symbols are illegible); also note location of Kapalani Catholic Church

4.2 Mid-Nineteenth Century and the Māhele

The Organic Acts of 1845 and 1846 initiated the process of the *māhele* - the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848 the crown and the *ali'i* (chiefly class) received their land titles. The common people received their *kuleana* (individual parcels) in 1850.

During the *Māhele* of 1848, 72 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III (Tuggle and Tomonari-Tuggle 1997:34). The 72 *kuleana* awards were almost all made adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields. Kepa Maly (1997: 38-42) provides a table recording information on each award, including awardee, *'ili*, and land use of the *'āpana* (lot). A summary of the information on houses, fields, and boundary landmarks noted for each *'ili* is given below in Table 1 and *'ili* locations are shown on Figure 9.

4.2.1 Project Area Māhele Awards

A comparison of Project Area maps with an 1878 map surveyed by M.D. Monsarrat (Figure 10) clearly show that all or portions of certain land claims belonging to Kelia (LCA 763), Pue (LCA 869), Leleiupa (LCA 1699) and Kua (LCA 5653) lie within the Project Area. These LCAs were once located on the east side of the main road along Honouliuli town, but now portions lay west of the current alignment of Old Fort Weaver Road. A brief review of the four known LCAs within the Project Area follows (see Figure 10):

Kelia'a *'Āpana* (*'Āp.*) 1 (LCA 763)

Kelia's claimed this land situated in the *'ili* of Poohilo and Uani for his houses. His witnesses agreed with his claim, but there was a dispute over whether there were 3 or 4 houses within the parcel. All agreed Kelia has one house there and that his father, Pueeu had two. The west or Wai'anae boundary was described variously as the "*pali* of Makaaku," "a ravine" or "a cliff." The claimant received his house lot from his father Pueeu and "has accepted it ever since 1836."

Pue *'Āpana* 1 and *'Āpana* 2 (LCA 869)

Pue claimed four parcels in the *'ili* of Maui at Honouliuli, 'Ewa. One parcel was a houselot and had two houses on it, one for himself and one for Puali who was his father-in-law. The western side was bounded by the land of Koi, the *luna* (overseer), who gave Pue's family their land in 1842. The other parcel within the Project Area was *kula*, pasture land to the east of the houselot.

Leleiupa *'Āpana* 1 and *'Āpana* 2 (LCA 1699)

Leleiupa 'Āpana 1 and 2 were claims for two parcels situated in the *'ili* of Maui. 'Āpana 1 was bordered on the west by the land of Koi.

Kua (LCA 5623)

Kua claimed two taro patches and a *kula* land called Kahui in the *'ili* of Maui. Of note was the sworn testimony of Maakuia on the Land Court Application for Mahina (LCA 749), which stated that the western boundary of Mahina's land was [Kaulaula] Pali, which had a wall on its top.

Table 1. Summary of land use and boundary landmarks recorded in Honouliuli LCA awards

'Ili	Land Use and Boundary Landmarks
Hiwalalo	kou trees
Ka'aumakua	houselots, *kalo* (taro) patches; *kula* (pasture/dryland agriculture), two fishponds called Mokumeha; landmarks - *kula ālialia* (salt plains), land division wall, Pānāhāhā *loko* (fishpond), Kalahu fishpond, Naholowaa pond, Honouliuli Stream (called stream of Makai'i), or *'aka'akai* (bulrush growth) of Kamo'okahi
Kaihuopala'ai	*mo'i* (arable land in a long strip); on lot bounded by *'auwai* (irrigation ditch) called Panaenui
Ka'ilikahi	houselot and *kalo* patches; landmarks – highway, Kauhipuna cliff, *lapalapa* (*panax*) thickets,meeting house
Kamilomilo	houselot and *kalo* patches
Kamoku	fenced *mo'o kalo*, *lo'i* (irrigated fields) *kalo*, houselot; landmarks – Kauhipuna pali
Kamo'okahi	bulrushes
Kapāpahi	houselots, *kalo* patches; bounded by ponds of Healani
Kapapapūhi	houselots, vineyard, *kula*, pond, trails, hog pens, and salt beds; a church and cemetery are shown on Figure 10 but not mentioned in testimony; therefore it was probably built in the post-Māhele period
Ka'ula'ula	*mo'o* next to Kaulaula (cliff) with a houselot and a wall
Loloulu	*kalo* patches, 1/3 of a fishpond (in land of Kahakuli'ili'i), hala grove, pig pens, breadfruit, bulrushes
Maka'u	houselot and *kalo* patches
Maui	kalo patches, *kula*, houselots, bounded by *pā'āina a ke Aupini* (land division wall of the government)
Mokumeha	2 fishponds, salt beds (western one called Kohumakahou)
Niuke'e	*kalo* patches, *kula*, potato field, houselots; landmarks - *loko kalo* (taro/ fishpond) of Nihola, Loko'eli pond, Kehewanakawalu pond, Kalokoiki pond, *pali* of Kihewamakawela; Ka'akau pali; Ka'akau community, meeting house, prison plot, cattle fences
Polapola	*kalo* patches; houselots, school house, prison plot; some bounded by *pā'āina a ke Aupini*, or high road from the sea, or Catholic Chapel yard
Pō'ohilo	*kula*, *kalo* patches, *loko kalo*, houselots; landmarks - *pā'āina*, Ka'aimanō fishpond, *kula* of Kahakai, *loko kalo* of Kalokoloa, Aimea Pond, Waianu pond, Kahui pond, Ka'aimano fishpond, *pupulu* cave (wet cave?), prison plot, Makaakua pali, Puehuehu Stream, Puehuehu road
Pua'alu'u	*lo'i*, houselot
Pu'uloa	houselots; boundaries include the sea, a *kula* called Waioipu, and the plain of Kaluanohu

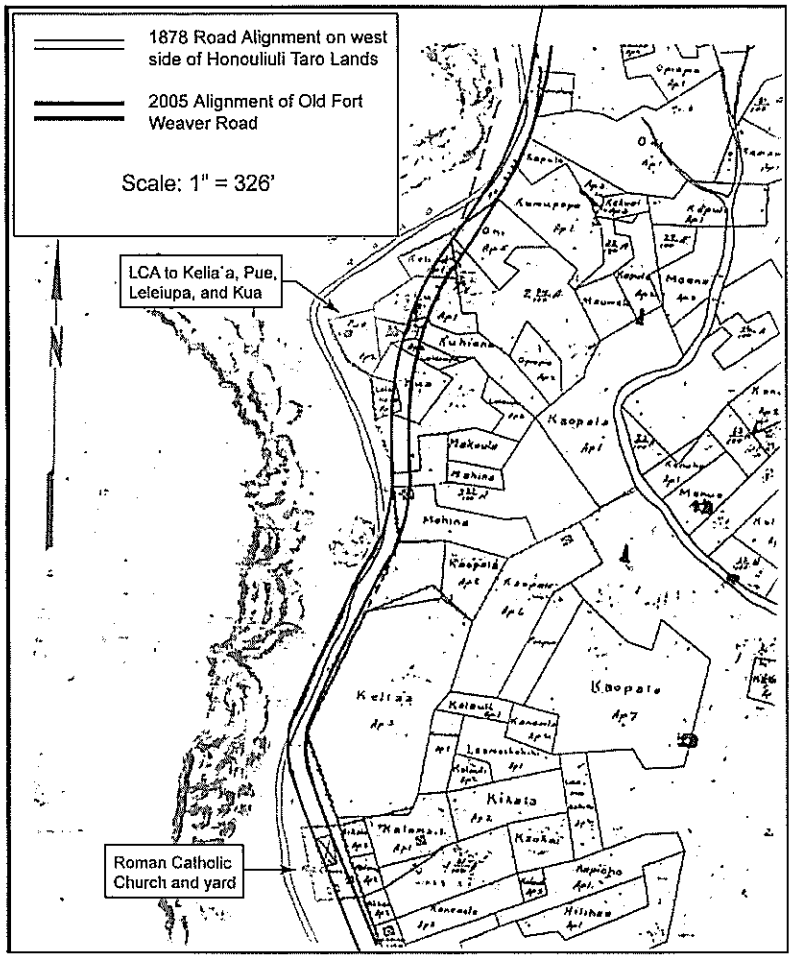

Figure 9. Portion of 1878 Monsarrat map, showing portion of Honouliuli Taro Lands in Relation to current alignment of Old Fort Weaver Road (eastern boundary of the Project Area)

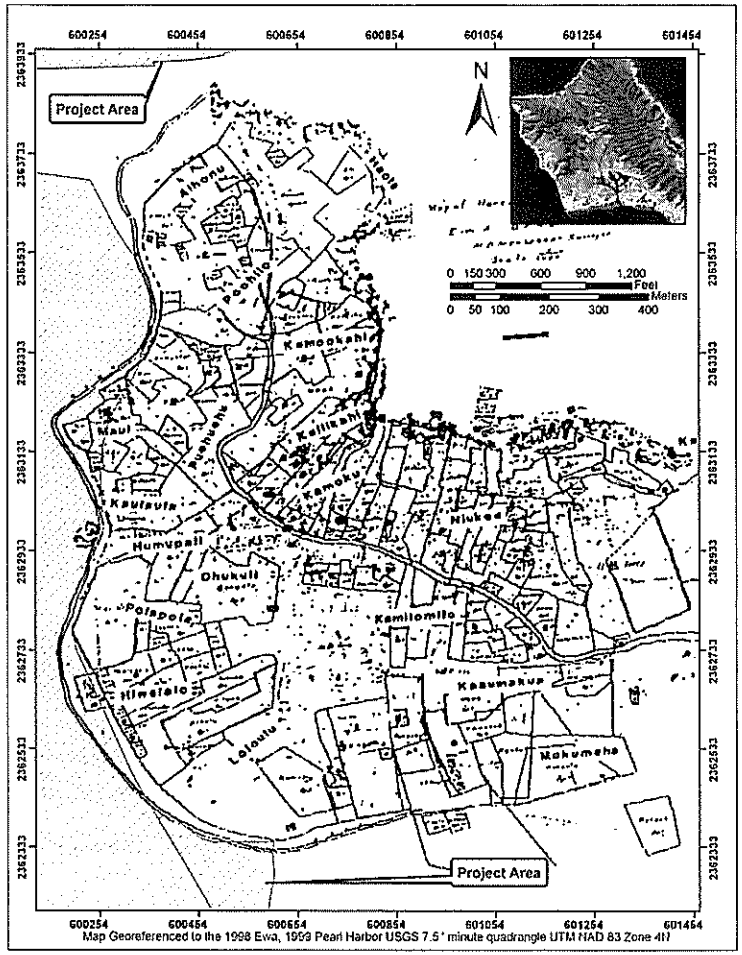

Figure 10. 1878 Map of Honouliuli Taro Lands (LCAs) by M.D. Monsarrat, with inserted '*ili* names

4.2.2 The Catholic Church

A portion of the former site of a Catholic church, called Kapalani Catholic Church, also now lies on the west side of the current road alignment, although the church itself was probably covered by the new road itself. This church and associated school house is believed to have been the site of the ministry of a particularly notable person, Kepelino Keauokalani.

There are two land applications that make reference to a Catholic Church near the town of Honouliuli. Kaohai in April of 1850 (LCA 5670B) claimed a house site in the '*ili* of Polapola "adjoining the Catholic Chapel yard." Hilinae (LCA 1720) in November of 1847 made a houselot claim in the '*ili* of Polapola bounded on the west by the Kapalani Church. Little is known about the Kapalani Roman Catholic Church. It is clearly annotated on Monsarrat's 1878 map (see) and is the lone "church" pictured on an 1873 and 1881 map of the Honouliuli district by Alexander (Figure 11). Even the name is uncertain, as Kapalani probably means "the Frenchmen's" church. Efforts to found a Catholic Mission in Hawai'i were initially met with hostility until the issuing of an edict of toleration in 1839. The establishment of the Catholic Mission in Hawai'i in May of 1849 initiated an active period of building churches and schools. The Kapalani church (and school house) cited in the Land Court Application of Hilinae in November of 1847 must have been constructed within the previous seven years. Father Raymond Delande was pastor of the Leeward District of the church from 1857-1885 and, operating out of Honouliuli, he covered an area extending as far as Makaha and Waialua. "Up to 1877, he had baptized 600 children and adults, all living along the SW coast of Oahu" (Schoofs 1978:110).

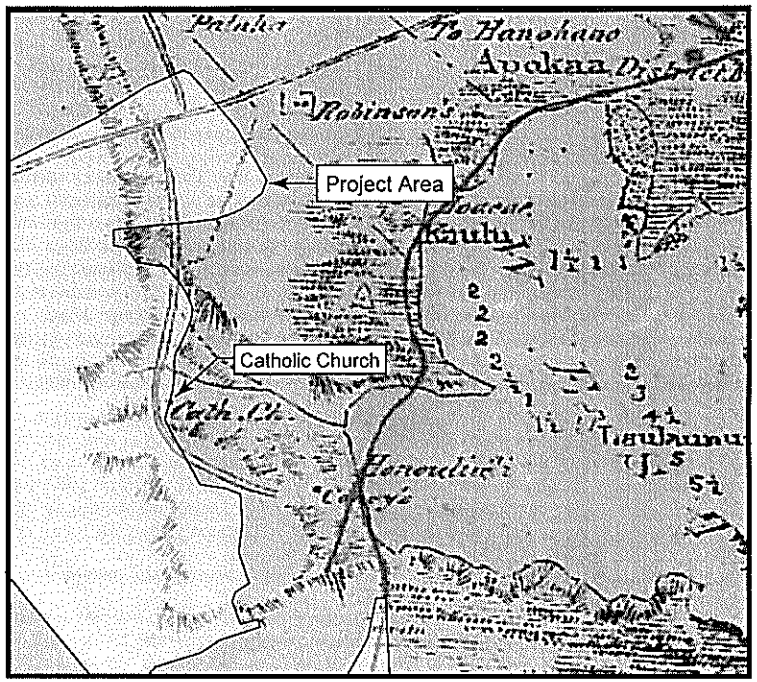

Figure 11. Portion of 1881 Hawai'i Government Survey Map (Alexander) showing location of the Catholic Church

Of particular interest is the association with this church of Kahoali'ikumaieiwakamoku Kepelino (Zepherino) Keauokalani, whose name means "to-be-the-chief-of-the-nine-districts" (Beckwith 1978:4). His father was Namiki, of the lineage of the high priest Pa'ao and his mother, Kahiwa Kaneikopulei, was a daughter of Kamehameha I. They had two children, the son Kepelino, and a daughter named Puahau. Namiki was the "old savage" whose narratives were collected by Jules Remy as "Contributions of a Venerable Savage to the Ancient History of the Hawaiian Islands" during his travels in the islands between 1851 and 1855. In a note on a section concerning the priest Pā'ao, the author talks about Namiki's son, who he met in 1853.

> The old historian Namiki, an intelligent man, and well versed in the secrets of Hawaiian antiquity, has left precious unedited documents, which have fallen into our hands. His son, Kuikauai, a school-master at Kailua, one of the true historico-sacerdotal race, has given us a genealogy of his ancestors which ascends without break to Paao [Remy 1857, in Nordhoff 1974:253].

The family was of Kailua, Kona, Hawai'i and converted to Catholicism very quickly after the arrival of Fathers Walsh and Ernest Herutel of the Catholic Mission to Kona in 1840. His parents sent him to Catholic school in Honolulu in 1845 to become a teacher. Father Ernest writes:

> Father Martial writes me about our little Zepherin, telling me that he has been received as teacher but that because they have no school to give him as yet, he has not received his diploma. Father Desire wants to keep him to send to the High School; but when will you have a High School? Perhaps not so soon. I think therefore that Zepherin would be more usful here as we lack teachers [cited in Beckwith 1978:4].

As noted above, Remy claims that at some point, Kepelino was a school teacher in Kailua; although Remy is believed to have met Kepelino in 1853, his teaching position at Kailua could have dated to an earlier period, possibly around 1845, when Father Ernst suggested that he return to the island of Hawai'i from Honolulu. At some point he attended the Catholic High School at Ahuimanu (established in 1846), where he is said "to have acquired English, French, Latin, and Greek" (Beckwith 1978:5). In 1847, at the age of 17, he was sent briefly with Father Ernest to Tahiti to help establish a Catholic mission. He developed a reputation for his pranks and was sent back to his partents (Beckwith 1978:5).

Controversial letters under the name of Z. Kahoali'i, addressed from the town of Honouliuli on O'ahu, were published in Catholic newspapers from 1860-1869. A letter in the Public Instruction Correspondence filed and dated 11/26/1851, written by a school teacher name Naheona to the Minister of Public Education, state his reasons for the rejection of a teacher "Kepilina" and accuses Kepilina of "dancing and thieving while employed as teacher of Honouliuli School and of general improper conduct." The letter also mentions "Catholic priests in the area who have been among the people for a while who do not recommend retaining Kepilina" (In Silva 1987:A8). It seems quite probable that Kepelino lived at Honouliuli from 1851 into the 1870s and that as a devout Catholic and teacher that he taught at the school house next to Kapalani Church.

Detailed biographic information on Kepelino is not readily available, which is probably due in part to the fact that he was "controversial" for the Catholics and for the government. He went on

to become Queen Emma's secretary (by at least 1874) and was one of the most important documenters about Hawaiian beliefs and traditions. He supported Queen Emma as the heir of King Lunalilo over David Kalākaua, and wrote letters to the king of Italy and the queen of England, asking for warships to support Queen Emma's cause. In 1874, the newly elected King Kālakaua had him tried for high treason and sentenced him to hanging, but the sentence was commuted and he was released from prison in 1876; he died in 1878 (Day 1984:77).

"The Honouliuli church . . . had by the 1880s outlived its usefulness and become dilapidated. It was therefore abandoned and replaced by a simple structure close, too close to the mill" [at 'Ewa Village, south of the Project Area] (Schoofs 1978:111). However, "in 1891 Honouliuli was still important enough to acquire its own Catholic cemetery" (Schoofs 1978:110). Whether this cemetery or any other Catholic cemetery was on the grounds of the Kapalani Church in unknown. In the late 1920s, Bishop Alencastre exchanged land at Honouliuli with Campbell Estate for land at 'Ewa Village to establish a new church.

4.2.3 Honouliuli Māhele Awards to *Ali'i*

In 1855, the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke'ahikuni Kekau'ōnohi (Royal Patent #6971 in 1877; Parcel #1069 in the Land Court office), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O'ahu (Indices of Awards 1929; Kame'eleihiwa 1992). Kekau'ōnohi was also awarded the *ahupua'a* of Pu'uloa, but she sold this land in 1849 to Isaac Montgomery, a British lawyer.

Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahalai'a, who was governor of Kaua'i (Hammatt and Shideler 1990:19-20:20). Subsequently, Kekau'ōnohi ran away with Queen Ka'ahumanu's stepson, Keli'iahonui, and then became the wife of Chief Levi Ha'alelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. A lawsuit (Civil Court Case No. 348) was brought by Ha'alelea in 1858, to reclaim the fishing rights of the Pu'uloa fisheries from Isaac Montgomery, and the court ruled in Ha'alaea's favor. In 1863, the owners of the *kuleana* lands deeded their lands back to Ha'alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha'alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney (Yoklavich et al 1995:16).

4.2.4 Early Ranching on the 'Ewa Plain

John Coney rented the land to James Dowsett and John Meek in 1871, who used the land for cattle grazing. In 1877, the land, except for the *'ili* of Pu'uloa, was sold to James Campbell for $95,000. He drove off 32,237 head of stock belonging to Dowsett and Meek and to James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12) (Figure 12). He let the land rest for one year and then began to restock the ranch, so that he had a head of 5,500 head after a few years (Dillingham 1885, cited in Frierson 1972:14). A 1880s photograph of James Campbell's residence in Honouliuli shows the open, sparsely vegetated plain of 'Ewa, likely an effect of the years of cattle grazing across the plain.

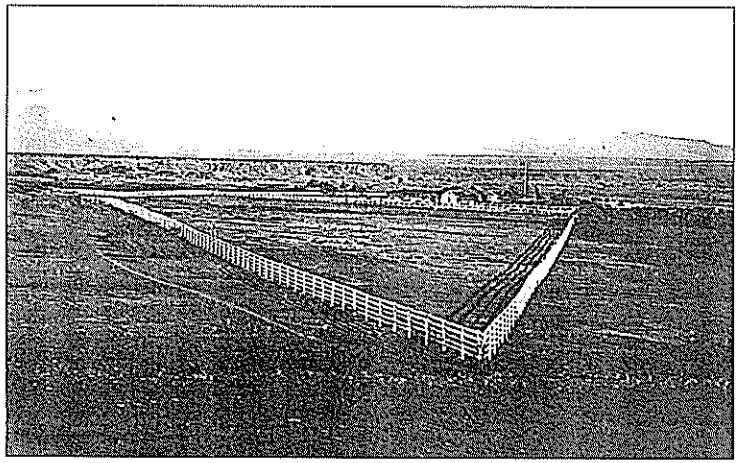

Figure 12. 1880s photograph of James Campbell's residence on the 'Ewa Plain (Bishop Museum Archives)

In 1880-81, the Honouliuli ranch was described as:

> . . . Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. . . . There are valuable fisheries attached to this estate . . . . [Bowser 1880:489].
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. . . . Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts [Bowser 1880:495].

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Co. 1923:6-7). In 1879, Campbell brought in a well-driller from California to search the 'Ewa plains for water, and the well, drilled to a depth of 240 feet near Campbell's home in 'Ewa, resulted in ". . . a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d., cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource. A Hawai'i Visitor Bureau,

marker, located in the southwestern portion of the Project Area, bears the inscription "Site of First Artesian Well in the Hawaiian Islands drilled by James Ashley for James Campbell owner of Honouliuli Ranch brought in on Sept. 22, 1879." Kuykendall (1967:III, 67) states that this well was "near Campbell's ranch house" but Campbell's ranch house, which is shown on Monsarrat's 1878 map, was located outside the Project Area.

4.3 History of the Ewa Sugar Plantation

4.3.1 General History of the Plantation

In 1886, Campbell and B. F. Dillingham put together the "Great Land Colonization Scheme," which was an attempt to sell Honouliuli land to homesteaders (Thrum 1886:74). This homestead idea failed, but with the water problem solved by the drilling of artesian wells, Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Wai'anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:100). This railroad line eventually ran across the center of the 'Ewa Plain at the lower boundary of the sugar fields.

To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly-formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company (Figure 13). Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch - established by Dillingham was - the "fattening" area for the other ranches (Frierson 1972:15).

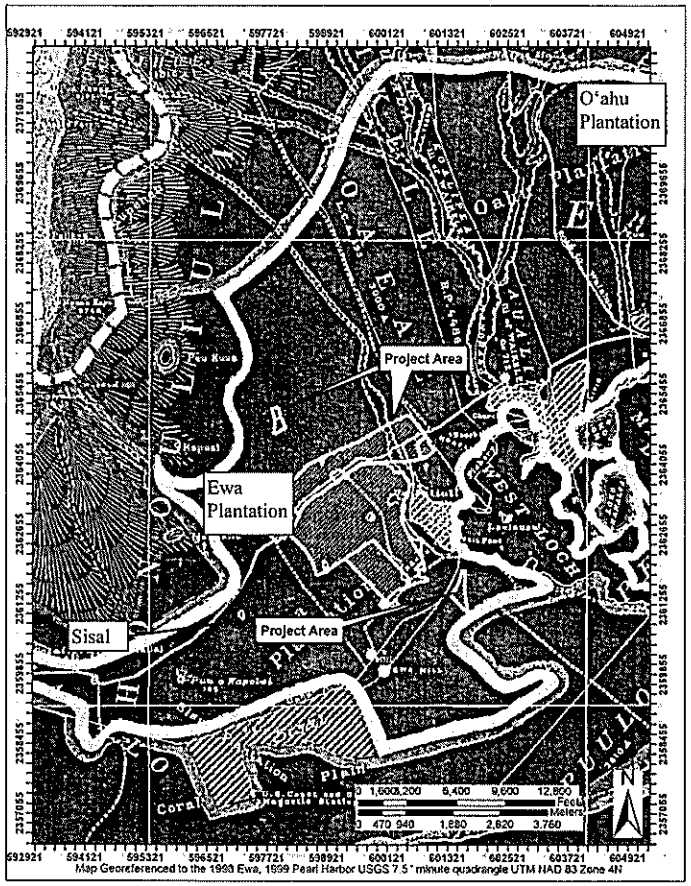

Figure 13. 1902 map showing relationship of Ewa Plantation and the Oahu Sugar Co. plantation; also note location of sisal growing area

4.3.2 History of the Ewa Sugar Plantation

Ewa Plantation Company (Figure 14) was incorporated in 1890 for sugar cane cultivation. The first crop, 2,849 tons of sugar, was harvested in 1892 at the Ewa Plantation. 'Ewa was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967:69). As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964). By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific,* Dec. 1902:19-22, cited in Kelly 1985:171).

Just north of 'Ewa Plantation was the equally sprawling O'ahu Sugar Company which "covered some 20 square miles . . . ranging in elevation from 10 feet at the Waipio Peninsula . . . to 700 feet at the Waiahole Ditch" (Condé and Best 1973:313). The Oahu Sugar Company was incorporated in 1897. Prior to commercial sugar cultivation, the lands occupied by the Oahu Sugar Company were described as being "of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project" (Condé and Best 1973:313). The Oahu Sugar Company took control of the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugar cane production in the combined plantation area (Dorrance and Morgan 2000:45, 50).

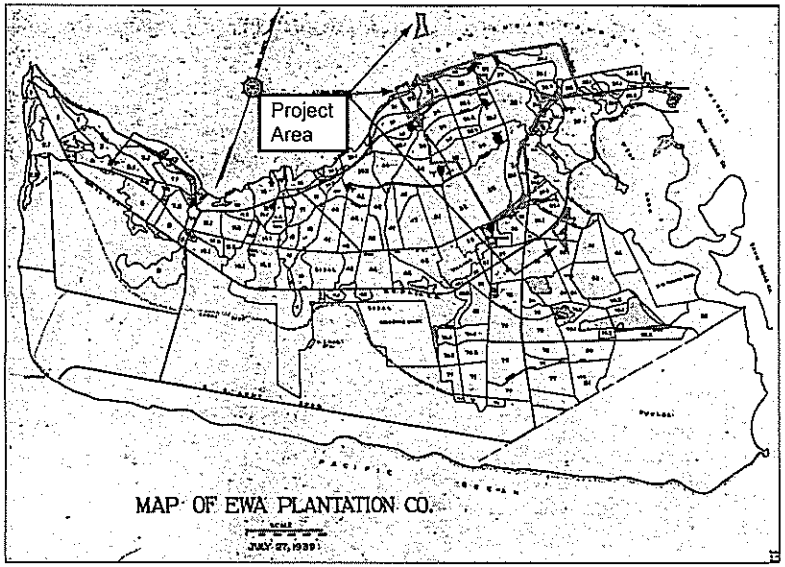

Figure 14. 1939 map of the Ewa Plantation Co. lands, showing Project Area and alignment of railroad.

During the subsequent decades of the twentieth century, sugar cane operations in 'Ewa phased out and, more recently, former cane lands have been rezoned for residential development. Structures in the area of the former plantation villages have fallen into disrepair or have been demolished. However, portions of the area - including Varona Village, Tenney Village, and Renton Village - have been designated the 'Ewa Villages Historic District (State site 50-80-12-9786), which has been nominated for National Historic Landmark status. Additionally, the still-existing O.R.&L. rail line through Honouliuli has been placed on the National Register of Historic Places (Site 50-80-12-9714).

4.3.3 History of PipeLine Village

During the twentieth century, the Ewa Plantation would continue to grow and, by the 1930s, would encompass much of the eastern half of Honouliuli Ahupua'a. This growth compelled the creation of plantation villages to house the growing immigrant labor force working the fields. In the decade of the 1890s, the plantation built 72 houses, cottages or dwellings; in the first decade of this century, 536; in the second decade, 132; in the 1920s, 285; in the 1930s, 168; and, in the 1940s, only 35. Censuses of the Ewa Plantation population record 4,967 persons in 1928, 4,477 in 1929, and 4,100 in 1932. After the outbreak of World War II, which siphoned off much of the

plantation's manpower, along with the changeover to almost complete reliance on mechanical harvesting in 1938, there was little need for the large multi-racial (Japanese, Chinese, Okinawan, Korean, Portuguese, Spanish, Hawaiian, Filipino, European) labor force that had characterized most of the early history of the plantation.

It is also important to note that in the history of construction, buildings were moved, demolished, and replaced all the time. As early as 1899, the plantation moved "the lower camp of thirty houses [believed to be duplexes built in 1890] to a position on the bluffs nearby . . . principally for sanitary reasons" (Ewa Plantation Company Annual Report for 1890).

The original location of these thirty houses is unknown. They probably were not in the area later known as "Lower Camp" and may have been in the Honouliuli Taro lands. It is also unknown where they moved to "on the bluffs," but it seems probable that they were moved to what became the west central portion of PipeLine Village near the present water pumping station in that vicinity. A 1908/1913 U.S. Army Fire Control map shows 47 houses in the area of Pipeline Village (Figure 15)

PipeLine Village was a major plantation community that lay in the central southern portion of the present Project Area and is shown in detail in a 1928 USGS map (Figure 16), which documents the location of about 160 houses, a church and a school. This was probably the great extent of PipeLine Village. An entry in the 1931 Annual Report of Ewa Plantation Company records that "The PipeLine Village of 162 cottages built in 1906" was dismantled and that "other cottages near [near the factory, south of the Project Area] were erected using the reclaimed lumber from the PipeLine Villages". Photos (Bishop Museum Visual Collection) (Figure 17) dated 1906 show what appear to be brand new single family residences at PipeLine Village, but the Annual Report for 1906 documents the construction of only 47 houses and many of there were probably not built in PipeLine Village. Some photos dated 1907 (Figure 18) show houses at PipeLine village with very well established gardens and tall banana, papaya, and many mango trees, suggesting that they are significantly older. Another photo dated January 1910 (Figure 19) shows a line of ten new cottages with the caption "Pipe Line Village (Family houses built during 1909)." One hundred and twenty-nine cottages were built for married laborers in that year and they well include the majority of the houses at PipeLine Village.

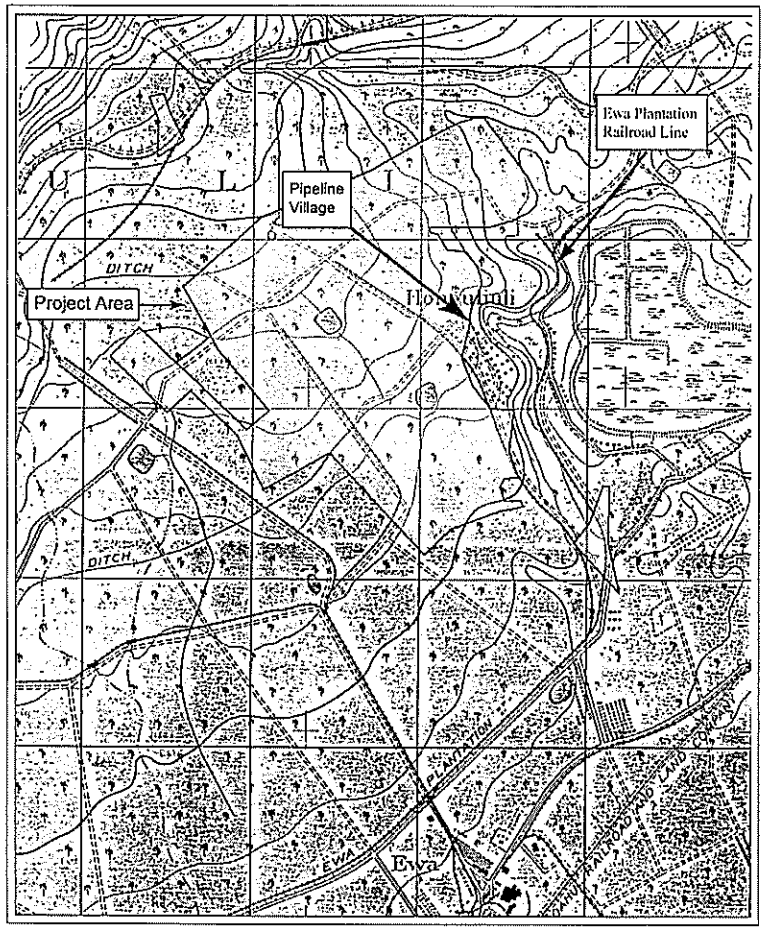

Figure 15. Portion of an 1908/1913 U.S. Army Fire Control map, showing 47 houses in Pipeline Village; map also shows the alignment for the Ewa Plantation railway

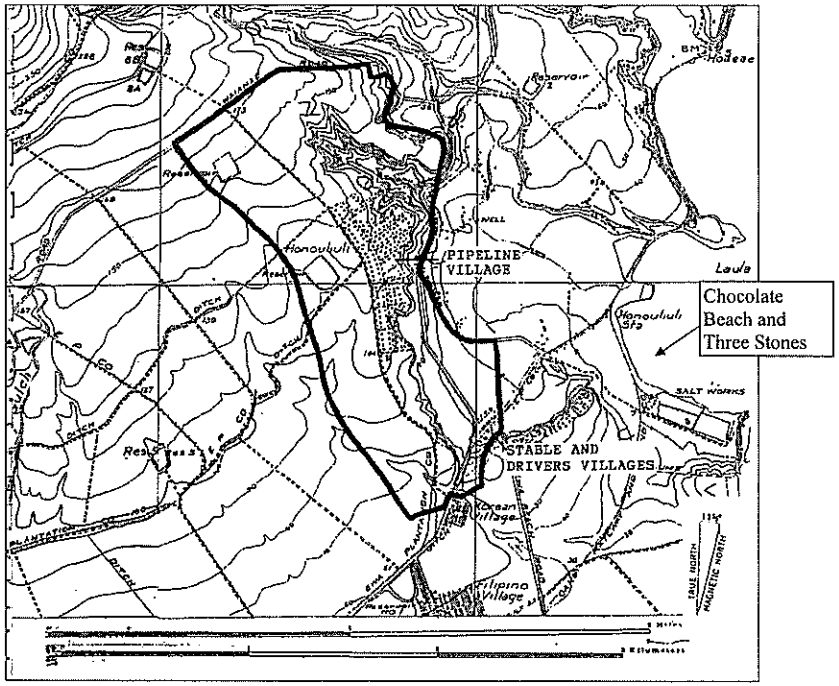

Figure 16. 1927/1928 US Geological Survey map, showing location of PipeLine Village, Stable Village, Drivers's Village, and other Ewa Plantation structures, Salt Works and location of Chocolate Beach and Three Stones.

In 1911 "60 new houses, principally for Spanish and Portuguese workmen with families" were erected. Thus, it seems highly probable that PipeLine village was largely constructed between 1906 and 1911, but may have incorporated a number of relocated structures dating to 1890. The demolition of 1931 was probably quite thorough, and not a trace of the structures was found on later maps.

Figure 17. Portuguese family residence at PipeLine Village. 1906

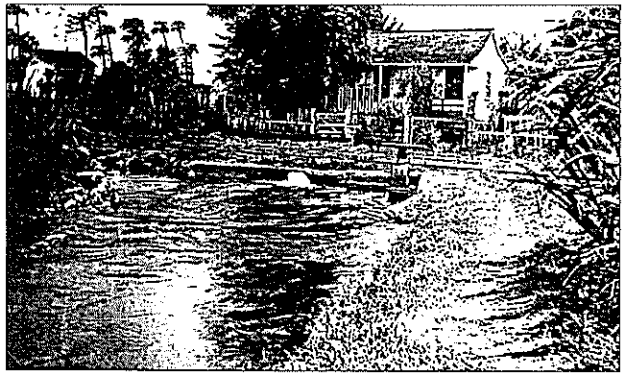

Figure 18 Discharge Pump No. 5, PipeLine Village 1907

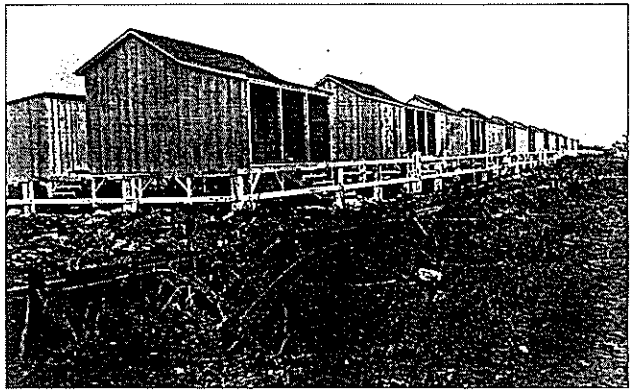

Figure 19. PipeLine Village, family houses built in 1909, photograph taken on January 1910

Figure 20. PipeLine Village, April 7, 1907; *forno* (Portuguese brick bread oven) at center of photograph

4.3.4 History of Stable Village and Drivers Village

The Ewa Plantation housing located in the southeastern corner of the Project Area, just north of the present Hale O Ulu School, is not well-documented. It appears that there were at least two small villages located here: "Stable Village" and "Drivers Village." The Ewa Plantation Company Annual Report for 1931 states that "The Drivers Village, located near the main stable was in such a bad location that it was decided to move all the fourteen cottages down to 'B" village near the factory." Drivers Village doubtlessly corresponds to the site of the 14 houses shown on the 1927/1928 map (see Figure 16), with Stable Village probably referring to the structures just to the south across the street. The date of construction of these villages is unknown. No houses are shown in this area on the 1908/1913 Fire Control map (see Figure 15). The villages were probably built in that flurry of construction in the first decade of this century. All of the structures of Stable Village and Drivers Village are shown on the War Department Map of 1943, but this map must be another example of a lack of military intelligence regarding the Pearl Harbor area; records indicate that the hosues were probably all demolished around 1931.

4.3.5 Other Enterprises in Honouliuli

One of the first enterprises in Honouliuli in the post-Contact period was the making of salt. Soon after Kekau'ōnohi sold the land of Pu'uloa to Isaac Montgomery in 1849, the king (Kamehameha III) and Montgomery entered into a partnership to run the salt works in Pu'uloa. Kamakau (1961:409) reported "The king and Isaac of Pu'uloa are getting rich by running the salt water into patches and trading salt with other islands." The salt was also sent to Russian settlements in the Pacific Northwest, where it was used to pack salmon (*Hawaiian Gazette,* January 29, 1897). An 1853 newspaper article (*Polynesian,* August 20, 1853) on the "Puuloa Salt Works" says that this was the only place "where large quantities of salt were manufactured. Kelly (1991:160) says that there was another salt works at Kualaka'i (Nimitz Beach), but does not give a reference for this claim.

There reference concerning salt works in 'Ewa by Carol Silva (1987:A-4):

> An extensive and antiquated system of salt works operated on the shore of the Honouliuli lobe of West Loch. Another salt works was situated further seaward at Puuloa. The Puuloa Salt Works had beginnings that were traceable to the 1820's and possibly even much earlier. By 1861, 100 acres had been devoted to the production of salt [*Pacific Commercial Advertiser* 4/18/1861:1].

A 1927/1928 US Geological Survey map (see Figure 16) shows several rectangles labeled "Salt Works" on the right side of the map.

The Chinese were involved in salt production around Pearl Harbor, usually in concert with their management of fishponds. One son of one Chinese resident of the area, Mau Yung Kui, the groundkeeper of the John 'I'ī estate on Waipi'o, remembered [for ca. 1900] the Chinese form of salt production for salt pans bordering the sea, which were continually fed seawater by the tides.

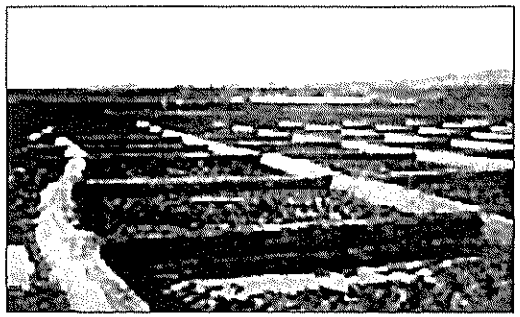

Figure 21. 1881 photo of salt pans near Kaunakakai, Moloka'i (Dorothe B. Curtis collection)

> Both the natural tides and the Chinese method of peddling a wooden wheel that transported water upward, helped to keep the salt beds damp with about three inches of water. After a few months, the senior Mau would drain off the remaining water and use a wooden rake with deep prongs to break up the salt. When the bed was dry a flat rake was used to flatten and smooth out the salt. Later it was raked into piles, packed in cloth bags and distributed. . . . Past the rice fields of Ho'ae'ae and the beginning of Honouliuli were a number of productive salt flats adjacent to the ancient fishponds operated by Chinese at the turn of the century [Chong 1988:108].

As noted above, part of Mr. Campbell's lands were also used to grow rice. By 1885, 200 acres in Honouliuli were used for rice and 50 acres were used to grow bananas (article in *Pacific Commercial Advertiser*, August 15, 1885, summarized in Silva 1987:A-12). These rice fields were planted in former taro fields or in undeveloped swamps, such as those in the Project Area in the former Honouliuli Taro lands. The rice fields in 1882 were described by Frank Damon, during a tour of the area.

> . . . Towards evening we reached Honouliuli, where the whole valley is leased to rice planters . . . This was one of the largest rice plantations we visited. Sometimes two or three men only, have a few fields which they cultivate for themselves, and we often too came upon houses where there were eight or ten men working their own land. But the larger plantations are owned by merchants in Honolulu, who have a manager acting for them. . . . [Damon 1882:37].

In 1890, Dillingham leased all land below 200 ft to William Castle, who used most of the land for sugar cane, but also leased some lands for rice cultivation, pasture, wood lots, bee-keeping, garden crops, and quarries. Some land above 650 ft was also leased for the cultivation of "canaigre", which may be a word used for pineapple (Frierson 1972:15-16).

An additional agricultural trial was conducted in the Honouliuli area for the cultivation of sisal, a plant used to make fibers for rope and other material. Some sisal was planted before 1898

and production continued until the 1920s (Frierson 1972:16). This was grown mainly on the coastal plain of Honouliuli in Kānehili, just *mauka* of Kualaka'i Beach (now Nimitz Beach). An article in the *Paradise of the Pacific* in 1902 described this venture in glowing terms.

> . . . The venture was made and a tract of land containing a large percentage of disintegrated coral, in the neighborhood of Ewa Plantation, where nothing else would grow, was chosen for the planting. . . . The Hawaiian Fiber Co., which Mr. Turner organized, and of which he is now manager, has 755 acres under fence, two and a half miles of which is stone wall with good gates at convenient places. . . . In a large field containing 130 acres, mauka of the Oahu Railway & Land Co. track, the first harvest is to be gathered in a few months. . . . Out of this section of 130 acres the company has figured on securing 50 tons of clean fiber, for which it is offered eight cents per pound in Honolulu or nine cents per pound in San Francisco . . . . [*Paradise of the Pacific* March 1902:17].

Although many of the fishponds at Pearl Harbor deteriorated from lack of care and lack of people to maintain them in the early nineteenth century, there was some action to reclaim these areas in the later part of the century. Some were converted to rice fields, but others were maintained as fish ponds or duck ponds. Records of the Minister of Public Instruction (1848) show that some ponds were maintained by local teachers and students, with the funds generated used for the upkeep of the school system. Some ponds as early as 1848 were also maintained by prisoners, possibly from the women's prison located at Honouliuli. In 1852, however, Levi Ha'alelea reasserted his claims to these neglected lands, when he claimed all of the mullet from this area be reserved to him (Hawaii Kingdom files, cited in Silva 1987:A-7 to A-9). During James Campbell's tenure of the land, fish ponds and Pu'uloa fishing rights were leased out to various entrepreneurs (Kelly 1985:175).

Into the early twentieth century, some Hawaiian families continued to live in Honouliuli and preserve the traditional lifestyle, including at the fishing village of Kualaka'i (see Figure 5). One resident, Mrs. Eli Williamson, recalled:

> In the Honouliuli area the train stopped among the *kiawe* (algaraboa) trees and *malina* (sisal) thickets. We disembarked with the assorted food bundles and water containers. Some of the Kualaka'i *'ohana* (family) met us to help carry the *'ukana* (bundles) along a sandstone pathway through the *kiawe* and *malina*. The distance to the frame house near the shore seemed long. When we departed our *'ukana* contained fresh lobsters, *limu* (algae), fish and *i'a malo'o* (dried fish) . . . [Williamson in Kelly 1985:160].

4.3.6 The Military and Modern Developments

In 1891, Russian explorer Otto Von Kotzebue tried to observe Pearl River, but his group could not obtain a canoe. What he was told, however, led him to speculate on the possible importance of Pearl Harbor to the future.

> In the mouth of this river are several islands; it is so deep, that the greatest ship of the line can lie at anchor a few fathoms from the shore; and so broad, that a hundred vessels can conveniently find room in it. The entrance into the Pearl Rivers is in the same situation as the harbour of Hana-rura [Honolulu]; but the windings between the reefs are, however, said to render a passage more difficult. If this place were in the hands of the Europeans, they would certainly employ means to make this harbour the finest in the world [Von Kotzebue 1821:338-348].

The early missionary Levi Chamberlain was able to take an outrigger canoe trip to Pearl River, and noted the difficulty of access for larger ships.

> Kawaa took passage in our canoe to go down the harbor to a place where oysters are abundant to give orders to his people to gather a mess. The sail down the harbor was delightful . . . The passage down the creek for a number of miles was very pleasant till we got down near the reef and our course altered. We then could sail no longer as the wind was against us. The sail was lowered the mast taken down and secured across the outrigger and the rowers plied their paddles [Journal of Levi Chamberlain 1822-1849, Hawaiian Mission Schools, Storage Case 4, p. 899, from Sterling and Summers 1978:51].

The first foreign attempt to survey Pearl Harbor was made in 1840 during the U.S. Exploring Expedition, led by Charles Wilkes.

> In this district is a large inlet of the sea, into which the river Ewa empties; at the entrance of this inlet is the village of Laeloa (at Kalaeloa Pont): the shore is known by the name of Pearl River or harbour, from the circumstance that the pearl oyster is found here; and it is the only place in these islands where it occurs.
>
> The inlet has somewhat the appearance of a lagoon that has been partly filled up by alluvial deposits. At the request of the king, we made a survey of it: the depth of water at its mouth was found to be only fifteen feet; but after passing this coral bar, which is four hundred feet wide, the depth of water becomes ample for large ships, and the basin is sufficiently extensive to accommodate any number of vessels. If the water upon the bar should be deepened, which I doubt not can be effected, it would afford the best and most capacious harbour in the Pacific. . . . [Wilkes 1970:79].

Although Wilkes was impressed by the harbor, he was not at this time thinking of how this survey could benefit the American government in the future. In fact, Wilkes (1970:79) concluded, "As yet there is no necessity for such an operation, for the port of Honolulu is sufficient for all the present wants of the islands, and the trade that frequents them."

This had changed in less than 30 years, however. The U.S. military had tried to make a coaling station on Midway Island in 1869 by blasting through the coral reef to make a harbor; this plan failed. In 1873, General Schofield presented a confidential report to the U.S Secretary of War, recommending that Pearl Harbor should be available to the U.S. Navy. Schofield wrote:

> In case it should become the policy of the Government of the United States to obtain the possession of this harbor for naval purposes, jurisdiction over all the

> waters of Pearl River with the adjacent shores to the distance of 4 miles from any anchorage should be ceded to the United States by the Hawaiian Government. . . .
>
> The cession of Pearl River could probably be obtained by the United States in consideration of the repeal of the duty of Sandwich Island sugar. Indeed, the sugar –planters are so anxious for a reciprocity treaty, or so anxious rather for free trade in sugar with the United States, that many of them openly proclaim themselves in favor of annexation of these islands of the United States [Sen. Ex. Docs, 52nd Cong. 2nd Sess. No. 77, pp. 150-154, reproduced in Judd 1971:Appendix 3].

This reciprocity treaty was concluded in 1876 with the provision that Hawai'i would not "lease or relinquish sovereignty to another country or any harbor, etc." In 1887, the treaty was renewed and amended and allowed the United States the "exclusive right to enter the harbor of Pearl River, in the Island of Oahu, at to establish and to maintain there a coaling and repair station for the use of vessels of the United States" (Judd 1971:128).

After annexation of the islands to the United States in 1899, development began in order to make a Pacific base that could be used as a staging area for the Spanish-American war (Coletta 1985:433). Dredging of the harbor began in 1901, and additional dredging to deepen and widen the channel was conducted in 1908 and again in the 1920s. Money for the funding of the construction of dry docks and other support facilities was approved in 1908. In 1931 the Navy built an ammunition depot at West Loch on a 213-acre parcel that it had bought from the Campbell Estate. Construction of a new depot in Lualualei Valley and at West Loch Harbor began in 1931.

In the early 1930s, the U.S. Navy leased 700 acres of the Campbell Estate to build 'Ewa Field, a base with a mooring mast for Navy dirigibles. Although the mast was completed, the program was abandoned before the *Akron*, the designated airship for the mast, was built. In 1937, 18 miles of roads were built in the coastal Honouliuli area, and in 1939-1940 the U.S. bought 3,500 acres of land in this area (Landrum et al 1997:62-67), to build several other military camps and installations, including Barbers Point Naval Air Station, at the site of the old mooring mast.

On December 7, 1941 the Japanese Navy launched the devastating surprise attack on the United States base at Pearl Harbor and other military facilities. Although the major battle damage to the US Pacific Fleet was at its base at Ford Island in the Middle Loch of Pearl Harbor, Honouliuli did not escape unscathed.

> The Waipahu and Ewa sugar plantation, next to Pearl Harbor and the town of Wahiawa, adjoining Schofield Barracks, saw more action than did Honolulu.
>
> At Waipahu, machine gun bullets, shrapnel, and shells started two cane fires, riddled the sugar mill, hit the plantation hospital in four places, went through the roof of the company store, exploding in an electric supply warehouse, and narrowly missed many houses. In nearly all of the fields of tall cane, many of which contained terrified women and children, shells buried themselves-dozens of them in some concentrated areas-blasting holes in the ground the size of barrels, and flattening cane for several square yards.

> At Ewa, after bombing the nearby Marine airfield [at Barbers Point], enemy planes machine-gunned the plantation's main street, the mill and power plant and some 30 houses and started two cane fires [Allen 1999:20].

The attack had consequences not only for the military, but also for the civilians, mostly Japanese, who lived around West Loch.

> Two permanent local evacuations were ordered in the first month of the war, partly to remove civilians from areas which might be dangerous in event of further attack and partly to protect installations from possible sabotage or espionage activities. On a Thursday less than two weeks after the bombing, farmers adjacent to West Loch at Pearl Harbor were ordered to leave their farms by sundown. The order was modified to allow two days to prepare and the men were permitted to return to their farms during daylight until livestock could be moved and crops harvested. The displaced farmers, who had only recently been established at West Loch by the Farm Security Administration, were forced to seek temporary housing with friends and relatives at Ewa Plantation. Since they had invested in the enterprises practically all of their life's savings and considerable money borrowed from the FSA as well, several suffered heavy losses [Allen 1999:122].

Section 5 Previous Archaeological Research

5.1 Early Archaeological Surveys

All archaeological projects previously conducted in Honouliuli and Pu'uloa are listed below in Table 2. Two archaeological features, a boundary *pōhaku* or rock and a *hōlua*, or sledding site, are recorded only in the Boundary Commission Reports establishing the division lines between the *ahupua'a* of Honouliuli and Hō'ae'ae (to the east). The surveyor wrote of the southern point of this boundary:

> In regard to Hoaeae . . . the point of commencement is Pōhaku Palahalaha, a well known rock, now marked by an arrow and the name "Honouliuli" on one side and "Hoaeae" on the other, which I have made the initial point of the survey . . . [Boundary Commission Vol. 1:243].

This rock is shown on the Sterling and Summer map as Pōhaku Palaha (see Figure 5). In another boundary survey, the *pōhaku* is called a "large, flat rock" (Boundary Commission Vol. 1:249), which may indicate the origin of the name from the Hawaiian word *pālaha*, which means "flattened, wide" (Pukui and Elbert 1986:307). As the surveyor continued to walk the Honouliuli/Hō'ae'ae boundary, he marked the northern point of the division as:

> The Kamaaaina took me to the corner of Pauhala (?)-Hoaeae and Honouliuli – there is an ancient holua or sleding [*sic*] place near this – which is agreed for the ancient corner. . . [Boundary Commission Vol. 1:243].

The earliest attempt to record archaeological remains in Honouliuli Ahupua'a was made by Thrum (1906:46). He reported the existence of a *heiau* located on Pu'uokapolei , west of the present Project Area. In a second monograph on *heiau*, Thrum (1917) called this *heiau* Palole'i (Kapolei). Emory mapped and photographed these structures in 1933 (field notes), but they were dismantled and destroyed sometime before McAllister's survey of the islands in the 1930s. According to legend, Pu'uokapolei was the location on which Kamapua'a, the pig-god, resided with his grandmother, Kamaunuahihio (McAllister 1933:108).

In his surface survey of the 1930s, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister recorded 14 specific sites at Honouliuli, numbered Sites 133-146 (McAllister 1933:107-108) Site 146, which McAllister used to denote the entire 'Ewa coral plains, is the only one of these sites in the Project Area. This "site," which is more of a general area covering all the coastal flatlands of 'Ewa would include portions of the current Project Area (all area outside the Honouliuli Gulch). Within Site 146, McAllister noted old ranching walls, salt work reminas, and coral pits used by the Hawaiians for cultivation of certain plants, such as bananas and sugar cane. The other thirteen sites are all outside of the Project Area.

The first six sites are in the upland section of Honouliuli, *mauka* of the 'Ewa coral plain and Pu'uokapolei . Site 133 is a possible *heiau*, a small enclosure at the foot of Pu'u Kānehoa. It was still standing during McAllister's day, and local residents informed him of its sacred nature. Site 134 is Pu'u Kuina Heiau, located in a gulch at the foot of Mauna Kapu. Only traces of a

largeterrace remained. Site 135 is a series of enclosures *makai* of Pu'u Kuina Heiau. McAllister believed that the walls marked *kuleana* lots. Site 136 is a small platform near Mauna Kapu, a sacred site, possibly an altar. Site 137 is Pu'u Ku'ua Heiau, plotted on a ridge near Pu'u Ku'ua; it had been modified for use as a cattle pen; some areas had been cleared for pineapple cultivation or planted with ironwoods. Site 138 is Pu'uokapolei Heiau, which had been on the *makai* side of the hill before it was destroyed. The stones of the structure had been crushed in a nearby rock crusher. McAllister was also told that there was once a cave on the hill, in which Kamapua'a and his grandmother lived (McAllister 1933:107-108).

The last eight sites recorded by McAllister are adjacent to Pearl Harbor or the coast. Site 139 is Kalanamaihiki Ko'a (fishing shrine) at Kapapapuhi Point (north of the current study area). McAllister described it as "two large rough stones about 2.5 feet in size, with six or seven smooth stones averaging 1 foot in size in a small pile adjoining the larger stones." Site 140 is a 4-5 acre fishpond on Laulaunui Island in West Loch, opposite Kapapapuhi Point. McAllister recorded the entire West Loch of Pearl Harbor as Site 141, Kaihuopala'ai. Although some versions of the legend of the traveling mullet (see Section 3.1, Mythological and Traditional Accounts) say that there was a fishpond called Kaihuopala'ai, McAllister recorded that local informants said there was never a fishpond by that name here; rather it was the name for the loch. Site 142 is Kapamuku, or Pamoku fishpond, a 3-acre fishpond, located south of the current study area, opposite the tip of Waipi'o peninsula. Site 143 is 'Oki'okiolepe fishpond, south of Loko Pamoku. The walls of this 6-acre fishpond were made of coral. As mentioned, Site 146 was used to represent the entire 'Ewa Plain.

McAllister records Site 144 as the location of fish traps and a fishing shrine described by Stokes in his study of the fishtraps of Pearl Harbor. This is the location of the fishtraps Kapākule (Pākule) and Kepo'okala, as described by Samuel Kamakau (1976:88). McAllister listed Site 145 as Pu'uloa, a legendary site where the first breadfruit was planted. It is not known whether Pu'uloa referred to is the *'ili* of Pu'uloa or the harbor of Pu'uloa, or an area within the *'ili* near the harbor. Site 146 covers the entire 'Ewa coral plain. This includes historic features, such as cattle walls and the walls near the Pu'uloa Salt Works, pre-Contact sites such as habitation, agricultural, and fishpond sites recorded by early European explorers, and paleontological sites, where in recent years many fossil bird bones have been discovered (McAllister 1933:108-110).

Between McAllister's 1930s study and the flurry of work that began in 1969, there are only a few sporadic pieces of research, which are not well documented. In 1933, Dr. Kenneth P. Emory recorded a well-preserved house site and a possible *heiau* (later destroyed by sugar cane cultivation) in the western part of the coral plains (Sinoto 1976:1). In 1959, William Kikuchi removed a number of burials from a burial cave site (Bishop Museum Site OA-B6-10) at the Standard Oil Refinery, which was subsequently destroyed (Barrera 1975:1). Kikuchi recovered 12-16 incomplete primary and/or secondary burials cached in a sinkhole or crevice exposed during construction activities near the big bend in Malakole Road (Kikuchi 1959; Davis 1990b: 146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling visited a house site (BPBM. Site OA-B6-8) within 'Ēkaha Nui Gulch. "Around this elevation (1200 feet), along the sides of the stream, were seen remains of many terraces and some house sites" (Sterling and Summers 1978:37). In 1962, Lloyd Soehren recorded another secondary human burial in a sinkhole at the BarbersPoint Naval Air Station (Davis 1990a:147). In 1966, Lloyd Soehren carried out salvage excavations at a possible fishing shrine (BPBM. Site # 50-OA-B6-13). The site was reported as destroyed by

construction (Barrera 1975:1), but Davis relocated the shrine and performed additional excavations in 1982 (Davis 1990a:148).

Table 2. Previous archaeological work in Honouliuli and Pu'uloa

Author	Report Type	Location
Thrum 1906	Heiau study	Hawaiian Islands
McAllister 1933	All island survey	O'ahu Island
Kikuchi 1959	Site letter report	Barbers Point
Bowen and Soehren 1962	Burial Discovery	Barbers Point
Soehren 1964	Site letter report	Waimanalo Gulch
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
McCoy 1972	Survey	Pu'uloa Elementary School
Hommon 1973	Survey and Excavations	Honouliuli
Barrera 1975	Archaeological & reconnaissance	Barbers Point (harbor area)
Clark and Connolly 1975	Reconnaissance survey	Barbers Point (harbor area)
Oshima 1975	Reconnaissance survey	Barbers Point
Sinoto 1976	Cultural resources survey	Barbers Point (harbor area)
Bordner 1977a	Reconnaissance survey	Kalo'i Gulch
Bordner 1977b	Reconnaissance survey	Makaiwa Gulch
Clark 1977	Reconnaissance survey	Puu O Kapolei
Connolly and Clark 1977	Reconnaissance survey	Puu O Kapolei
Davis 1978	Scholarly paper	Barbers Point (harbor area)
Davis and Griffin 1978	Archaeological Survey	Barbers Point (harbor area)
Hawai'i Marine Research Inc.	Geoarchaeological reconnaissance	Barbers Point (harbor area)
Kirch 1978	Land snail study	Barbers Point (harbor area)
Sinoto 1978a	Reconnaissance Survey and Burial	NAVMAG -West Loch
Sinoto 1978b	Archaeological & Paleontological	Barbers Point (harbor area)
Barrera 1979	Archaeological survey	West Beach
Clark 1979	Reconnaissance survey	Barbers Point (harbor area)
Cleghorn 1979	Reconnaissance survey	Barbers Point
Davis 1979a	Emergency excavations	Barbers Point (harbor area)
Davis 1979b	Emergency excavations	Barbers Point (harbor area)
Davis 1979c	Archaeological survey	'Ewa Marina Community
Jourdane 1979	Reconnaissance Survey	'Ewa Marina Community
Komori and Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
Ahlo 1980	Reconnaissance survey	Solid Waste Processing
Davis 1980	Research design	Barbers Point
Kirch and Christensen 1980	Land snail study	Barbers Point (harbor area)
Christensen and Kirch 1981	Land snail study	Barbers Point (harbor area)
Hammatt and Folk 1981	Archaeological and Paleontological	Barbers Point (harbor area)
Davis 1982	Academic paper	Barbers Point
McCoy et al. 1982	Proposal for investigations	Barbers Point (harbor area)
Neller 1982	Scholarly study	Barbers Point
Ahlo and Hommon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch

Author	Report Type	Location
Davis 1983	Archaeological & Paleontological Excavations	Barbers Point
Ahlo and Hommon 1984	Test excavations	Barbers Point (harbor area)
Hammatt 1984a	Reconnaissance survey	Kahe Point
Hammatt 1984b	Reconnaissance survey	Ewa Marina Community
Haun and Kelly 1984	Research resign	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
Barrera 1985	Archaeological survey	West Beach
Neller 1985	Review and evaluation	West Beach
Barrera 1986	Archaeological Investigations	West Beach
Davis and Haun 1986	Intensive survey and test excavations	West Beach
Davis et al. 1986a, b	Research design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Athens & Pietrusewsky 1987	Burial documentation	Iroquois Point
Davis and Haun 1987	Intensive survey & test excavations	West Beach
Dicks et al. 1987	Reconnaissance survey	West Loch
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Reconnaissance survey	Ko Olina Resort
Rosendahl 1987c	Reconnaissance survey	West Loch
Rosendahl 1987d	Reconnaissance survey	Kapolei Golf Course
Welch 1987	Reconnaissance survey	Naval Air Station
Davis 1988a	Subsurface Survey	'Ewa Gentry
Davis 1988b	Reconnaissance survey	Barbers Point HECO
Kennedy 1988a	Reconnaissance survey	'Ewa Gentry
Kennedy 1988b	Field Report	Waiau-Campbell Industrial
Rosendahl 1988	Reconnaissance survey	Camp Malakole
Sinoto 1988a	Reconnaissance survey	'Ewa Golf Course
Sinoto 1988b	Reconnaissance survey	Makakilo Golf Course
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial documentation	Kahe
Bath 1989c	Burial documentation	West Loch – Hō'ae'ae
Burgett and Rosendahl 1989	Subsurface archaeological testing	North of O.R.&L.
Hammatt and Shideler 1989a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1989b	Reconnaissance survey	Kahe Point
Carlson and Rosendahl 1990	Inventory survey	Kaomi Loop Subdivision
Cleghorn and Davis 1990	Archaeological and paleontological	Barbers Point (harbor area)
Collin and Kennedy 1990	Burial documentation	Pu'uloa Golf Course
Davis 1990a	Archaeological and paleontological	Barbers Point (harbor area)
Davis 1990b	Archaeological and paleontological	Barbers Point (HECO area)
Davis et al. 1990	Survey and Test Excavations	Ewa Marina Community
Hammatt and Shideler 1990	Inventory survey	West Loch Bluffs
Hammatt, Robins, et al. 1990	Inventory survey	Makaiwa Hills
Hammatt, Shideler, et al. 1990	Inventory Survey	'Ewa Villages
Kawachi 1990	Inadvertent Burial find	Campbell Industrial Park
Miller 1990	Inadvertent Burial find	Barber's Point, Nimitz
Rosendahl 1990a	Letter report	Kapolei Golf Course

Author	Report Type	Location
Rosendahl 1990b	Archaeological Survey and Test	'Ewa Marina Community
Davis and Burtchard 1991	Inventory Survey	NAVMAG-West Loch
Dunn et al. 1991	Inventory Survey and Test	'Ewa Marina Community
Folk 1991	Reconnaissance Survey	Kapolei Town
Goodman and Cleghorn 1991	Surface Survey	Laulani Fairways Housing
Kennedy 1991	Subsurface testing	Pu'uokapolei
Hammatt 1991	Reconnaissance Survey	Honouliuli Livestock Park
Hammatt and Shideler 1991a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1991b	Inventory Survey	St. Francis Medical Center
Haun et al. 1991	Survey report	Naval Air Station
Burgett and Rosendahl 1992	Inventory survey	Barbers Point (harbor area)
Charvet-Pond and Davis 1992	Data Recovery	West Beach
Cleghorn and Anderson 1992	Inventory survey	Kahe Point
Hammatt and Folk 1992	Subsurface testing	Barbers Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Folk 1992	Subsurface Testing	Barbers Point
Hammatt 1992	Inventory Survey	Palikea
Jayatilaka et al. 1992	Survey and Test Excavations	Hawai'i Prince Golf
Kennedy et al. 1992	Inventory Survey	Pu'uloa Golf Course
Shideler et al. 1992	Assessment	Kahe Point
Trembly et al. 1992	Burial documentation	West Beach
Davis 1993	Archaeological and paleontological	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Goodman et al. 1993	Reconnaissance Survey	20-acre Commercial
Jones 1993	Fossil coral reefs study (Ph.D.	Hawaiian Islands
Landrum and Schilz 1993	Reconnaissance and subsurface	Naval Air Station
Miller 1993	Data recovery	Barbers Point (harbor area)
Nakamura et al. 1993	Inventory survey	Makakilo
Pantaleo and Sinoto 1993	Inventory survey	Ewa Gentry
Hammatt and Shideler 1994	Archaeological assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory survey	Barbers Point (harbor area)
Tuggle 1994	Inventory survey	Barbers Point
Davis et al. 1995	Archaeological & Palcontological	Barbers Point (harbor area)
Dye 1995	Burial documentation	Barbers Point
Franklin 1995	Data Recovery	Ewa Marina Community
Hammatt and Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
Yoklavich et al. 1995	CRM Overview	Barbers Point
Corbin et al. 1996	Reconnaissance Survey	Laulaunui Island
O'Hare et al. 1996	Intensive survey and testing	Naval Air Station
Athens et al. 1997	Cultural resources,	'Ewa Plain:Naval Air
Schilz and Landrum 1996	Test Excavations	Barbers Point
Spear 1996	Reconnaissance Survey	Kapolei Town
Borthwick 1997	Archaeological assessment	Palehua, Honouliuli
Hammatt 1997	Inventory survey	Pu'uloa
Hammatt and Chiogioii 1997	Reconnaissance Survey	Corridor in Honouliuli
Jensen and Head 1997	Reconnaissance Survey	NAVMAG-West Loch

Author	Report Type	Location
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	'Ewa Plain
Tuggle and Tomonari 1997a,b	Cultural resource inventory survey	Naval Air Station
Wickler and Tuggle 1997	Cultural resources, Inventory Survey	Naval Air Station
Wolforth and Wulzen 1997	Data Recovery	West Loch Estates
Wulzen and Rosendahl 1997	Data Recovery	Barbers Point Nimitz
Goodfellow et al. 1998	Data Recovery	West Loch
Hammatt and Shideler 1999	Inventory survey	Waimanalo Gulch
Magnuson 1999	Reconnaissance Survey	Farrington Hwy.
McDermott et al. 2000	Data recovery	Barbers Point (harbor area)
Elmore et al. 2001	Honouliuli	Pu'u Kapolei/Fort Barrette
Ostroff et al. 2001	Inventory survey	Pu'uokapolei
Tulchin et al. 2001	Inventory survey	'Ewa Shaft Renovation
McIntosh and Cleghorn 2003	Inventory survey	'Ewa Gentry Makai
Cordy and Hammatt 2003	Archaeological assessment	Barbers Point, North of
O'Hare et al. 2005	Field Check	Kapolei Property
O'Hare et al. 2004	Documentation of Plantation	North of O.R.&L.
Terry et al. 2004	Archaeological Inventory Survey of	North of O.R.&L.
Hoffman et al. 2004	Archaeological Inventory Survey	Between OR&L and

5.2 Previous Archaeological Work near Honouliuli town

Beginning in the late 1970s, archaeological research has been conducted in Honouliuli in the general vicinity of the present study area (Figure 22). Work has been focused on the West Loch Estates (east of the current Project Area), Pearl Harbor Naval Magazine (NAVMAG) – West Loch (east of the current Project Area), the 'Ewa Gentry project (south of the Project Area), and 'Ewa Villages (south of the Project Area).

5.2.1 West Loch Estates

An archaeological reconnaissance survey (Rosendahl 1987c) was conducted in association with the development of the 232-acre "West Loch Estates" Residential Increments I and II (including golf course and parks) project, which lies to the east of the present study area, in the section of the Honouliuli Taro lands adjacent to Pearl Harbor. This project covered portions of the old town of Honouliuli, the focus of population in the early historic period (and possibly earlier). This study identified a modern cemetery (Site 3319) with a remnant pre-Contact deposit, two historic sites of minimal integrity with some possible pre-Contact deposits (Site 3318 and 3320) at Kapapapuhi Point, a significant pre-Contact deposit with trash pits, fire pits and at least one human burial (Site 3321), a buried fishpond (Site 3322), an historic fishpond (Site 3323) built in the 1890s during the construction of the OR& L railroad, and a buried pond field system (Site 3324) (Rosendahl 1987c:7, 9). It was noted that some artifacts "indicate the possibility of pre-1900 occupation" (Rosendahl. 1987c:8). As noted in the final reconnaissance survey report (Dicks et al. 1987:28) for the surface and subsurface reconnaissance survey, an effort was also made to relocate McAllister's Site 139, Kalanamaihiki Ko'a (fishing shrine). The archaeologists found a small boathouse and dock in the area and concluded that the shrine had been destroyed since McAllister's survey in the 1930s.

A total of 21 radiocarbon dates were determined; at Site 3321, the cultural deposit, the age of a lower cultural deposit was dated to A.D. 540-880, while an upper deposit was dated to A.D. 1327-1640. For the buried fishpond (Site 3322), ages ranged from A.D. 70-610 in the lowest layer to A.D. 1160-1410 in the upper layer. For the buried pond field systems (Site 3324), ages ranged from B.C. 400-A.D. 240 (interpreted as the original surface of the upper valley) in the lowest layers to A.D. 1430-1952 in the upper layers of upper valley area and A.D. 1020-1280 in lower valley area. In summary, the authors (Dicks et al. 1987:78-79) concluded that agricultural use of the Honouliuli Stream floodplain for pondfield cultivation of taro may have begun in the lower valley segment as early as A.D. 1000, while cultivation of the upper valley pondfields may have begun as early as the thirteenth and fourteenth centuries. Site 3321in the upper valley may have been a habitation locus established as early as the mid-sixth to mid-ninth century (Wolforth et al. 1998).

In 1989, a burial was found on Ho'ae'ae Point (formerly called Papapuhi Point), when someone was digging under a mango tree on a residential property. There is no follow-up report (Bath 1989) to whether the bones were left in place or disinterred. The burial was given the site designation 50-80-13-4816.

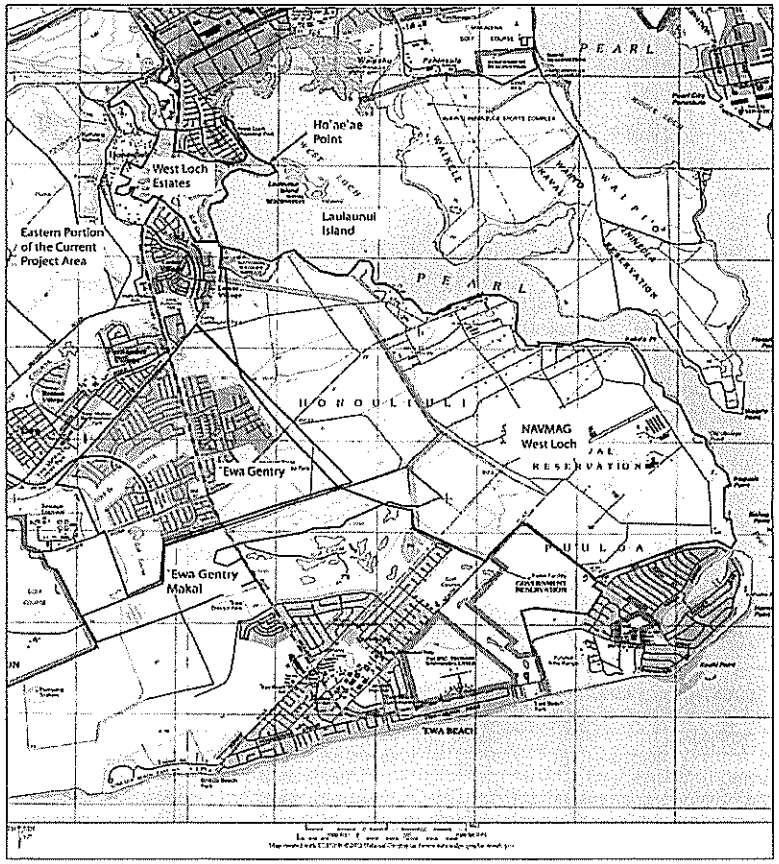

Figure 22. U.S. Geological Survey topographic map, showing previous archaeological survey areas in relation to the Project Area

5.2.2 NAVMAG – West Loch

In 1978, Sinoto conducted an archaeological reconnaissance survey on a 32-acre portion of NAVMAG-West Loch. A sinkhole 200 miles inland and northwest of 'Oki'okiolepe Fishpond was found, containing ten human burials (Site 50-80-13-2310). The historic artifacts found in the pit, indicated that the pit was probably used by the Chinese in the historic period as a family crypt (Sinoto 1978a).

Davis and Burtchard (1991) conducted an archaeological inventory survey of a 36-acre lot for a proposed housing area in the Pu'uloa portion of NAVMAG-West Loch in 1991. No archaeological sites were found. They concluded that extensive alteration to the landscape due to military land disturbance had erased all surface traces of pre-Contact habitation.

In 1992, a crew from Archaeological Consultants of Hawai'i, Inc. (ARCH) conducted an archaeological inventory survey with subsurface testing, and later data recovery at the proposed Pu'uloa Golf Course (Kennedy et al. 1992). A total of 72 sites were identified, 47 from the pre-Contact/early historic period and 25 sites associated with ranching, military training, and modern quarrying. Radiocarbon dates of these habitation, agricultural, and ceremonial sites indicate that traditional Hawaiian use extended from A.D. 1090 to 1695.

An overview survey of the NAVMAG Lualualei was completed by Ogden Environmental and Energy Services in 1977 (Landrum et al. 1977). A total of ten sites had been previously recorded during the West Loch survey, three in the Honouliuli section, one within Pearl Harbor (Site 140, Laulaunui Island), five on Waipi'o peninsula, one in both (salt works), and one encompassing all lands (Pearl Harbor Navy Base). In Honouliuli, the sites were Site 141, Kaihuopala'ai (West Loch), Site 142, Loko Pamoku or Kapamuku, Site 143, 'Oki'okiolepe Fishpond, and salt works at Honouliuli (no site designation). NAVMAG-West Loch is considered part of the Pearl Harbor Navy Base (Site 50-80-13-9992) due to its importance during World War II. The site was listed as a National Historic Landmark in 1966, on the National Register of Historic Places (NRHP) in 1966, on the State Inventory of Historic Places (SIHP), in 1971, and on the State Register of Historic Places in 1971 (Landrum et al. 1977:160).

In 1996, a crew from Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed a Phase I archaeological reconnaissance survey of the 1,483 acres of land at the U.S. Naval Magazine – West Loch Branch (Jensen and Head 1997). This survey covered the southern section of Waipi'o peninsula on the east side of West Loch, Laulaunui Island, the Naval Reservation on the west side of West Loch, and the West Loch Outleased Cultivated Lands, which included the National Wildlife Refuge. Only 25% of the outleased lands were actually surveyed. The PHRI crew found that most of the outleased area had been bulldozed for sugarcane cultivation. Only a small strip adjacent to West Loch was unmodified. In the West Loch Outleased Lands, eight features were recorded; all but one was associated with military use of the area. The seven military sites consisted of six concrete slabs (Sites 50-80-13-5040, 5080, 5081, 5133, 5134), a metal container (5080), and a pressure tank (5133). The one non-military site (4971) was a cave with a partially blocked (blocked with roof fall) entrance that the crew members believed should be investigated in the future to see if it at one time was used as a pre-Contact or historic burial site (Jensen and Head 1997:85).

In 1996, a field reconnaissance of Laulaunui Island and fishpond was conducted by the State Historic Preservation Division (Corbin et al. 1996) to determine if restoration of the fishpond was possible and if the site would be a good candidate to be used as an educational tool. The crew simply walked to the island from the West Loch Waterfront Park; water depth varied from one to four feet. Five concrete structures, probably built by the military, were observed. The fishpond was surrounded by mangroves and was silted in; portions of a coral wall (about 500 ft long) around the pond were still intact, and a concrete gate allowed water to circulate into the pond.

5.2.3 'Ewa Villages

In 1990, Cultural Surveys Hawaii conducted an archaeological reconnaissance survey of a 616-acre area, which included three extant plantation villages, (Renton, Tenney, and Varona Village), the sites of three former plantation villages (C Village, Mill Village, Middle Village), and other sites associated with the Ewa Plantation infrastructure (Hammatt, Shideler, et al. 1990:i). The survey found no evidence of any pre-Contact activity within the survey area and recommended further documentation of some of the ruined plantation structure sites.

In 1996, Scientific Consultant Services (Spear 1996) conducted an archaeological survey in an area west of the Tenney and Varona plantation villages and north of the Honouliuli Treatment Plant. No archaeological sites were identified.

5.2.4 'Ewa Gentry Project

In the initial reconnaissance (Kennedy 1988a) of the 1,016 acre 'Ewa Gentry survey area, no surface evidence of potentially significant pre-Contact remains was found. The old OR&L railroad bed/right of way (Site 50-80-12-9714) did form a portion of the *mauka* boundary. According to historic maps, a Filipino Camp for sugarcane workers once existed near the intersection of the OR&L bed and a cane road near Ft. Weaver Road, but the archaeologists did not find any surface remains for this camp.

A subsequent subsurface exploration was undertaken. Eighteen backhoe trenches were excavated; however, "no evidence of past in situ cultural activity was found anywhere in the 'Ewa Gentry Project Area" (Davis 1988).

An inventory survey was conducted in 1993 by Aki Sinoto Consulting (ASC) (Pantaleo and Sinoto 1993) for the 'Ewa Gentry Off-Site Drainage System. This proposed drainage Project Area is a narrow strip that extends along the western boundary of NAVMAG West Loch, and is adjacent to the southern non-contiguous parcel (TMK 9-1-010:002) for the current Project Area. An 1897 map of Pearl Harbor indicated that the OR&L railroad, salt pans, and a fishpond were within this Project Area; only the railroad bed was found during the ASC survey. Iron flumes and concrete culverts (one with an inscribed date of July 1935) used for sugarcane irrigation were found bulldozed to the edge of the sugar cane fields near the dropoff to the shoreline of Pearl Harbor. These were not considered historically significant due to the absence of structural and locational integrity. No further archaeological work was recommended for this project prior to commencement of construction of the drainage system.

In 2003, Pacific Legacy (McIntosh and Cleghorn 2003) conducted an archaeological survey of the proposed 'Ewa Gentry Makai Development Project Area, which is adjacent to the southern

(*makai*) boundary of the 'Ewa Gentry Project Area for the 1988 surface and subsurface inventory surveys (Kennedy 1988a; Davis 1988).

5.2.5 Previous Archaeology in the Current Project Area

As noted previously, and as discussed in more detail in the next section, a 546-acre portion of the current Project Area (the southeastern section) was previously surveyed in 1990 by a crew from Cultural Surveys Hawai'i. In 2005, a field assessment was conducted over the entire current Project Area by archaeologists from the firm Archaeological Consultants of the Pacific, Inc. (Elison and Kouneski 2005). The archaeologists found one "stone-faced hill" in the northern section of the Project Area (north of Farrington Highway), but did not describe it further. The report presents recommendations for field work in the different sections of the Project Area, concluding that the majority of the Project Area is farm land and did not need to be surveyed. Only the area around Honouliuli Gulch, and other areas of natural vegetation in the northern section needed to be surveyed.

Section 6 Traditional Land Use In Honouliuli Ahupua'a

The *ahupua'a* of Honouliuli is the largest traditional land unit on the island of O'ahu. Honouliuli includes all the land from the western boundary of Pearl Harbor (West Loch) westward to the 'Ewa/Wai'anae District Boundary with the exception of the west side of the harbor entrance, which is in the *ahupua'a* of Pu'uloa (the 'Ewa Beach/Iroquois Point area). This comprises approximately 12 miles of open coastline from One'ula westward to Pili O Kahe. The *ahupua'a* extends *mauka* (almost pie-shaped) from West Loch nearly to Schofield Barracks, and the western boundary is the Wai'anae Mountain crest running *makai* to the east ridge of Nānākuli Valley.

Not only is there a long coastline fronting the normally calm waters of leeward O'ahu, but there are also four miles of waterfront along West Loch. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless "desert" plain marked in pre-contact times (previous to sugar cultivation) by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Wai'anae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat 'Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch.

Honouliuli Ahupua'a, as a traditional land unit, had abundant and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain, which is the most readily visible terrain, does not do justice to the *ahupua'a* as a whole. The richness of this land unit is marked by the following available resources:

1) 12 miles of coastline with continuous shallow fringing reef, which offered rich marine resources.

2) Four miles of frontage on the waters of West Loch, which offered extensive fisheries (mullet, *awa*, shellfish), as well as frontage suitable for development of fishponds.

3) The lower portion of Honouliuli Valley in the 'Ewa plain offered rich level alluvial soils with plentiful water for irrigation from the stream as well as abundant springs. This land would have stretched well up the valley.

4) A broad limestone plain, which because of innumerable limestone sinkholes, offered a nesting home for a large population of avifauna. This resource may have been one of the early attractions to human settlement.

5) An extensive upland forest zone extending as much as 12 miles inland from the edge to the coastal plain. As Handy and Handy (1972:469) have pointed out, the forest was much more distant from the lowlands here than it was on the windward side, but on the leeward side was more extensive. Much of the upper reaches of the *ahupua'a* would have had species-diverse forest with *kukui*, *'ōhia*, sandalwood, *hau*, *ti*, banana, etc.

Within this natural setting, archaeological and traditional sources show a general pattern of three main areas of settlement within the *ahupua'a*: a coastal zone, the Honouliuli taro lands, and inland settlement at Pu'u Ku'ua.

6.1.1 The Coastal Zone - Kalaeloa (Barbers Point), Ko'olina (West Beach)

Kalaeloa (Barbers Point)

Archaeological research at Barbers Point has focused on the areas in and around the newly constructed Deep Draft Harbor (Barrera 1975; Davis and Griffin, 1978; Hammatt and Folk, 1981, McDermott et al. 2000). Series of small clustered shelters, enclosures and platforms show limited but recurrent use at the shoreline zone for marine-oriented exploitation. This settlement covers much of the shoreline with more concentrated features around small marshes and wet sinks. Immediately behind the shoreline, under a linear dune deposit, is a buried cultural layer believed to contain some of the earliest habitation evidence in the area.

The attraction of the area to early Hawaiians was the plentiful and easily exploited bird population. Particular evidence for taking of petrels occurs at Site -2763 (Hammatt and Folk, 197:213). Initial heavy exploitation of nesting seabirds and other species in conjunction with habitat destruction probably led to early extinction. There is some indication of limited agriculture in mulched sinkholes and limited soil areas. Considering rainfall, this activity would have been limited, but probably involved tree crops and roots (sweet potatoes). The archaeological content of the sites indicates a major focus on marine resources.

Davis and Griffin (1978) distinguish functional classes of sites, based on surface area size and argues that the Barbers Point settlement consists of functionally integrated multi-household residence groups. Density contours of midden (by weight) and artifacts (by numbers) plotted for residence sites by Hammatt and Folk (1981) generally indicate narrowly defined spatial foci of discard, possibly indicating continuous use, or at least with no refurbishing or additions to the structures through time (Hammatt and Folk 1981). The focus is small habitation sites, typically lacking the full range of features found in large permanent residence complexes such as high platforms, complex enclosures, and ceremonial sites.

Ko'ōlina (West Beach)

There are three available studies on the Ko'ōlina Project Area (Davis et a. 1986a; Davis et al. 1986b; and Davis and Haun 1987).

Davis documents around 180 component features at 48 sites and site complexes consisting of habitation sites, gardening areas, and human burials. Chronologically the occupation covers the

entire span of Hawaiian settlement, in what Davis and Haun describe as "one of the longest local sequences in Hawaiian prehistory" (Davis and Haun 1987:37). The earliest part of the sequence relates to the discovery of an inland marsh, and early dates were also obtained for the beachfront site and an inland rock shelter.

6.1.2 Honouliuli Taro Lands

Centered around the west side of Pearl Harbor at Honouliuli Stream and its broad outlet into the West Loch are the rich irrigated lands of the *'ili* of Honouliuli, which give the *ahupua'a* its name. The major archaeological reference to this area is Dicks, Haun, and Rosendahl (1987) who documented remnants of a once-widespread wetland system (*lo'i* and fishponds) as well as dryland cultivation of the adjacent slopes. The Project Area is within this environmental zone.

The area bordering West Loch was clearly a major focus of population within the Hawaiian Islands, and this was a logical response to the abundance of fish and shellfish resources in close proximity to a wide expanse of well-irrigated bottomland suitable for wetland taro cultivation. The earliest detailed map (Malden 1825) shows all the roads of southwest O'ahu coalescing and descending the *pali* (cliff) as they funnel into the locality (i.e. Honouliuli Village). Dicks et al. (1987:78-79) conclude, on the basis of 19 carbon isotope dates and 3 volcanic glass dates that "Agricultural use of the area spans over 1,000 years." Undoubtedly, Honouliuli was a locus of habitation for thousands of Hawaiians. Pre-Contact population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census (Schmitt 1973:19) 1831-1832, the land (*'āina*) of Honouliuli contained 1026 men, women, and children. It is not clear whether this population relates to Honouliuli Village or the entire *ahupua'a*, but the village probably contained the vast majority of the district's population. The nature of the reported population structure for Honouliuli (less than 20% children under 12 years of age) and the fact that the population decreased more than 15% in the next 4 years (Schmitt 1973:22) suggests that the prehistoric population of Honouliuli Village may well have been significantly greater than it was in 1831-1832. A conservative estimate would be that tens of thousands of Hawaiians lived and died at Honouliuli Village.

6.1.3 Pu'uku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic in that there are relatively few documented archaeological sources. However, it is probable that the area around Pu'uku'ua, on the east side of the Wai'anae Ridge seven miles inland of the coast, was a Hawaiian place of some importance.

In 1899, Hawaiian Newspaper *Ka Loea Kālai'āina* relates a story of Pu'uku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

> There were two important things concerning this place. (1) This place was entirely deserted and left uninhabited and it seems that this happened before the coming of righteousness to Hawai'i Nei. Not an inhabitant is left. (2) The descendants of the people of this place were so mixed that they were all of one class. Here the gods became tired and returned to Kahiki [Sterling and Summers 1978:33].

McAllister recorded three sites in this area, two *heiau* (134, 137) (Pu'u Kuina and Pu'uku'ua, both destroyed) and a series of enclosures in Kukuilua which he called "kuleana sites" (McAllister 1933). On the opposite side of the Wai'anae range, along the trail to Pōhākea Pass, Cordy (2002:36) states "Kākuihihewa was said to have built (or rebuilt) Nōi'ula, a *pō'okanaka heiau* (1,300 sq. m.) in Hālona in upper Lualualei, along the trail to Pōhākea Pass leading into 'Ewa, ca. A.D. 1640-1660" (Cordy 2002:36). There is no direct archaeological evidence available to the authors' knowledge that intensive Hawaiian settlement occurred here, but it is considered as a place of high probability, based on the above indications. John Papa 'Ī'ī (1959) described a journey that Liholiho took which led him and an entourage through inland Honouliuli and over Pōhākea Pass. Geographically, the area receives sufficient quantities of water and would have had abundant locally available forest resources.

6.1.4 Summary

On the basis of archaeological studies, informed by historic records, the following may be concluded:

1) There are three areas of Hawaiian settlement in the *ahupua'a*; two are well-documented and one is problematic:
    a. the extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;
    b. the rich cultivated lands of Honouliuli 'ili for extensive wetland taro and clearly the *ahupua'a* population center; and,
    c. the uplands around Pu'uku'ua associated with *kauwā* residence but probably used for agriculture and forest resources.

2) Honouliuli is designed as a unit to contain all the geographic elements of a typical Hawaiian valley *ahupua'a*, except they are arranged geomorphically in an atypical relationship. The *ahupua'a* is not organized around a single drainage network but shares the west portions of Waikele drainage in its upper reaches. A typical and highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, an extensive limestone plain which would support only limited agriculture but would be excellent for bird catching in early times, and a huge expanse of sloping forest land. The richest forest land for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The surveys by Bordner (1983) and Hammatt and Shideler (1999) at Waimānalo Gulch indicated no evidence of Hawaiian occupation, but the gulch has been impacted in modern times (Bordner 1983).

3) The *makai* slope was not a major thoroughfare. We can see some very limited evidence of part-time agriculture in and around gulches and two foci of sparse habitation. The first is limited to *makai* portions of gulches and lava flats. This habitation is considered a *mauka* component or continuing of the Ko'ōlina coastal settlement rather than an independent focus. The second focus, separated from the first by a barren zone, is generally above the 800-foot elevation. This *mauka* habitation which could have been supported by seasonal dry land planting and forest foraging may be the lower portion of a

thinly scattered, but widespread zone of settlement which stretches eastward and northeast along the east Wai'anae Range slopes and may increase in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

4) There is to date no archaeological evidence of high status residence in Honouliuli. Large residential structures are not present along the Pacific shoreline where they would be expected. The late prehistoric occurrence of chiefs' houses is not apparent, perhaps because the ocean shoreline, although rich in marine resources, is uninviting for sport and unsuitable for fishponds. The chiefly focus of 'Ewa District was Waipi'o. Whatever activities of this class occurred in Honouliuli would have been in or near the rich lands fronting West Loch (the *'ili* of Honouliuli). Concerning status associations with Honouliuli, it is interesting to note the connection of the Pu'uku'ua settlement with slaves (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

5) The focus of population and agriculture within the *ahupua'a* of Honouliuli was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other prehistoric times, all other habitation zones were economically and socially co-dependent.

Section 7 Community Consultation

Throughout the course of this study, an effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of and/or concerns about traditional cultural practices associated with the Project Area. CSH contacted the individuals listed on Table 3 by letter, e-mail, telephone, and in personal contact. In the majority of cases, a letter along with a TMK map and a USGS topographical map of the Project Area were mailed with the following text:

> In collaboration with Environmental Communications, Inc., Cultural Surveys Hawai'i (CSH) is conducting a Cultural Impact Assessment for the proposed East Ho`opili Project, 'Ewa District, Honouliuli Ahupua'a, O'ahu Island (TMK: [1] 9-1-010:002; 9-1-017:004, 059; 9-1-018:001, 004, 072; 9-2-001:001). A map of the Project Area is enclosed for your reference.
>
> The purpose of this assessment is to identify any traditional cultural practices associated with the Project Area, past or present, pursuant to Hawaii revised Statutes 343. We are seeking your *kokua* and guidance regarding the following aspects of our study:
>
> General history and present and past land use of the study area;
>
> Knowledge of cultural sites that may be impacted by the project, for example historic sites, archaeological sites, and burials;
>
> Knowledge of traditional gathering practices in the study area, both past and on-going;
>
> Cultural associations with the study area through legends, traditional use or otherwise;
>
> Referrals of *kūpuna* or anyone else who might be willing to share their general cultural knowledge of the study area, and the surrounding *ahupua'a* lands.
>
> Any other cultural concerns the community might have related to cultural practices within or in the vicinity of the Project Area.
>
> The focus of this study is to document the potential impacts to cultural practices or resources of the proposed Project Area. If you wish to voice any cultural concerns or provide input on any of the above, please contact Kēhaulani Souza of Cultural Surveys Hawai'i at (808) 262-9972. Ms. Souza may also be contacted by e-mail at ksouza@culturalsurveys.com.

The individuals, organizations, and agencies attempted to be contacted and the results of any consultations are presented in Table 3: Community Contact List

Cultural Surveys Hawai'i Inc.
Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

Providing Excellence in Cultural Resource Management

O'ahu P.O.Box 1114 Kailua, HI 96734 Ph.:(808) 262-9972 Fax.:(808) 262-4950
Maui 16 S. Market St., #2N Wailuku, HI 96793 Ph.: (808) 242-9882 Fax.:(808) 244-1994
Kaua'i P.O.Box 498 Lawai, HI 96765 Ph.:(808) 245-4883

(November 17, 2005 date first sent)
January 26, 2006

Subject: **Cultural Impact Assessment for the East Kapolei Community Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island [TMK9-1-010:001, 9-1-017:004, 059, 072; 9-1-018:001, 004, 9-2-001:001] approximately 1,585-acres**

Aloha:

At the request of D. R. Horton-Schuler Division, Cultural Surveys Hawai'i is conducting a Cultural Impact Assessment (CIA) for the East Kapolei Community Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu (TMK: 9-1-010:001, 9-1-017:004, 059, 072; 9-1-018:001, 004, 9-2-001:001) (Figure 1 and 2).

The purpose of the Cultural Impact Assessment is to assess potential impacts to traditional cultural practices as a result of future development of the proposed East Kapolei Community Project. The development will include residential, commercial, educational and recreational facilities.

We are seeking your *kōkua* or help and guidance regarding the following aspects of our study:

- **General history and present and past land use of the project area.**
- **Knowledge of cultural sites which may be impacted by future development of the project area - for example, historic sites, archaeological sites, and burials.**
- **Knowledge of traditional gathering practices in the project area – both past and ongoing.**
- **Cultural associations of the project area, such as legends and traditional uses.**
- **Referrals of *kūpuna* or elders who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua'a* lands.**
- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.**

I invite you to contact me, Kēhaulani Souza at (808) 262-9972 or send me an e-mail at ksouza@culturalsurveys.com if you have any information you would like to share.

Me ka ha'aha'a,

Kēhaulani Souza

www.culturalsurveys.com info@culturalsurveys.com

Figure 23: Contact letter sent to organizations and individuals in Table 3

Table 3: Community Contact List

Name	Affiliation	Comments
Ailā Willliam	Hui Mālama I Nā Kūpuna O Hawai'i Nei, Wai'anae Representative	Made referral: Shad Kane
Cayan, Coochie	Former O'ahu Island Burial Council member	Made referrals: Shad Kane, Nettie Tiffany, and the Neighborhood Board.
Crail, Gail	Former resident of Honouliuli	Mrs. Crail remembers the Project Area always covered with sugar cane. She suggested that we contact the Murata and the Iwata families who have lived in Honouliuli a long time.
Eaton, Arline	*Kupuna* at Iroquois Elementary School	See Traditional Cultural Practices below for response.
Futoshi, Shinogi	Resident of Honouliuli	Mr. Futoshi mentioned that the east side of old Fort Weaver Road was all wetlands. He also mentioned that this area was well know for artesian wells and the current site of the first artesian well is not the original site, it was further back near the current *lo'i* (taro pond).
Hirata, Richard "Dickey"	President of Hawaii Plantation Village; Raised at the 'Ewa Plantation	Made referral: Arakawa family.
Iwata, Tom	Resident of Honouliuli for 90 years	Mr. Iwata has lived in Honouliuli all his life and remembers Pipeline Village above old Fort Weaver Road; *lo'i* behind his house; and the entire Project Area being covered with sugar cane.
Ka'eliwai, George	Hawaiian Civic Club of 'Ewa/Pu'uloa	Mr. Ka'eliwai would gather oysters from Pu'uloa.
Kalili, Christina	Raised in Tenney Village	Made referral: Soma 'Ohana
Kane, Shad	Makakilo, Kapolei, Honokai Hale Neighborhood Board Member	Made referral
Malama, Tesha	Former 'Ewa Neighborhood Board member	Made referrals: Mary Serrao, Arline Eaton.
Murakami, Mae	Raised in Honouliuli. Grandparents and parents owned Honouliuli Shokai Store	Mrs. Murakami's grandfather Katsuhei Murata started the Honouliuli Shokai store on Old Fort Weaver road. She noted: "the store was like a little Wal-Mart with its own tailor, butcher and groceries. They also

Name	Affiliation	Comments
		imported and exported to Japan. It was "ahead if its time." She also mentioned that her grandfather set up a credit system for the people in the community. Mae also added that Chocolate Beach was a childhood place where they would often go to gather clams, and fish from the ocean.
Nāmu'o, Clyde	Administrator at Office of Hawaiian Affairs	In a letter to CSH dated 2-20-06 Office of Hawaiian Affairs stated that they had no comment at this time.
Nakamatsu, Charles	Raised in the 'Ewa Plantation in "C" Village.	See Traditional Cultural Practices below for response
Oshiro, Richard	Former 'Ewa Plantation employee	See Traditional Cultural Practices below for response
Paishon, Frank	Raised in Tenney Village	Mr. Paishon mentioned east of the Project Area was a great place to go fishing AT Chocolate Beach. They would catch oysters, clams, and all types of crabs.
Ramos, Rodolfo	Chair of 'Ewa Task Force	Mr. Ramos mentioned that they would go fishing at Chocolate Beach, east of the Project Area, and they would catch all types of crabs and pick oysters and clams. He said as far as he remembers that area was always sugar cane.
Sato, Melvin	Raised in Ewa Plantation "C" Village	Mr. Sato mentioned that Chocolate Beach was a great place to fish and gather oysters and clams. He said his uncle Charles Nakamatsu would know more about the Project Area.
Soma, Kenneth	Retired 'Ewa Plantation and current resident	See Traditional Cultural Practices below for response
Soma, Millie	Raised in 'Ewa Plantation Tenney Village	Mrs. Soma was born in 1935 and has lived in 'Ewa Plantation ever since. She has no major concerns.
Tiffany, Nettie	O'ahu Island Burial Council, Kahu for Lanikuhonua	Mrs. Tiffany commented the land has been altered over the years by the plantation. She suggested that consultation be conducted with people from the plantation
Quintal, Leti	Raised in 'Ewa Plantation, Secretary for the Immaculate Conception Church in 'Ewa	Mrs. Quintal remembers the Project Area always covered with sugar cane. She also made referrals of people in the community Mr. Kojima and his wife, Shgeru Yawata, and Lida and Pio Barbieto.

7.1.1 Biographical Sketches of the Interview Informants

Aunty Arline Wainaha Pu'uloa Eaton

Aunty Arline Eaton is 79 years old, born in 1927. She was raised in the old traditional Hawaiian style, speaking her native language (Hawaiian) and traveling by canoe. She was raised in the area known as Keahi and Kūpaka, now known as Iroquois Point/'Ewa. She also lived for a short time in Kalihi before moving to Keahi. Her Papa Brede was the head of operations for the Dowsett Ranch. She has been the *kupuna* at Iroquois Elementary School for 19 years. Aunty Arline is one of the oldest and most knowledgeable Hawaiians for this area of O'ahu.

Richard "Dickey" Hirata

Mr. Hirata is 72, born in 1934 at the 'Ewa Plantation with the assistance of a midwife. He was raised in one of the many 'Ewa Plantation Villages called Lower Village, which was adjacent to the Project Area. Mr. Hirata's parents came to O'ahu to work in the plantation. Mr. Hirata worked for the 'Ewa Plantation for nine months then went into the army for three years. He then graduated from North Carolina State with a Bachelors Degree in Electrical Engineering. He later returned home and accepted a job with the State of Hawai'i as a Development Manager. He retired from the State of Hawai'i and now is the President of the Hawai'i Plantation Village, located in Waipahū.

Charles Yosei Nakamatsu

Mr. Nakamatsu is 85 years old, born in 1920. He was raised in the Ewa Plantation in "C" Village. He is second generation Okinawan and his parents came to Hawaii to work in the plantation. Mr. Nakamatsu worked for the plantation for 18 years as a welder then went to work for an air conditioning company.

Richard Oshrio

Mr. Oshiro is 78, born in 1928. His parents, Guikichi and Kamado Oshiro, were first generation immigrants from Okinawa. They came to Hawaii to work at the 'Ewa Plantation. Mr. Oshiro has a long history with the 'Ewa Plantation; for 77 years he has lived and worked in 'Ewa. He first lived in the Waimānalo Village, which is now known as the Ko'olina area, then in 1943 his family moved closer to the plantation's "C" Village, then to Tenney Village where he resides today. He retired in 1990 from the plantation.

Kenneth Soma

Mr. Soma is 80, born in 1926. He is full-blooded Japanese. His parents came from Japan to work at the 'Ewa Plantation. He was raised in the plantation and later worked for the plantation as a heavy equipment operator. After the Ewa Plantation closed, Oahu Sugar took over so he retired from Oahu Sugar. He also worked as a director at the Mililani Mortuary for 26 years. Today he enjoys his life in the same area that he was raised in 'Ewa.

Section 8 Traditional Cultural Practices

The northern portion of the Project Area is adjacent to Farrington Highway and the east end of the Project Area is on the boundary of the Honouliuli Taro Lands; a once-widespread wetland used for the cultivation of taro (*lo'i* and fishponds), as well as dryland cultivation of the adjacent slopes, which may have been utilized as early as A.D. 1000 (Dicks et al. 1987:78-79). East of the Project Area is West Loch (Kaihuopala'ai) of Pearl Harbor, which offered extensive fishponds (mullet, milkfish, shellfish), as well as shoreline frontage suitable for development of more fishponds. However, the majority of the Project Area is plateau land which would not have been as extensively modified or utilized based on environmental factors.

Discussions of specific aspects of traditional Hawaiian culture during information gathering interviews and "talk story" sessions are incorporated throughout this section as they may relate to the Project Area. The interviewees are represented by first and last initials with CSH denoting the Cultural Surveys Hawai'i interviewer. Some interviewees gave permission for CSH to include pertinent excerpts from interviews on Honouliuli conducted by CSH in the past for this assessment.

8.1 Gathering for Plant Resources

In the Māhele records it was documented that taro was primarily abundantly grown on the eastern edge of the Project Area (see Figure 9 & 10). Also, according to a documentation included in a study of land use in Honouliuli, it was mentioned that Kukui trees were abundant in the area, "...and of an 'old kukui tree' which was one of the boundary markers between Honouliuli and Hoaeae. This boundary runs along the present Kunia Road, and the tree is another indication that there was once a forest at this point" (Frierson 1972:12).

Given the ecosystem diversity of coastal lowland, transition, and upland forest zones in Honouliuli Ahupua'a, it is likely that one of the primary traditional cultural practices associated with the present project area would have been the gathering of native plant resources. Table 4 lists Honouliuli lowland plants and uses with columns for "common/Hawaiian name", "scientific name" and "use" based on research conducted by Barbara Frierson (1973) on native plant species present in Honouliuli before 1790, in addition to plant use recorded by Isabella Abbott (1992).

Table 4. Native Plants in Honouliuli

Hawaiian/Common Name	Scientific Name	Use
Hala, pandanus	*Pandanus odoratissimus*	Weaving
Hau, hibiscus	*Hibiscus tiliaceus*	Cordage
Milo	*Thespesia paradisiaca*	Wood used for bowls
Neneleau, Sumac	*Rhus sandwicensis* *Rhus chinensis*	Unknown
'Ilima	*Sida cordifolia*	Leis, medicine

Hawaiian/Common Name	Scientific Name	Use
Kou	*Cordia subcordata*	Bowls
Makaloa, sedge	*Cyperus laevigatus*	Mats (Abbott)
Pili grass	*Heteropogon contortus*	Thatch
Kakonakona, grass	*Panicum torridum*	Unknown
Honohonowai	*Commelina nudiflora*	Unknown
Ma'o, cotton	*Gossypium tomentosum* *Abutilon incanum*	Flowers used as dye for kapa (Abbott)
'Ūlei	*Osteomeles anthyllidifolia*	Branches used for fishing nets (Abbott)
'Uhaloa	*Waltheria americana*	Medicine (Abbott)
Koali 'ai	*Ipomoea cairica*	Cordage (Abbott)
Pā'ū o Hiiaka	*Jacquemontia sandwicensis*	Unknown
Ko'oko'olau	*Bidens* sp.	Used as tea (Abbott)
'Ulu, breadfruit	*Artocarpus incisus*	Food
Taro	*Colocasia esculenta*	Food
Niu, coconut	*Cocos nucifera*	Food, liquid

The accessibility of Honouliuli lands, including the present Project Area, to the Hawaiians for gathering or other cultural purposes would be radically curtailed during the second half of the nineteenth century. As noted above in this evaluation, by the 1870s, herds of cattle grazing across the 'Ewa Plain likely denuded the landscape of much of the native vegetation. Subsequently, during the last decade of the nineteenth century, the traditional Hawaiian landscape was further altered by the introduction and rapid development of commercial sugar cane cultivation. Throughout the twentieth century, sugar cane cultivation was the dominating land use activity within the Project Area. Cane cultivation. –and the sense that the Project Area was private property– made it difficult for employees of the 'Ewa Plantation to get access inside the Project Area, restricting right of entry. .

Based on the evidence gathered for this evaluation, at present no contemporary or continuing cultural practices occur within the Project Area specifically.

8.2 Taro in Hawaiian Culture in Regards to the Project Area

It has been documented that taro was grown in the wetlands adjacent to the Project Area and a few interviewees remembered those times as well. In this section, the cultural connections of Hawaiians to taro will be discussed.

Taro has an intimate connection to the Hawaiian culture. Taro (*kalo; Colocassia esculenta*) was probably brought to Hawai'i by the earliest Polynesian voyagers and has been a staple crop on the islands ever since. Taro is intimately connected through myth to the origins of Hawaiians as a people. There are different versions of this myth, but all of them make the connection between the first-born Hawaiian and the taro plant, according to Mary Kawena Pukui:

> The first Hāloa, born to Wākea and Ho'ohoku-ka-lani, became a taro plant. His younger brother, also named Hāloa, became the ancestor of the people. In this way, taro was the elder brother and man the younger-both being children of the same parents [Handy and Handy 1972:80].

The physical attributes, the growth patterns, and the propagation of taro all reflect the structure of Hawaiian kinship and an obvious relationship to the human body. The main plant in the center is the *makua* (parent), the smaller plants budding out of the *makua* are the *'ohā* (offspring). The center of the leaf where it connects to the stem is the growth center of the veins of the leaf and is called the *piko* (belly button). The stem is called *ha*, which is also a word for breath, the basis of life. The cycle of planting is a reflection of the human life cycle. When the taro is harvested the *kalo* (corm) is cut right below the green top, the cut top is called the *huli* (turning, returning or transforming). The *huli* is replanted and the family of taro once again continues its growth cycle. The generations of taro are thought of interchangeably with the generations of Hawaiians as reflected in the saying "*Kalo kanu o ka 'āina*"-literally "taro planted on the land" but figuratively referring to successive generations of natives (Pukui 1983:157). Both the *'ohā* and the *makua* can be used as *huli*, but as in a family, the *'oha* (child) must be separated to become independent of the parent and – to become a parent itself. If it is not, it remains a dependent attachment, overshadowed by the leaves of the *makua*. Another saying, *I makika'I kekalo I ka 'ohā*-"the goodness of the taro is judged by the young plant it produces" (Pukui 1983:133), is a metaphor for the parents being judged by the behavior of their children.

All parts of the taro plant are used for food: the corm is cooked and eaten as table taro or steamed and pounded into *poi*; the stem can be steamed and used in various soup and stew dishes; the young leaves are used for *laulau* and *lū'au* dishes mixed with fish, squid, pork, chicken or beef. Generally, the leaves are not harvested from the plants designated for corm production because continuous cutting makes the corms soft and tasteless (*loli*). Taro growers who grow leaf for home use or commercial purpose always have specially designated *lū'au* patches. It is traditional Hawaiian practice to use all the coarse green cuttings that are the by-product of the harvesting of the corns as food for the pigs. This green material, when cooked and fed to the animals, is highly nutritious. For this reason, raising pigs is traditionally is symbiotic relationship to taro production. In a traditional taro field, no space is wasted. The *lo'i* are used for the taro and any extra space on the banks is used for subsistence, utilitarian and medicinal plants, such as bananas, *noni*, and *ti*.

The practice of taro cultivation most resembles gardening in its scale and methods. Much of the work is undertaken by an individual or family, and is performed by hand. The *lo'i* and banks are beautifully manicured, ostensibly for weed control but the result is aesthetically like a garden. Yet, taro production remains viable even on this small scale because of its high per-acre productivity.

Nowhere else in the world was taro cultivation more developed than in Hawai'i (Kirch 1985:215). It was the staple for the hundreds of thousands of Hawaiians before European contact. It was grown in areas with sufficient rainfall (above 30-50 inches per annum) or under dryland management. In areas of suitable water sources extensive and sophisticated irrigated systems were developed for its cultivation. The social requirement for the planning, development, and maintenance of theses irrigated systems was a stable political system and community cooperation. Although the cultivation and maintenance of individual fields could be the purview of single families or individuals, the maintenance of the water supply system on which the entire system depended had to be organized on a community level.

Although less than 100 varieties of taro survive today, there may have been, at one time, as many as 300 varieties in the islands, distinguished by leaf shape, corm, morphology, color and use. The labels of wetland and dryland taro do not refer to different taro varieties, but only to different cultivation practices. All varieties of taro can be grown in dryland fields and all but a few in *lo'i* (flooded fields). Today there are only a few widely-grown commercial varieties. Mechanical devices are used, such as tillers and small tractors; in some cases PVC pipes have replaced earthen or stone lined *'auwai* or waterways, and commercial fertilizers are routinely used. A typical taro crop will take from 10 to 14 months to mature. With modern farming methods taro is one of the most productive per-acre staple crops in the world. However, in spite of these modern overlays, the bulk of the labor is done by hand in the context of the family and the essence of a traditional taro growing community. Cooperation in management of water and land resources remains an integral part of this lifestyle.

In pre-contact Hawaii, during the late prehistoric era, as documented by archaeological studies, taro cultivation was practiced in virtually every suitable locality, including floodplains in windward valleys with perennial streams, open lava and beach flats near stream systems, and moist leeward slopes. Taro was such an important crop it was even grown in artificial microenvironments created by mulching pits in lava fields.

Since European contact there has been a slow but steady decline in taro cultivation. In the late nineteenth and early twentieth centuries, many of the large taro growing areas were given over to rice planting. Taro cultivation returned on a smaller scale to these areas after development of the California rice industry. Today, commercial Hawaiian taro cultivation is confined to a few areas in the islands: Hānalei/Waioli, Hanapēpē and Waimea on Kaua'i, Waikāne/Waiāhole and Haleiwa on O'ahu, Honokohau, Ke'anae/Wailuanui on Maui, and Waipi'o Valley on the island of Hawai'i.

Taro cultivation was a recurrent theme of the LCA testimonies for individual kuleana in Honouliuli. There were four individual kuleana LCAs in the Project Area. The testimonies indicated that these LCA's contained at least one *lo'i* as well as house lots, *kula* and fishponds (see Figure 10 and Table 1). The LCA's and assorted taro patches are depicted on a 1878 map of Honouliuli Taro Lands (see Figure 9)

'Ewa was well known for its rare *kai* variety of taro that was very flavorful as well as the ability to reproduce itself over a ten year span. The taro of 'Ewa was poetically referred to a man's love for a 'Ewa women that was so strong he would never leave:

> "The *kai* was native to 'Ewa and was often referred to as Kai o 'Ewa. . . . An 'Ewa *kama'āina* described this in 1899: When planted, it sends up shoots, more shoots and still more shoots. Again and again it will send up new shoots, filling the mounds until they mixed with the taro of other mounds. . . . This description (*Ka Loea Kalani'āina*), June 3, 1899) indicates that in the flat, wet lowlands of 'Ewa this famous taro was grown in mounds (*pu'epu'e*) as in marshy localities. The article quoted above says that '*Kai koi* multiplies itself over and over with one planting and often last as long as ten years. No other variety or locality can equal this. This fragrant taro was likened to a woman with whom a man falls in love, and it was said that anyone who married a native of 'Ewa would come and settle there and would never leave, because of the *kai koi* of 'Ewa. Our Hawaiian writer describes two other varieties of *kai: Kai 'ele'ele*, black *kai*, has a black stalk, with dark skin on stems and leaves; its corm was tough and hard to pound. *Kai kea*, white *kai*, had a light-colored stem and leaves; the skin (of the corm) was red, but the flesh was dark like that of black *kai*, the corm likewise tough. In 1931 we collected four varieties of *kai: kai koi*, whose corm was white, vase of stalk pink, petiole pink, with a pink edge on the leaf; *kai kea* or *keokeo* with white corm, white base, whitish stalk with red margin, and a leaf with white edge and white center and pinkish veins; *kai 'ula'ula* (red *kai*) with corm flesh purplish white, and cortex of corm reddish purple, base red, stalk green with black streaks becoming light green and pink above, and finally, *kai-uliuli* (dark-*kai)* with white corm and lavender cortex, red to pink base, whitish and dusky green petiole with red and white margin, and leaf with a slightly reddish center. It was the *kai keokeo* which was described as being fragrant *('ala)*. From this was made the *poi* reserved for the chiefs (*poi ali'i)* [Handy and Handy 1972:471].

As indicated earlier the traditional settlement patterns as depicted in mid 1800s, *Mahele* documents was focused on taro cultivation in the wetlands of Honouliuli Ahupua'a.

Mr. Soma and Mr. Oshiro both mentioned a *lo'i* near Korean Camp (see Figure 19), which was adjacent to the south end of the Project Area. Aunty Arline Eaton shared her memories of gathering taro in the Honouliuli taro lands while looking at an 1825 (see Figure 7) map during the interview:

> AE: Oh, well then I wasn't even born but I know it (taro) was there, because even up to my time we had to go up there. Even though they had over there, they also had it down here, this was dry land taro. And everybody said, taste good to me. You know I never died, I'm still here. . . . All this has to do with water, fresh water, because this is where they used to have the *lo'i* . . . that's why these areas, were well water, but people don't use the names. Hey, have certain *kalo*, cause when you pick the ones over here it's a reddish color, and if you go up here (Project Area) it's a more purple color. It's the soil I think, and each one has a different taste. It's still *ono* [good], its *poi*! Yeah and the purple. I remember they having all these different *kine* [kinds] like *ulaula kalo*, *poneia*, I like the *poniponi* [taro varieties] one. But people never know, you tell them and they tell you its

something else. I don't like to explain because people don't understand. But now that your coming with this stuff [maps], now you know that its there.

Currently there is no taro cultivation in the Honouliuli Taro Lands that is within the Project Area.

8.3 Pa'akai (Salt Making)

Pa'akai (salt) was one of the condiments used by Hawaiians for curing fish and other foods. Out of all Polynesia, Hawaiians were the only group of people to produce salt from the sea by properly constructing salt pans. These salt pans were noticed and described by Reverend William Ellis:

> We saw a number of their pans, in the disposition of which they display great ingenuity. They have generally one large pond near the sea, into which the water flows by a channel cut through the rocks, or is carried thither by natives in large calabashes. After remaining there some time, it is conducted into a number of smaller pans, about six to eight inches in depth, which are made with great care, and frequently lined with large evergreen leaves, in order to prevent absorption. Along the narrow banks or partitions between the different pans, we saw a number of large evergreen leaves placed. They were tied up at each end, so as to resemble a shallow dish, and filled with sea water, in which the crystals of salt were abundant [Ellis 1839 in Buck 1964:71].

Salt making was abundant through out the 'Ewa district as documented on old maps. Mr. Oshiro mentioned that there was a Chinese man that would gather salt near the shore, at Chocolate Beach. He stated "there were 12 salt beds, the man would let the water in and trap the salt, then the salt would dry up and he would shovel the salt." Aunty Arline Eaton also mentioned that they never had to worry about not having enough salt growing up as a child:

> AE: During that period of time they had salt works in the area (looking at the 1927 map see figure 16). . . . yeah that's what it was, and there's that flume. We used to ride on this thing . . .you go right under here . . . but they don't have the salt works anymore, sad yeah? Yeah, that had the salt pans, all the way down to Ku'alaka'i, all the way to Kalaeloa, the whole thing. From Pu'uloa, which is Pearl Harbor, working all the way around pass Keone'ula, all the way down past where Ku'alaka'i is. That's almost the ending, though they maybe had one or two close to Kalaeloa. Because a lot of the boats came in there. I think, like how they have, [on the map]. That's true, exactly what you have over there. See it has Ewa Plantation, but there was water all in this area. The salt pans are really, actually, no more pan, but its coral, and you can see. But they called it that ["salt pans"]. But now that's all made out of the reef, the coral, all in that area.
>
> CSH: *So your family would gather salt?*
>
> AE: Oh, yeah. We never worried about salt, because it's right there. And had the *'alaea* [type of ocherous earth, mixed with the salt] down at Keone'ula, we go

> pick that up too. Because the water comes all in here it [the map] doesn't show you that. But water used to come all in that area. I tell people, this whole area here had water before we even had the *paniolo* here.

The most coastal portion of the Project Area is approximately 600 m (2,000 feet) from the West Loch of Pearl Harbor and the environment is not conducive to the "old" style of salt making.

8.4 Marine Resources

The sea and West Loch was a rich resource and the Hawaiian people were traditionally expert fishermen. Fish, shellfish, and other invertebrates of all types supplied the Hawaiian diet with a rich source of protein. The gathering of seaweed and salt was practiced by Hawaiian women. Today many people continue to fish along the shoreline south of the Project Area. In traditional Hawaiian times, Hawaiians going to and from marine resources at the coast, fishery resources of West Loch and its fishponds, and the low-lying mud-flats used for salt production may have crossed the present Project Area.

All the interviewees shared information about the abundant marine life just east of the Project Area, at Pu'uloa. They (Arline Eaton, Richard Oshiro, Kenneth Soma, Charles Nakamatsu and Dickey Hirata and many others) all mentioned a beach called Chocolate Beach and a well-known place to go fishing called Three Stones (see figure 16). At these places, they would often catch *pāpio*, mullet, oysters, clams, and all types of crab such as Hawaiian crab and *haole* crab and *limu* as well. They would use shrimp for bait, or as Mr. Soma mentioned "we would often get guts from the slaughter house and use that for bait." Mr. Nakamatsu also added " we would go get meat or slop from Kahuā Ranch or the Hawaiian Meat Market then we would go catch crab, such as Haole Crab, Kanaka Crab which is the reddish brown Crab and we would dig for clams and oysters". Mr. Nakamatsu and Mr. Soma both mentioned that on the way to the beach they would cut the Koa Haole tree before they would go fishing to use as a fishing pole". Below, Aunty Arline Eaton expresses her *mana'o* (thoughts) on different fishing resources:

> . . .That was beautiful, because you can get like *'ō'io* [bonefish], *u'u* [soldierfish], *enenue* [pilotfish], *kala* [surgeonfish], *manini* [surgeonfish], *moano* [goatfish], *he'e* [octopus], *pāpa'i* [crabs], and many others. And it was clean, and nowadays I don't know about what you'd get. . . . Moku'ume'ume we called it, Ford Island. And had oysters, you know they said never had, but they had oysters over there. But you know we never went over there and took a lot, we'd just take what you want, that's all. Why you need plenty, you don't need them all. You want some more, then you could always go back over there and go get some more. Each area had its own certain kind. . . . It's different from the one over here, because of the kind of *limu* [seaweed] they eat. Cause over here is lots of *līpo'a* [brown seaweed], so you can smell them [in the fish, yeah?]. Yeah, and you could smell it at high tide too. But now, you no can smell the *limu*. And when you open up *manini* you can look inside what they eat. They only eat *limu*, they only eat certain kinds, and they're clean. That's why you can just take 'em and throw them on the fire, you no need clean 'em. *Manini* don't eat just any kind stuff, still *ono*.

CSH: *I remember last time I talked to you, you said your tutu papa would go to Waikiki in a canoe?*

AE: . . . and go out to Kou, to Waikiki, yeah, to Kahanamoku's place. Bernice Kahanamoku and I are good friends, that's Duke's only sister. He only had one sister out of all of them. When we went down there we couldn't come home, cause it would take time to get over there. So, we would sleep over night over there.

CSH: *He would paddle all the way over there in a four man canoe?*

AE: Well, I was young, but yeah I would just go with him, and he would paddle. I guess he would take stuff over there, not that they didn't have fish over there, but certain places get certain kinds. We have all different kinds of *limu* over here, any kind you could think of, but if you want to get *limu kohu*, good *kine*, you go Kaua'i. We have over here, but not as *ono*, you know what I'm saying? Like here the *'ō'io* was known to be one of the best in Pu'uloa, so that's why *tutu papa* would bring. That's what Duke's papa used to like.

Limu was very important in the Hawaiian diet and is defined by Pukui & Elbert (1971) "A general name for all kinds of plants living under water, both fresh and salt, also algae growing in any damp place in the air, as on the ground, on rocks and other plants." Aunty Arline spoke of the different types of *limu* in the 'Ewa area:

This whole area was known as the house of the *limu*. You can imagine the smell, but we never bothered. And now no more *limu*. Had plenty . . . and now no more. Well you know, there was a heavy influx of immigrants coming in. First they look at it, oh this is plenty, lets pick em (*limu)* all up, and they'd go and sell em. They'd never think about just pick their part, no they'd take the whole thing. So when they'd go, they'd pick up everything. Oh no, had in the locks, in Hō'ae'ae, had to have *limu* over here, all the way out. You know, maybe not as much as you see out there, but they did have *limu* in there because you had the fish. As long as you have the fish inside there, gotta have the *limu* inside there. That's why I said the *limu* is very important. That's why we were teaching the children. Had *līpo'a*, plentiful, but not as much as you would find in Pu'uloa, because of the changing of the ocean and the tide.

You need to have lots of running water back and forth, like waves coming in, going out. That's how that *limu* is strong and fresh. But we also had it in here too, all into this area. Mostly, the kind of *limu* you would find in here is *'ele'ele*. They had, cause of the water, there was a lot of fresh water that went in there. You would find it close up into an area where there is a lot of running water. That's how we knew there had fresh water coming out, can't live without fresh water, all of it needs it.

The Project Area is approximately 600 m (2,000 feet) back from the coast therefore marine resources will not be affected.

8.5 Burials

East of the Project Area, a pre-contact Native Hawaiian burial was found at Hō'ae'ae Point (Papapūhi Point) in West Loch Estates, and a historic Chinese crypt was found in a cave in the NAVMAG-West Loch area, (see Figure 22). Though none of the interviewees knew of any burials in the Project Area or in the vicinity, Aunty Arline did suggest that if people were living in the area, there is a possibility of burials:

My only thought is that for every person that lives in that area, that's where they bury their people . . .We never said anything. if people died, we'd go over there and they'd bury them right there where the house is. We'd never go four-hundred-million-miles away, its right there. All your *'ohana* stay right in the same area. We never went afar, not in the rural areas.

8.6 Historic Properties

CSH previously performed an assessment of 546-acres of the Project Area in 1990 as part of theWest Loch Bluffs project, which was postponed. During the previous survey CSH identified the following historic features:

Sites 50-80-12-4344 (plantation infrastructure), -4345 (railroad berm), -4346 (northern pumping station), -4347 (central pumping station), and -4348 (southern pumping station).

8.7 Stream Resources

William Puleloa of the DLNR, Division of Aquatic Resources summarizes the importance of streams as a traditional Native Hawaiian cultural resource:

From the earliest days, streams were among the most important natural resources sought after by native Hawaiians. Battles were fought and lives sacrificed for the right to use stream water. The Hawaiians called freshwater wai, and considered it to be sacred. People using wai from streams took only what was absolutely necessary. They were expected to share the wai with others. This was done without greed or selfishness. Such practices gave Hawaiians their word for law, which is kanawai, or the "equal sharing of water." Water was so valuable to Hawaiians that they used the word "wai" to indicate wealth. Thus to signify abundance and prosperity, Hawaiians would say waiwai.

The Honouliuli Stream passes through the northeastern side of the Project Area (north of Farrington Highway), extends through the Honouliuli Taro Lands east of the Project Area and then empties into Pearl Harbor. The stream was the main water source for the lo'i in the Honouliuli Taro Lands. Aunty Arline spoke about the days that her *tutupa* and herself would go up stream in his four-man canoe. The canoe was filled with *i'a* (fish) and *limu* to trade with the people who lived near Honouliuli Stream who cultivated taro. She mentioned that as children they would often gather *'ōpae* and *'o'opu* from the stream. Aunty Arline also stated, "my *tutupa* would visit these people and he would chant in Hawaiian and the people on shore would chant back." This was a common practice of asking for permission to come ashore, visit, and trade. She

also mentioned that the same thing would happen when people would come and visit her and her family in Keahi (Keahi Point in Pu'uloa; see Figure 5). At this time we have not found evidence of any cultural activity currently being practiced within the stream.

8.8 Trails

Trails served to connect the various settlements throughout the District of 'Ewa. Based on nineteenth and twentieth century maps, the primary transportation routes *mauka/makai* and cross-*ahupua'a* correlated closely to the existing major roadways (see Figure 6). John Papa 'I'ī describes a network of Leeward O'ahu trails that in later historic times encircled and crossed the Wai'anae Range, allowing passage from West Loch to the Honouliuli lowlands, past Pu'uokapolei and Waimānalo Gulch to the Wai'anae coast and onward, circumscribing the shoreline of O'ahu ('I'ī 1959:96-98). It seems clear that a major east/west artery from 'Ewa and Kona O'ahu to Wai'anae was the pre-cursor trail that 'I'ī was referring to, and what could possibly be the current Farrington High Way. However, today no remnants of the trail remain. (Figure 6). Trails in relation to the Project Area

8.9 *Wahi Pana* (Storied Places)

The concept of *wahi pana* (a place with a story or legend attached to it) is very important in the Hawaiian culture because it is a connection to the past and, therefore, the ancestors. From the name of a place one can know intimate details about the people who lived there, the environment, cultural practices, and historical events that took place. In Hawaiian culture, if a particular spot is given a name, it is because an event occurred there that has meaning for the people of that time. Because Hawaiian culture was based on oral traditions, place names and their stories were an important way of remembering these traditions and ensuring these stories would be passed on to future generations. In Hawaiian thinking, the fact that a place has a name deems it important. Often, spiritual power or *mana* is attached to a place, which increases its importance. On the subject of *wahi pana*, Edward Kanahele writes:

> As a native Hawaiian, a place tells me who I am and who my extended family is. A place gives me my history, the history of my clan, and the history of my people. I am able to look at a place and tie in human events that affect me and my loved ones. A place gives me a feeling of stability and of belonging to my family, those living and dead. A place gives me a sense of well-being and of acceptance of all who have experienced that place [Kanahele, in James 1995:6].

Aunty Arline agrees that it is very important to use the old place names that were given by Hawaiian people because it gives meaning to a specific area (see Figure 5):

> CSH: *How come they don't have Kūpaka on the map? Here's Ke'ahi and Kūpaka, so you lived near the beach then?*
>
> AE: [showing on map] right here, in this area, 'Ewa beach road. Kūpaka goes all the way up to where Parish Drive is. And it was named after Mr. Dowsett and the Parish's, cause they're related, they were the ones that came with Kamehameha. So he lived here, in Ke'ahi, and it was him who gave that name, Kūpaka, for that area. So that's why he named that area, and yet there was nothing [nothing there], These people came and they gave all that land to the Dowsetts and the Parish's. [CSH: Liholiho] Yeah, he gave it to them.
>
> CSH: *What did you call this beach?*
>
> AE: Keone O Keahi and Keone O Kūpaka, all of this is Pu'uloa. All the way down till you come to Keone'ula. Actually, it's Keone'ula because that's where that *'alaea* was. A lot of people don't know, but that's the reason why it was named that. It should not be One'ula, it should be Keone'ula. I keep saying that over and over they say, why you have to put that, Keone'ula?
>
> CSH: *So, it's the beach-that-is-red, the red beach?*
>
> AE: Yeah. But of course it doesn't show it now, but at that time, even when I was young, I remember seeing that big mound. Because all of this was fishponds. All in this area, this whole place all the way going down to, I don't like to say, Pearl Harbor the name should be Pu'uloa, until even Manana, all of that had fishponds. This whole area was like that, and salt pans.

Kapapapūhi is a point just east of the Project Area and Aunty Arline Eaton shared a story about this special place that was told to her as a child:

> Oh yeah, you talking about the outside area. Had *pūhi* [eel] all over, but mainly they used that point. There's a *mo'olelo* [story] that goes with that. There was this *pūhi* who is supposed to be, like, king of the area, and the *Tutukane* and the *Tutuwahine* came over there, and the *pūhi* looked and said oooh that *wahine*, I like that one. Well so the *pūhi* make sure plenty *i'a* [marine creatures] around, and one day the *Tutukane* never came, only her went over there, and she was picking *'opihi* [limpets]. Pretty soon she went underneath the water, and he saved her. . . . He loved her, he fell in love with her [*pūhi* king]. And he didn't want to let her go. And she said, Oh please I want to go home, and he said, no you stay with me, don't go, I'll give you everything you want, and you don't have to worry. And she cried, and she cried. Then he found out that boy that came down was not her sweet heart or anything, that was her brother. But you know Hawaiian style! And together they would always go out and go fishing because the father had gone out fishing and got lost, and only had the mama. And the mama wasn't feeling well. So these two [the brother and sister] would help out the grandmama and grandfather and go out. And the *pūhi* felt so sorry, so he said okay but anytime you need help I will always be here. And so every time I see this place and see this name I think of that. I could imagine him just standing over there and looking at her and thinking, oh how he loved her. Yeah that's one of the stories that they had about that. And that was told to me, I don't see it in a book. My papa told me that so I always remembered that. Then there was a song . . . that they would sing, it was so pretty.

Section 9 Conclusion and Recommendations

9.1 Conclusion

Honouliuli is associated with a number of legendary accounts. Many of these concern the actions of gods or demi-gods such as Kāne, Kanaloa, *Māui*, Kamapua'a, the reptile deity (*mo'o*) Maunauna, the shark deity Ka'ahupāhau, and the demigod hero Palila. While there are several references to chiefly lineages and references to the ruling chiefs Hilo-a-Lakapu and Kūali'i, there is no clear reference to powerful chiefs living permanently in Honouliuli.

The accessibility of Honouliuli lands, including the proposed Project Area, to the Hawaiians for gathering or other cultural purposes was radically curtailed during the second half of the nineteenth century. As noted above in this assessment, by the 1870s, herds of cattle grazing across the 'Ewa Plain likely denuded the landscape of much of the native vegetation. Subsequently, during the last decade of the nineteenth century, the traditional Hawaiian landscape was further distorted by the introduction and rapid development of commercial sugar cane cultivation. Throughout the twentieth century, sugar cane cultivation was the dominating land use activity within the Project Area. Cane cultivation – and the sense that the Project Area was private property – restricted access inside the Project Area to employees of 'Ewa Plantation.

Hawaiian organizations, government agencies, community members, and cultural and lineal descendants with ties to 'Ewa were contacted to: (1) identify potentially knowledgeable individuals with cultural expertise and knowledge of the Project Area and its surroundings, and (2) identify cultural concerns and potential impacts within the Project Area. An effort was made to locate informants with ties to 'Ewa and neighboring *ahupua'a* who live, or had lived in the region or who, in the past, used the area for traditional and cultural purposes. For this assessment, Arline Eaton, Richard Hirata, Richard Oshiro, Kenneth Soma, Charles Nakamatsu and other *kūpuna* were interviewed. They mentioned that in the past there was traditional gathering of taro and salt, along with fish such as *pāpio*, mullet, as well as oysters, clams and a variety of crab near the Project Area. They all referred to this area of rich marine resources as Chocolate Beach and Three Stones. The people contacted were not aware of any on-going cultural practices, archaeological sites, trails, or burials within the Project Area. Most of the people contacted mentioned that the Project Area was heavily altered by plantation activities.

Based on what was gathered from the consultation process and the evidence of LCA's and lack of resources, the vast majority of the Project Area was utilized less intensively during traditional times. Additionally the years of sugar cane cultivation left no reason for access. Most of the resources such as taro farming and gathering of marine resources were on the fringing edge or outside of the Project Area. Based on the evidence gathered for this evaluation, at present no contemporary or continuing cultural practices occur within the Project Area specifically.

9.2 Recommendations

No contemporary or continuing cultural practices currently occur within the proposed Project Area. It should be noted that subsurface historic properties associated with former traditional Hawaiian activities in the project area, such as artifacts and cultural layers, may be present despite the decades of modern activities such as ranching and sugar cane. As a precautionary measure, personnel involved in future development should be informed of the possibility of inadvertent cultural finds, and should be made aware of the appropriate notification measures to follow.

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APPENDIX G
Environmental Noise Assessment

D. L. ADAMS ASSOCIATES, LTD.
Consultants in Acoustics and Performing Arts Technologies

Environmental Noise Assessment Report
Ho'opili
Ewa, Oahu, Hawaii

February 2008

DLAA Project No. 06-34

Prepared for:
PBR Hawaii
Honolulu, Hawaii

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1.0 EXECUTIVE SUMMARY

1.1 The project area is currently exposed to varying daytime ambient noise levels, depending on the proximity to major roadways. The areas adjacent to H-1 Freeway and Farrington Highway experience high ambient noise levels during peak traffic hours. Ambient noise levels range from 59 to 72 dBA adjacent to the H-1 Freeway and 44 to 59 dBA adjacent to Farrington Highway. The ambient noise environment is relatively low in areas that are far from the major roadways, where ambient noise levels range from 37 to 60 dBA. The dominant noise sources are traffic, wind, birds, occasional distant aircraft flyovers, and farm equipment.

1.2 Development of project areas will involve excavation, grading, and other typical construction activities. The Ho'opili project is not expected to impact adjacent properties, however, residences from the initial phases may be impacted by construction noise from subsequent phases due to their proximity to the construction site. Noise from construction activities should be short term and must comply with State Department of Health noise regulations.

1.3 The proposed land uses may include noise generating activities which could impact adjacent residences. Noise mitigation measures should be incorporated into the project design to prevent such impacts, such as creating buffer zones, installing mufflers and/or erecting barriers around noisy equipment. Consideration should also be given to the layout of the commercial areas to meet State Department of Health noise regulations and reduce the noise impact. Restrictions may need to be placed on commercial uses allowed in the commercial areas in order to strictly control development of potential noise producing industries.

1.4 Increases in peak hour traffic noise along Fort Weaver Road due to the project are estimated to be less than 1 dB. Increases in peak hour traffic noise along Old Fort Weaver Road due to the project are estimated to be between 3 and 8 dB. This is a significant increase for homes currently located along Old Fort Weaver Road.

1.5 Vehicular traffic noise from the H-1 Freeway may significantly impact the proposed development. Traffic noise mitigation will be necessary to satisfy the FHWA maximum exterior L_{eq} noise limit of 67 dBA for parcels adjacent to H-1 Freeway. Because of its vicinity to the H-1, much of the project site will be impacted by noise from the freeway. The construction of a noise barrier wall, as well as the construction of buildings, along H-1 will mitigate traffic noise for most of the impacted area. However, the parcels that are very close to the H-1 are the most impacted by traffic noise. Homes and schools that are built within 120 feet of the H-1 Freeway will not satisfy the FHWA maximum exterior L_{eq} noise limit of 67 dBA, even if noise mitigation (i.e., noise barrier wall) are implemented. To limit the noise impact on the project, the 120 foot buffer zone is best suited for structures that are less sensitive to noise, such as commercial and light industrial uses. The FHWA noise criterion is less stringent for commercial and light industrial uses. However, even for these uses located within 120 feet from the H-1 Freeway, noise mitigation (i.e., noise barrier wall) will be needed to meet the FHWA maximum exterior Leq noise limit of 72 dBA. Although the FHWA criteria is not a regulatory requirement for this project, as it has no authority to enforce land use, its noise limit criteria is recommended by the FHWA to be used as a guideline for consideration of land use and the impact of traffic noise.

1.6 Vehicular traffic noise from Farrington Highway and Fort Weaver Road may significantly impact the proposed development. Any homes, schools, or parks within 80 feet of Farrington Highway and 70 feet of Fort Weaver Road will require traffic noise mitigation to meet the FHWA maximum exterior L_{eq} noise limit of 67 dBA.

1.7 The addition of the proposed transit system is not expected to cause a significant change in traffic noise levels from roadways within the project site.

1.8 Aircraft noise due to operations at nearby Kalaeloa Airport and the Honolulu International Airport may be audible at the project site. However, flights directly above the site are infrequent and the project site is outside of the L_{dn} 55 noise contour for both airports. Therefore, a significant noise impact due to aircraft noise is not expected.

1.9 The proposed alignments of the future Honolulu rail transit system run along Farrington Highway and North-South Road and may include two transit stations. Design of the Ho'opili development should include a minimum setback distance between the nearest residences and the transit guideway and stations to minimize the impact due to transit system related noise. The City and County of Honolulu is currently developing an Environmental Impact Statement for the proposed transit system. We assume that transit noise mitigation measures and appropriate setback distances will be addressed in the EIS.

1.10 Exterior noise levels at two school sites (H-1 Freeway/Kunia Road and Farrington Highway) will exceed the Hawaii State Board of Education (BOE) Policy 6700 noise limit of $L_{10} = 65$ dBA. Policy 6700 requires that air conditioning be provided to schools that are exposed to exterior noise levels in excess of the noise limit. The layout and construction of the school should be carefully designed such that exterior noise will not disturb learning activities and interfere with speech intelligibility. To reduce ambient noise levels at the school site, traffic noise mitigation measures may also be necessary, such as an earthen berm or noise barrier wall.

2.0 PROJECT DESCRIPTION

The Ho'opili project is a proposed Transit-Oriented-Development (TOD) that is a mixed-use, transit-ready community including residential (approx. 11,750 units, including affordable housing), business and commercial areas (approx. 145 acres), light industrial/business areas (approx. 50 acres), transit stops, schools and other public facilities (approx. 100 acres), parks (approx. 60 acres), and large amounts of open space (approx. 150 acres). The project area is located in the Ewa District, on the island of Oahu and is bounded by several major roadways: H-1 Freeway, the proposed North-South Road, and Fort Weaver Road. Other major roadways contained within the site include Farrington Highway, Old Fort Weaver Road and the proposed East-West Road.

Historically, the site was cultivated in sugarcane and is currently utilized for diversified agriculture. The proposed project involves the reclassification of approximately 1,554 acres from the Agricultural District to the Urban District.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and have set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 State of Hawaii, Community Noise Control

The State of Hawaii, Community Noise Control Rule [Reference 1] defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to *stationary* noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc. The Community Noise Control Rule does not address most *moving* sources, such as vehicular traffic noise, air traffic noise, or rail traffic noise. However, the Community Noise Control Rule does regulate noise related to agricultural, construction, and industrial activities, which may not be stationary.

The maximum permissible noise levels are enforced by the State Department of Health (DOH) for any location at or beyond the property line and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 1. With respect to mixed zoning districts, the rule specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level. In determining the maximum permissible sound level, the background noise level is taken into account by the DOH.

3.2 U.S. Federal Highway Administration (FHWA)

The FHWA defines four land use categories and assigns corresponding maximum hourly equivalent sound levels, $L_{eq(h)}$, for traffic noise exposure [Reference 2], which are listed in Figure 2. For example, Category B, defined as picnic and

recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67dBA and a maximum interior L_{eq} of 52 dBA. These limits are viewed as design goals, and all projects meeting these limits are deemed in conformance with FHWA noise standards. Calculation of traffic noise levels should be conducted using a Federal Highway Administration traffic noise model [Reference 3].

3.3 State of Hawaii Department of Transportation (HDOT)

The HDOT has adopted FHWA's design goals for traffic noise exposure in its noise analysis and abatement policy [Reference 4]. According to this policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15 dB.

3.4 U.S. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 5]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

3.5 U.S. Department of Housing and Urban Development (HUD)

HUD's environmental noise criteria and standards in 24 CFR 51 [Reference 6] were established for determining housing project site acceptability. These standards are based on day-night equivalent sound levels, L_{dn}, and are not limited to traffic noise exposure. However, for project sites in the vicinity of highways, the L_{dn} may be estimated to be equal to the design hour $L_{eq(h)}$, provided "heavy trucks (vehicles with three or more axles) do not exceed 10 percent of the total traffic flow in vehicles per 24 hours and the traffic flow between 10:00 p.m. and 7:00 a.m. does not exceed 15 percent of the average daily traffic flow in vehicles per 24 hours." For these same conditions, L_{dn}, may also be estimated as 3 dB less than the design hour L_{10}.

HUD site acceptability criteria rank sites as Acceptable, Normally Unacceptable, or Unacceptable. "Acceptable" sites are those where exterior noise levels do not exceed an L_{dn} of 65 dBA. Proposed housing projects on "Acceptable" sites do not require additional noise attenuation other than that provided by customary building techniques. "Normally Unacceptable" sites are those where the L_{dn} is above 65 dBA, but does not exceed 75 dBA. Housing on "Normally

Unacceptable" sites requires some form of noise abatement, either at the property line or in the building construction, to ensure the interior noise levels are acceptable. "Unacceptable" sites are those where the L_{dn} is 75 dBA or higher. The term "Unacceptable" does not necessarily mean that housing cannot be built on those sites; however, more elaborate sound attenuation will likely be needed.

3.6 Federal Aviation Administration (FAA)

The FAA addresses guidelines for compatible land use that surrounds airports [Reference 7]. Noise contour maps are expressed in terms of yearly day-night average sound levels, L_{dn}, due to aircraft operations. The FAA states that residences outside of the L_{dn} 65 noise contour are compatible without restrictions. Residences between the L_{dn} 65 and 75 contours are only compatible if noise mitigation measures are incorporated into the building structure. Residences inside of the L_{dn} 75 noise contour are generally not compatible. The compatibility of other land uses, such as commercial, manufacturing, public, and recreation, are shown in Table 1.

3.7 State of Hawaii Department of Transportation (HDOTA), Airports Division

The State of Hawaii, Department of Transportation, Airports Division has adopted noise restrictions that are similar to the FAA's, but more stringent [Reference 8]. Similar to the FAA, HDOTA expresses land use compatibility guidelines based on yearly day-night average sound levels, L_{dn}, due to aircraft operations. In most cases, the HDOTA states maximum noise limits that are 5 dB lower than the FAA. For example, the HDOTA states that residences outside of the 60 L_{dn} noise contour are compatible. Residences between 60 and 70 L_{dn} contours are only compatible if noise mitigation treatments are implemented. However, HDOTA states:

> "Where the community determines that these uses must be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 L_{dn}, or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure, plus air conditioning, may be required to provide additional outdoor to indoor NLR, and will not eliminate outdoor noise problems."

The HDOTA guidelines also specify 60 dBA as the maximum allowable L_{dn} level for school, day care center, and church uses without any mitigation measures. Commercial uses such as retail shops, restaurants, shopping centers, etc. are compatible with L_{dn} levels up to 65 dBA without any mitigation measures. With noise mitigation measures implemented, such commercial uses are allowed in areas exposed to an L_{dn} as high as 75 dBA. The compatibility of other land uses, such as manufacturing, public, and recreation, are shown in Table 2.

In addition to the HDOTA compatibility guidelines, The Hawaii Revised Statutes, Chapter 0508D, Section 15 states a notification is required to the buyer for real estate property that lies,

> "Within the boundaries of the noise exposure area shown on maps prepared by the department of transportation in accordance with Federal Aviation Regulation Part 150-Airport Noise Compatibility Planning (14 Code of Federal Regulations Part 150) for any public airport;"

The FAR Part 150 noise exposure area boundary is defined as the 55 L_{dn} noise contour. Therefore, a notification to the buyer is required for all real estate transactions within the 55 L_{dn} noise contour.

3.8 Federal Transit Administration (FTA)

The FTA defines three land use categories and provides guidance in the assessment of noise and vibration due to transit systems based on an increase in cumulative noise. Methods for determining noise and vibration impacts and possible mitigation measures for typical transit projects are provided in the Transit Noise and Vibration Impact Assessment report [Reference 9]. One set of criteria defined in the report applies to all rail projects (including light rail transit, rapid rail transit, etc.) and their fixed facilities. The criteria, specified in maximum hourly equivalent sound levels, $L_{eq(h)}$, and day-night equivalent sound levels, L_{dn}, varies according to the existing noise levels, the predicted transit system project noise levels, and the land use category, as shown in Figure 3. The area between the two curves labeled as "Impact" is a transitional area where the change in cumulative noise level will be noticeable to most individuals, but may not be sufficient to cause adverse reactions from the community.

The FTA criteria were developed to recognize the heightened community annoyance caused by late night and early morning transit service and the varying sensitivity of communities to transit systems under different background noise conditions and is concurrent with various noise standards defined by other Federal agencies. It is important to note that the criteria are not enforceable regulations, but design goals that are useful tools for assessing the noise environment.

3.9 State of Hawaii State Board of Education (BOE)

BOE policy 6700 [Reference 10] sets four classroom noise level requirements:

1. Soundproofing design shall be used to reduce the noise level whenever the internal noise level exceeds 50 dBA.

2. Noise control shall be provided for all school facilities which generate exterior noise levels at the property line exceeding DOH standards.

3. Noise control measures shall be installed in classrooms and administration/staff facilities (excluding shop classrooms) whenever 50 percent of the intruding noise level measurements exceed 55 dBA when inside the classroom with windows and doors open and the room empty.

4. Air conditioning shall be provided to facilities exposed to exterior noise levels greater than L_{10} = 65dBA.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Two types of noise measurements were conducted to assess the existing acoustical environment in the vicinity of the project location. The first noise measurement type consisted of continuous long-term ambient noise level measurements (Locations L1, L2, L3 and L4), as shown in Figure 4. The second type of noise measurement was short-term and included traffic counts (Locations S1, S2, S3, and S4), also shown in Figure 4. The purpose of the short-term noise measurements and corresponding traffic counts were to calibrate a traffic noise prediction model. The noise measurements were conducted between October 9, 2006 and October 15, 2006.

4.1 Noise Measurement Procedures

Long-Term Noise Measurements

Continuous, hourly, statistical sound levels were recorded for approximately 3 days at each location. The measurements were taken using a Larson-Davis Laboratories, Model 820, Type-1 Sound Level Meter together with a Larson-Davis, Model 2560 Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. The microphone was mounted on a tripod, approximately 6 feet above grade. A windscreen covered the microphone during the entire measurement period. The sound level meter was secured in a weather resistant case.

Short-Term Noise Measurements

An approximate 30-minute equivalent sound level, L_{eq}, was measured at each location. Vehicular traffic counts and traffic mix were documented during the measurement period. The noise measurement was taken using a Larson-Davis Laboratories, Model 824, Type-1 Sound Level Meter together with a Larson-Davis, Model 2541 Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. The microphone and sound level meter were mounted on a tripod, approximately 5 feet above grade. A windscreen covered the microphone during the entire measurement period.

4.2 Noise Measurement Locations

Long-Term Noise Measurements

Location L1: Approximately 200 feet makai of the H-1 Freeway. The dominant noise source was vehicular traffic from the H-1 Freeway. Secondary noise sources included aircraft flyovers, birds, wind, and farm equipment.

Location L2: Approximately 150 ft makai of Farrington Highway near the HECO Station. The dominant noise source was vehicular traffic from Farrington Highway. Secondary noise sources included farm equipment, birds, wind, and aircraft flyovers.

Location L3: Near the eastern edge of the project area, approximately 0.7 miles makai of Farrington Highway. The dominant noise sources were birds, wind, aircraft flyovers, and farming equipment that may have been operated in the vicinity of the sound meter.

Location L4: Near the western edge of the project, approximately 0.9 miles makai of Farrington Highway and 0.25 miles east of the proposed North-South Road. The dominant noise sources were birds, wind, aircraft flyovers, and farming equipment that may have been operated in the vicinity of the sound meter.

Short-Term Noise Measurement Locations

Location S1: Positioned adjacent to Old Fort Weaver Road, approximately 40 feet west of the edge-of-pavement.

Location S2: Positioned adjacent to Fort Weaver Road, approximately 50 feet west of the edge-of-pavement.

Location S3: Positioned adjacent to Farrington Highway, approximately 35 feet makai of the edge-of-pavement.

Location S4: Positioned adjacent to H-1 Freeway, approximately 50 feet makai of the edge-of-pavement.

4.3 Long-Term Noise Measurement Results

The ambient sound levels at locations L1 and L2 are relatively dynamic and depend significantly on the vehicular traffic patterns of the surrounding roadways. Thus, the areas adjacent to H-1 Freeway and Farrington Highway experience high ambient noise levels during peak traffic hours. The ambient noise environment is relatively low in areas that are far from the major roadways, i.e. locations L3 and L4, where ambient sound levels do not vary significantly during the daytime hours but drop off at night. The measured equivalent sound levels, L_{eq}, in A-weighted decibels (dBA) are graphically presented in Figures 5 for locations L1

and L2 and Figure 6 for locations L3 and L4. Noise measurement results are also summarized in Table 3.

Adverse weather was experienced between October 12, 2006 and October 17, 2006. The sound level meter experienced several overloads, likely due to rainfall. The portions of data from the meters at location L3 and L4 that may be erroneous have been indicated on Figure 6. However, the overall trend in noise levels is still apparent.

4.4 Project Vicinity

Existing residential developments immediately surrounding the project site include Waipahu and West Loch to the east and Ewa Villages to the south. Vehicular noise from Fort Weaver Road, Farrington Highway and the H-1 Freeway dominate the ambient environment in the vicinity of these roadways. The future UH West Oahu and DHHL sites, west of the Ho'opili project site, experience an acoustical environment similar to the project site with wind and occasional aircraft flyovers being dominant noise sources. In addition, a quarry and a recycling plant located west of the project site may contribute to some of the ambient noise. Heavy trucks, which generate more noise than automobiles, travel to and from the quarry and recycling plant and constitute 10% of the AM peak hour traffic total on Farrington Highway. Heavy trucks also constitute 10% of the AM peak hour traffic total on H-1 Freeway.

4.5 Kalaeloa Airport and Honolulu International Airport Noise Contours

The project is several miles northeast of the Kalaeloa Airport and west of Honolulu International Airport. Therefore, the project site was assessed for aircraft noise using airport noise contour maps. The Kalaeloa Master Plan [Reference 11] includes year 2020 projections of airport operations and noise contour maps for airport alternates. Also included in the airport noise contour maps is the effect of the Honolulu International Airport operations [Reference 8]. A complete description of the Kalaeloa Airport alternatives can be found in the Kalaeloa Master Plan. The Ho'opili project site is outside of the L_{dn} 55 noise contours for both airports.

5.0 POTENTIAL NOISE IMPACTS

5.1 Project Construction Noise

Development of project areas will involve excavation, grading, and other typical construction activities during construction. The various construction phases of the project will generate significant amounts of noise. Depending on when construction occurs, the Ho'opili development and construction of the transit corridor may impact existing adjacent properties, such as the homes adjacent to Fort Weaver Road and Old Fort Weaver Road. Future developments such as UH West Oahu and DHHL on adjacent properties that are completed before the Ho'opili development may also be impacted by construction noise. Similarly, residences from the initial phases may be impacted by construction noise from

subsequent phases due to their proximity to the construction site. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 7. Pile driving, if employed, and earthmoving equipment, e.g., bulldozers and diesel-powered trucks, will probably be the loudest equipment used during construction.

5.2 Project Generated Stationary Mechanical Noise and Compliance with State of Hawaii Community Noise Control Rule

The Ho'opili project is proposed to be a mixed-use development of which 80 percent of the residential units will be multi-family. Approximately 195 acres of the project site is proposed for commercial, business, or light industrial development which will be distributed throughout the residential and open space areas located within the project site. Noise emanating from these commercial uses could significantly impact the proposed adjacent noise sensitive residential areas. The various phases in the long range development plan will incorporate stationary mechanical equipment that is typical for residential and commercial buildings. Expected mechanical equipment may include air handling equipment, condensing units, refrigeration units, etc.

Noise from this mechanical equipment and other equipment must meet the State noise rules, which stipulate maximum permissible noise limits at the property line. For multi-family dwellings, business, and commercial areas, the noise limits are 60 dBA during the day and 50 dBA during the night, as shown in Figure 1. For residential areas (i.e., single-family homes), noise limits are 55 dBA during the day and 45 dBA during the night. For industrial areas, the noise limit is 70 dBA during the day and night. For mixed zoning districts, the primary land use designation is used to determine the maximum permissible noise limits. However, the DOH takes into consideration background noise levels when assessing noise infractions. Mitigation of mechanical noise to meet the State DOH noise rules should be incorporated into the project design.

5.3 Compliance with FHWA/HDOT Noise Limits

A vehicular traffic noise analysis was completed using the FHWA Traffic Noise Model Look-up Tables Software Version 2.5 (2004) [Reference 12] for the existing conditions, future year 2030 projections with the "No Build" condition, and future year 2030 projections with the "Build" condition under Scenario A (with Transit) and Scenario B (without Transit). The traffic noise analysis is based on the peak hour traffic volumes provided by the Traffic Consultant [Reference 13]. Intersection geometric configurations and future speed limits were also provided by the traffic consultant.

Vehicular traffic noise levels were calculated for 7 locations, Locations A, B, C, D, E, F, and G as shown in Figure 8. Table 4 summarizes the constraints used in the traffic noise analysis. The short-term noise measurement and corresponding traffic counts were used to validate the software at noise prediction locations A,

B, C, and D. Only future noise level predictions were made for Locations E, F, and G. The results of the traffic noise analysis for the existing and future year projections are described below and summarized in Tables 5 and 6.

5.3.1 Vehicular Traffic Noise Impacts on the Surrounding Community

Noise Prediction Location A - Old Fort Weaver Road

Existing residences located adjacent to Old Fort Weaver Road currently experience traffic noise levels well below the FHWA maximum noise limit of 67 dBA. Future improvements to roadways in the area (under the "no build" condition) will actually reduce the traffic volume on Old Fort Weaver Road, thereby reducing traffic noise by 1 to 3 dB. A 3 dB change or less in noise level is not considered to be significant. Traffic noise is expected to increase by 3 to 8 dB in the future due to the project, which is a significant noise increase.

Noise Prediction Location B - Fort Weaver Road

Existing residences located adjacent to Fort Weaver Road currently experience high traffic noise levels. Residences located farther than 70 feet from the edge-of-pavement (EOP) experience traffic noise levels that satisfy the FHWA maximum noise limit of 67 dBA. Residences that are located closer than 70 feet from the EOP exceed the FHWA noise limit. There is currently a noise barrier wall along Fort Weaver Road that shields the adjacent homes from traffic noise such that the FHWA noise limit is satisfied. However, the barrier has no effect on the upper levels of two story homes that still have a line-of-sight to Fort Weaver Road.

Future improvements to roadways in the area will reduce the traffic volume slightly on Fort Weaver Road, thereby reducing traffic noise by less than 1 dB. The future increase due to the project is an insignificant increase of less than 1 dB.

5.3.2 Vehicular Traffic Noise Impacts on the Project

Noise Prediction Location A - Old Fort Weaver Road

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will be satisfied for residences or schools that are built on the project site more than 25 feet from the EOP of Old Fort Weaver Road.

Noise Prediction Location B - Fort Weave Road

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will not be satisfied for the parks that are located within 70 feet from the EOP of Fort Weaver Road. In order to reduce the impact of traffic noise, the park should be designed such that a buffer zone (e.g., a parking lot) is constructed between the roadway and the park area.

The FHWA maximum noise limit of 72 dBA will be satisfied for commercial areas adjacent to Fort Weaver Road.

Noise Prediction Location C - Farrington Highway

For the parcels adjacent to Farrington Highway, vehicular traffic noise levels are expected to increase by up to 2 dB in the future under the "No Build" condition. The increase in traffic noise due to the Ho'opili project is 4 to 6 dB. A 3 dB change or more in noise level is considered significant.

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will not be satisfied for residences or schools that are built within 80 feet from the EOP of Farrington Highway unless noise mitigation treatments are implemented.

Noise Prediction Location D - H-1 Freeway

For the parcels adjacent to the H-1 Freeway, vehicular traffic noise levels are expected to increase by up to 3 dB in the future. The increase in traffic noise due to the Ho'opili project is less than 1 dB which is insignificant.

Because of its vicinity to the H-1, much of the project site will be impacted by noise from the freeway. Future year traffic projections show that the FHWA maximum exterior L_{eq} noise limit of 67 dBA will not be satisfied for parcels adjacent to the H-1 Freeway without traffic noise mitigation. Possible mitigation measures are described in Section 6.3.2. However, the parcels that are very close to the H-1 are the most impacted by traffic noise. Homes and schools that are built within 120 feet of the H-1 Freeway will not satisfy the FHWA maximum exterior Leq noise limit of 67 dBA, even if noise mitigation is implemented.

To limit the noise impact on the project, the 120 foot buffer zone is best suited for structures that are less sensitive to noise, such as commercial and light industrial uses. The FHWA noise criterion is less stringent for commercial and light industrial uses. However, even for these uses located within 120 feet from the H-1 Freeway, noise mitigation will be needed to meet the FHWA maximum exterior Leq noise limit of 72 dBA.

Although the FHWA criteria is not a regulatory requirement for this project, as it has no authority to enforce land use, its noise limit criteria is recommended by the FHWA to be used as a guideline for consideration of land use and the impact of traffic noise.

Noise Prediction Locations E and F - Road B and East-West Road

The Ho'opili development will provide single and multi-family housing, schools, and commercial businesses, all which will create vehicular traffic

on minor roadways in the project area. Noise levels due to vehicular traffic were predicted for locations 25 feet from Roads B and East-West Road, noise prediction location E and F, respectively, and are below the FHWA maximum noise limit of 67 dBA.

Noise Prediction Location G - Fort Weaver/Kunia Road

Future year traffic projections show that the FHWA maximum noise limit of 67 dBA will be satisfied for schools that are built on the project site more than 40 feet from the EOP of Fort Weaver/Kunia Road.

Commercial areas located adjacent to Fort Weaver/Kunia Road are not expected to experience traffic noise levels that exceed the FHWA maximum noise limit of 72 dBA.

5.3.3 Effect of Rail Transit on Vehicular Traffic Noise

The vehicular traffic noise analysis for future year 2030 projections with the "Build" condition under Scenario A (with Transit) was compared to the Scenario B (without Transit) condition in order to evaluate the effect of the proposed high capacity transit service between Kapolei and Ala Moana Shopping Center. Rows "i" and "f" of Tables 5 and 6, respectively, show the change in noise level due to the proposed transit system. As shown in the tables, there is not a significant difference in traffic noise due to the addition of transit in the area.

5.4 Compliance with EPA and HUD Noise Guidelines

The results from the long-term noise measurements conducted at the proposed Ho'opili site show calculated day-night levels, L_{dn}, that vary between 48 dBA and 74 dBA, as shown in Table 3. As described in the section above, noise levels at the proposed project site are predicted to increase due to the projected increase in vehicular traffic along all roadways. Day-night noise levels are expected to exceed the HUD noise guidelines, which state an exterior design goal of $L_{dn} \leq 65$ dBA, for homes adjacent to the following roadways:

- Within 100 feet from Fort Weaver Road
- Within 125 feet from Farrington Highway
- Within 350 feet from the H-1 Freeway
- Within 25 feet from any minor roadway within the project site, e.g., 1st Ave, A Street, as well as Old Fort Weaver Road.

Traffic noise mitigation measures should be considered to reduce the aforementioned setback distances or to satisfy HUD noise guidelines within the setbacks. Traffic noise mitigation options such as noise barrier walls are discussed in detail in section 6.3.2 below.

It is important to note that the HUD and EPA noise guidelines are design goals and not enforceable regulations, although the HUD noise guidelines must be satisfied for projects involving HUD or federal financing. However, these guidelines and design goals are useful tools for assessing the noise environment.

5.5 Compliance with FAA and HDOT Airports Division Guidelines

The Ho'opili project site is outside of the 55 L_{dn} noise contours of both Honolulu International Airport and Kalaeloa Airport. Therefore, the project will not be impacted by aircraft noise. However, aircraft flyovers may be audible at the project site at times. These flyovers should be infrequent, and therefore, should not significantly impact the proposed development.

5.6 Honolulu High Capacity Transit Project and Compliance with FTA Guidelines

The City and County of Honolulu, Department of Transportation Services has evaluated alternatives for a high capacity transit service between Kapolei and Ala Moana Shopping Center. The most current alignment alternative runs along Farrington Highway and the proposed North-South Road and may include more than one station in the vicinity of the Ho'opili project site. A complete description of the most recent alignment and current planning documents can be found on the Honolulu High Capacity Transit Project website [Reference 15]. Typical sound exposure levels of various transit systems are shown in Table 7.

The day-night level, L_{dn}, along Farrington Highway is estimated to be 64 dBA at the project site due to increased traffic noise levels, not including rail transit noise. The FTA noise impact criteria shown in Figure 3 shows that an impact will occur if the rail transit project noise exceeds 60 dBA and a severe impact will occur if the transit project noise exceeds 66 dBA. This means the overall noise level increase of 1 dB due to the transit line will become noticeable to residents closest to the transit line. Residents will likely complain if the overall noise levels increase by more than 4 dB.

5.7 Compliance with State of Hawaii BOE Noise Guidelines

The State of Hawaii, Board of Education (BOE) Policy 6700 [Reference 10] requires that air conditioning be installed for schools exposed to an exterior noise level of L_{10}=65dBA. There are 5 schools planned within the Ho'opili project site. Most schools sites will experience L_{10} less than 65 dBA if they are located adjacent to minor roadways such as B Street and East-West Road. The school site located adjacent to Fort Weaver/Kunia Road and the H-1 Freeway and the school site adjacent to Farrington Highway are both expected to exceed the exterior noise BOE Policy 6700 of L_{10}=65dBA unless traffic noise mitigation is included. Noise mitigation options are discussed in detail in Section 6.6.

6.0 NOISE MITIGATION

6.1 Mitigation of Construction Noise

In cases where construction noise exceeds, or is expected to exceed the State's "maximum permissible" property line noise levels [Reference 1], a permit must be obtained from the State DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit noise levels in excess of the "maximum permissible" levels.

In order for the State DOH to issue a construction noise permit, the Contractor must submit a noise permit application to the DOH, which describes the construction activities for the project. Prior to issuing the noise permit, the State DOH may require action by the Contractor to incorporate noise mitigation into the construction plan. The DOH may also require the Contractor to conduct noise monitoring or community meetings inviting the neighboring residents and business owners to discuss construction noise. The Contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engines, using properly tuned and balanced machines, etc. However, the State DOH may require additional noise mitigation, such as temporary noise barriers, or time of day usage limits for certain kinds of construction activities.

Specific permit restrictions for construction activities [Reference 1] are:

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels ... before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels... before 9:00 a.m. and after 6:00 p.m. on Saturday."
>
> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The use of hoe rams and jack hammers 25 lbs. or larger, high pressure sprayers, chain saws, and pile drivers are restricted to 9:00 a.m. to 5:30 p.m., Monday through Friday. In addition, construction equipment and on-site vehicles or devices whose operations involve the exhausting of gas or air, excluding pile hammers and pneumatic hand tools weighing less than 15 pounds, must be equipped with mufflers [Reference 1].

The DOH noise permit does not limit the noise level generated at the construction site, but rather the times at which noisy construction can take place. Therefore, noise mitigation for construction activities should be addressed using project management, such that the time restrictions within the DOH permit are followed.

Temporary noise mitigation measures will be required if construction activities occur in the vicinity of the schools. Construction and/or occupancy of the schools should occur after other construction activities near the school sites are completed.

6.2 Mitigation of the Ho'opili Development Noise

The design of the new development should give consideration to controlling the noise emanating from stationary mechanical equipment so as to comply with the State Department of Health *Community Noise Control* rules [Reference 1]. In order for the commercial areas to be compatible with the adjacent residential areas, noise mitigation measures should be implemented. Typical noise mitigation for stationary equipment such as air-conditioning and ventilation equipment, refrigerators, compressors, etc, includes mufflers, silencers, acoustical enclosures, noise barrier walls, etc. However, other noise sources may include non-stationary equipment such as trucks loading and unloading supplies. Additional light industrial and commercial noise sources may include ambulance sirens and backup alarms on trucks and forklifts, which are exempt from DOH noise regulations. Consideration could also be given to the layout of the commercial areas to meet DOH noise regulations and reduce the noise impact. For example, noisier activities, such as traffic access and loading areas, should be located away from adjacent residential areas. Enclosed mechanical rooms may be required for some equipment.

Restrictions may need to be placed on all commercial uses allowed in the commercial areas in order to strictly control development of potential noise producing industries. For example, sale and lease documents for the commercial property should disclose and emphasize the significance of the DOH noise regulations with respect to the abutting residential areas. With respect to mixed zoning districts, the DOH regulations specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level. However, zoning district class B includes commercial, business, multi-family dwellings, and apartments with the corresponding maximum permissible sound level listed in Figure 1.

6.3 FHWA Traffic Noise Mitigation

Vehicular traffic noise from Farrington Highway, Fort Weaver Road, and the H-1 Freeway may significantly impact the proposed development unless noise mitigation is considered.

6.3.1 Mitigation Through Setbacks or Buffer Zones

According to the FHWA's Highway Traffic Noise Analysis and Abatement Policy and Guidance [Reference 15], "the FHWA encourages State and local governments to practice compatible land use planning and control in the vicinity of highways. Local governments should use their power to regulate land development in such a way that noise-sensitive

land uses are either prohibited from being located adjacent to a highway, or that the developments are planned, designed, and constructed in such a way that noise impacts are minimized." Although the FHWA criteria is not a regulatory requirement for this project, as it has no authority to enforce land use, its noise limit criteria is recommended by the FHWA to be used as a guideline for consideration of land use and the impact of traffic noise. The following setback distances are recommended to minimize traffic noise impact and are based on calculated traffic noise levels and compliance with the FHWA's maximum exterior L_{eq} noise limit of 67 dBA for homes, parks, and schools and 72 dBA for commercial areas.

Fort Weaver Road

Parks constructed adjacent to Fort Weaver Road should be at least 70 feet from the edge of pavement so as not to exceed the FHWA's maximum exterior noise limit. The use of parking lots as noise buffer zones is recommended.

Farrington Highway

Residences and schools constructed on parcels that border Farrington Highway should be at least 80 feet from the edge of pavement so as not to exceed the FHWA's maximum exterior L_{eq} noise limit of 67 dBA. Any homes within 80 feet of Farrington Highway will require noise mitigation, as discussed in Section 6.3.2, to meet the criteria.

H-1 Freeway

Vehicular traffic noise from the H-1 Freeway will significantly impact the proposed development. The calculated traffic noise levels show that residences and schools constructed on parcels within 120 feet from the H-1 Freeway will exceed the FHWA's maximum exterior L_{eq} noise limit, even with some form of traffic noise mitigation. To limit the noise impact on the project, the 120 foot buffer zone is best suited for structures that are less sensitive to noise, such as commercial and light industrial uses. The layout of these buildings should be carefully designed to block or shield adjacent residential buildings from freeway noise. Commercial areas constructed within 120 feet from the H-1 Freeway will require noise mitigation to meet the FHWA criteria.

6.3.2 Additional Noise Mitigation Options

A comprehensive traffic noise and barrier analysis using roadway layout data and the FHWA Traffic Noise Model Software was not performed. The guidelines listed below are general in nature and should be applied where residential housing, schools, parks, and commercial areas are constructed within the setback limits listed above and noise mitigation

becomes necessary. The following are effective noise mitigation measures.

- Construct barrier walls and/or earth berms along roadways.
- Air-condition buildings instead of relying on natural ventilation.
- Acoustically soften interior spaces by the addition of thick carpeting with a padding underlayment, an acoustical tile ceiling, louvered closet doors, etc.
- Use exterior wall constructions which exhibit high noise reductions.

Typical exterior-to-interior noise reductions for naturally ventilated homes, i.e., with open windows, are approximately 9 dB. Adding absorption to interior spaces, (acoustically softening), can further reduce the noise levels 1 to 5 dB, depending upon the absorption initially present, and the amount of absorption added to the space. Air-conditioned or mechanically ventilated homes will also typically exhibit higher exterior-to-interior noise reductions achieved by several types of building constructions. Estimating the noise reduction provided by a barrier, however, is more difficult to generalize. Factors such as distances to roadways and setbacks, intervening ground conditions, barrier construction, barrier height, roadway elevations, etc., will determine the noise reduction afforded by a traffic noise barrier. In general, a 5 to 10 dB reduction can be expected.

6.4 Mitigation of Aircraft Noise

The Ho'opili project site is well outside the L_{dn} 55 dBA noise contour. Therefore, noise mitigation to attenuate aircraft noise is not necessary.

6.5 Mitigation of Rail Transit Noise

The FTA's impact assessment report has identified appropriate "screening" distances, i.e. minimum setback distances, within which a transit project has little possibility of creating a noise impact. The screening distances for various fixed guideway systems and facilities are listed in Table 8.

If a transit system noise impact has been determined, noise mitigation may be required. The City and County of Honolulu is currently developing an Environmental Impact Statement for the proposed transit system. We assume that transit noise mitigation measures will be addressed in the EIS.

6.6 Board of Education Noise Mitigation

6.6.1 Proposed H-1/Kunia School Site

Exterior noise levels at the school site located adjacent to the H-1 Freeway and Fort Weaver/Kunia Road will exceed the BOE Policy 6700 noise limit

of L_{10} = 65 dBA. The BOE policy requires that air conditioning be provided for this school in order to reduce the impact of traffic noise on the school.

Furthermore, the layout and construction of the school should be carefully designed such that exterior noise will not disturb learning activities and interfere with speech intelligibility. The following design parameters should be considered during the design phase of the school:

- To reduce traffic noise at the school site, an earthen berm or noise barrier walls should be included in the design of the new school.
- Noise buffer zones should be provided between the roadway and the noise sensitive school buildings. Parking lots should be located in this noise buffer zone.
- The exterior shell of the school should be constructed with materials such that interior noise levels are reduced to 50 dBA or less. Rooms facing the major roadways should not have operable windows and may require sound rated or double glazed windows.
- Arrange the rooms and buildings such that noise sensitive classrooms, libraries, lecture halls, offices, and all other rooms used for speech are buffered from traffic noise by rooms with noisier activities such as the gymnasium, cafeteria, shop, music.
- The school building should be used as a noise barrier to athletic fields or other school activities that take place outdoors.

6.6.2 Proposed Farrington School Site

Exterior noise levels at the school site located adjacent to Farrington Highway will exceed the BOE Policy 6700 noise limit of L_{10} = 65 dBA. The FHWA noise limit of 67 dBA will also be exceeded. In order to comply with the BOE Policy, one of the following options are necessary:

- As required by the BOE, provide air conditioning to the school facility. A substantial exterior shell construction may also be required to reduce interior noise levels to 50 dBA or less.
- Provide noise barrier walls along Farrington Highway to reduce the exterior noise levels at the school site.

6.6.3 Other School Sites

The three remaining school sites will not require noise mitigation.

REFERENCES

1. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.
2. *Department of Transportation, Federal Highway Administration Procedures for Abatement of Highway Traffic Noise*, Title 23, CFR, Chapter 1, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; Revised at 47 FR 29654, July 8, 1982.
3. *Federal Highway Administration's Traffic Noise Model*, FHWA-RD-77-108; U.S. Department of Transportation, December 1978.
4. *Noise Analysis and Abatement Policy*, Department of Transportation, Highways Division, State of Hawaii, June 1977.
5. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.
6. *Department of Housing and Urban Development Environmental Criteria and Standards*, Title 24, CFR, Part 51, 44 FR 40860, July 12, 1979; Amended by 49 FR 880, January 6, 1984.
7. *FAA Regulations on Airport Noise Compatibility Planning Programs*, Code of Federal Regulations, Title 14, Chapter 1, Subchapter I, Part 150; Issued by 49 FR 49269, December 18, 1984; corrected by 50 FR 5063, February 6, 1985; amended by 53 FR 8723, March 16, 1988; corrected by 53 FR 9726, March 24, 1988.
8. *Honolulu International Airport Master Plan Update and Noise Compatibility Program*, State of Hawaii Department of Transportation, Airports Division, Vol. 2, December 1989.
9. *Transit Noise and Vibration Impact Assessment*, Office of Planning, Federal Transit Administration, April 1995.
10. *Policies and Standards for School Facilities Design*, Board of Education, Policy 6700, Appendix A, Acoustical and Environmental Control, March 1995.
11. *Kalaeloa Airport Master Plan*, State of Hawaii Department of Transportation, Airports Division, November 1998.
12. *Federal Highway Administration's Traffic Noise Model Look-up Tables Software*, Ver. 2.5; U.S. Department of Transportation, December 17, 2004.
13. *Traffic Impact Analysis Report - Ho'opili*, Wilbur Smith Associates, December, 2007.
14. Honolulu High Capacity Transit Corridor Project, www.honolulutransit.org.
15. *Highway Traffic Noise Analysis and Abatement Policy and Guidance*, US Department of Transportation Federal Highway Administration, June 1995.

TABLE 1:
FAR Part 150 Recommendations for Land Use Compatibility in Yearly Day-Night Average Sound Levels

TYPE OF LAND USE	Yearly Day-Night Average Sound Level (L_{dn})					
	< 65	65-70	70-75	75-80	80-85	> 85
RESIDENTIAL:						
Residential (except mobile homes & transient lodgings)	Y	N(1)	N(1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
PUBLIC USE:						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
COMMERCIAL USE:						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale/Retail:(bldg. Mater., hardware, & farm equip.)	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade – general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION:						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL USE:						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables and water recreation	Y	Y	25	30	N	N

Note: Numbers in parentheses refer to the following notes.

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor-to-indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

(2) Measures to achieve NLR 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(3) Measures to achieve NLR 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(4) Measures to achieve NLR 35 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(5) Land use compatible provided special sound reinforcement systems are installed.

(6) Residential buildings require a NLR of 25.

(7) Residential buildings require a NLR of 30.

(8) Residential buildings are not permitted.

Abbreviations:

Y(Yes) = Land Use and related structures compatible w/o restrictions.

N(No) = Land Use and related structures are not compatible and should be prohibited.

NLR = Noise Level Reduction (outdoor-to-indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.

25, 30, or 35 = Land use and related structures general compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structures.

Regulatory Note.

The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

Source: FAR Part 150, Appedix A, Table 1. "Land Use Compatibility with Yearly Day-Night Average Sound Levels."

TABLE 2:
State Department of Transportation Airports Division Recommendations for Local Land Use Compatibility in Yearly Day-Night Average Sound Levels (Ldn)

TYPE OF LAND USE	Yearly Day-Night Average Sound Level (L_{dn})					
	< 60	60-65	65-70	70-75	75-80	80-85
RESIDENTIAL:						
Low density residential, resorts, & hotels (w/ outdoor fac)	Y(a)	N(b)	N	N	N	N
Low density apartment w/ moderate outdoor use	Y	N(b)	N	N	N	N
High density apartment with limited outdoor use	Y	N(b)	N(b)	N	N	N
Transient lodgings (w/limited outdoor use)	Y	N(b)	N(b)	N	N	N
PUBLIC USE:						
Schools, day care centers, libraries, and churches	Y	N(c)	N(c)	N(c)	N	N
Hospitals, nursing homes, clinics, and health facilities	Y	Y(d)	Y(d)	Y(d)	N	N
Indoor auditoriums, and concert halls	Y(c)	Y(c)	N	N	N	N
Government services and offices serving the public	Y	Y	Y(d)	Y(d)	N	N
Transportation and parking	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
COMMERCIAL USE:						
Offices - government, business and professional	Y	Y	Y(d)	Y(d)	N	N
Wholesale/Retail: bldg. Mater., hardware, & heavy equip	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
Airport businesses - car rental, ticketing, lei stands, etc	Y	Y	Y(d)	Y(d)	N	N
Retail trade, restaurants, shp. Centers, financial inst., etc	Y	Y	Y(d)	Y(d)	N	N
Power plants, sweage treatment plants, & base yards	Y	Y	Y(d)	Y(d)	Y(d)	N
Studios w/o outdoor sets, broadcasting & Production fac	Y(c)	Y(c)	N	N	N	N
MANUFACTURING AND PRODUCTION:						
Manufacturing, general	Y	Y	Y(d)	Y(d)	Y(d)	N
Photographic and optical	Y	Y	Y(d)	Y(d)	N	N
Agriculture (except livestock) and forestry	Y	Y(e)	Y(e)	Y(e)	Y(e)	Y(e)
Livestock farming and breeding	Y	Y(e)	Y(e)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL USE:						
Outdoor sports arenas and spectator sports	Y	Y(f)	Y(f)	N	N	N
Outdoor music shells, amphitheaters	Y(f)	N	N	N	N	N
Nature exhibits and zoos, neighborhood parks	Y	Y	Y	N	N	N
Amusements, beach parks, active playgrounds, etc	Y	Y	Y	Y	N	N
Public golf courses, riding stables, cemeteries, gardens, etc	Y	Y	N	N	N	N
Professional/resort sports facil., media event facil., etc	Y(f)	N	N	N	N	N
Extensive natural wildlife and recreation areas	Y(f)	N	N	N	N	N

Note: Letters in parentheses refer to the following notes.

(a) A noise level of 60 L_{dn} does not eliminate all risks of adverse noise impacts from aircraft noise. However, the 60 L_{dn} planning level has been selected by the State Airports Division as an appropriate compromise between the minimal risk of level of 55 L_{dn} and the significant risk level of 65 L_{dn}.

(b) Where the community determines that these uses should be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 L_{dn} or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure plus air conditioning may be required to provide additional outdoor-to-indoor NLR, but will not eliminate outdoor noise problems.

(c) Because the L_{dn} noise descriptor system represents a 24-hour average of individual aircraft noise events, each of which can be unique in respect to amplitude, duration, and tonal content, the NLR requirements should be evaluated for the specific land use, interior acoustical requirements, and properties of the aircraft noise events. NLR requirements should not be based solely upon the exterior L_{dn} exposure level.

(d) Measures to achieve required NLR must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(e) Residential buildings require NLR. Residential buildings should not be located where exterior noise is greater than 65 L_{dn}.

(f) Impact of amplitude, duration, frequency, and tonal content of aircraft noise events should be evaluated.

Abbreviations:
Y(Yes) = Land Use and related structures compatible without restrictions.
N(No) = Land Use and related structures are not compatible and should be prohibited.

Source: Airports Division, Department of Transportation, State of Hawaii

TABLE 3:
Long Term Noise Measurement Results

	AM L_{eq}	PM L_{eq}	L_{dn} (Calculated)
L1	63 - 72 dBA	59 - 72 dBA	74 dBA
L2	48 - 58 dBA	44 - 59 dBA	59 dBA
L3	40 - 60 dBA	37 - 50 dBA	53 dBA
L4	39 - 55 dBA	33 - 45 dBA	48 dBA

TABLE 4:
Vehicular Traffic Noise Analysis Constraints

Noise Prediction Location	A	B	C	D	E	F	G
Roadway	Old Fort Weaver	Fort Weaver	Farring-ton	H-1	B Street	East-West	Kunia
Distance to EOP+ (existing) ft.	25	85	90	120	N/A	N/A	N/A
Distance to EOP (future) ft.	25	70*	80*	120	25	25	40
Total Lanes (existing)	2	4	2	6	N/A	N/A	N/A
Total Lanes (2030)	2	6	4	6	2	2	4
Speed Limit (existing) mph	25	45	35	60	N/A	N/A	N/A
Speed Limit (2030) mph	30	40	40	60	30	40	40

Notes:
+ EOP - Edge-of-Pavement
* Future widening of the roadway will result in a reduced distance between the roadway and the prediction location.

TABLE 5:
Predicted Traffic Noise Levels With and Without the Project and Resulting Increases Due to the Project at Locations A, B, C, and D[*]

Noise levels shown in the table are based on peak-hour traffic volumes, and are expressed in A-weighted decibels (dBA).

Row ID	Traffic Analysis Conditions	Location A[*]		Location B[*]		Location C[*]		Location D[*]	
		AM	PM	AM	PM	AM	PM	AM	PM
A	Existing (Calculated)	58.6	62.7	66.0	66.3	61.6	59.8	76.8	75.5
B	Future Without Project (2030)	57.3	59.7	65.0	65.3	61.6	61.8	79.1	77.7
C	Future With Project Scenario A (w Transit) (2030)	65.1	63.0	65.3	66.3	66.1	66.1	79.6	78.3
D	Future With Project Scenario B (wo Transit) (2030)	64.1	62.5	65.4	66.3	67.1	66.5	79.6	78.3
B-A	Future Increase Without Project (2030)	-1.3	-3.0	-1.0	-1.0	0.0	2.0	2.3	2.2
C-A	Future Increase With Project Scenario A (2030)	6.5	0.3	-0.7	0.0	4.5	6.3	2.8	2.8
D-A	Future Increase With Project Scenario B (2030)	5.5	-0.2	-0.6	0.0	5.5	6.7	2.8	2.8
C-B	**Future Increase Due to Project Scenario A (2030)**	**7.8**	**3.3**	**0.3**	**1.0**	**4.5**	**4.3**	**0.5**	**0.6**
D-B	**Future Increase Due to Project Scenario B (2030)**	**6.8**	**2.8**	**0.4**	**1.0**	**5.5**	**4.7**	**0.5**	**0.6**
D-C	**Effect of Transit on Project**	**-1.0**	**-0.5**	**0.1**	**0.0**	**1.0**	**0.4**	**0.0**	**0.0**

Notes:
[*] The noise level calculations were based on the traffic study provided by the Traffic Consultant [Reference 12].
- Location A - 25 feet east of Old Fort Weaver Road edge-of-pavement
- Location B - 85 feet and 70 feet east of Fort Weaver Road edge-of-pavement for the existing and future conditions, respectively
- Location C -90 feet and 80 feet south of Farrington Highway edge-of-pavement for the existing and future conditions, respectively
- Location D - 120 feet south of H-1 Freeway edge-of-pavement

TABLE 6:
Predicted Traffic Noise Levels With the Project and Resulting Increases Due to the Project at Locations E, F, and G[*]

Noise levels shown in the table are based on peak-hour traffic volumes, and are expressed in A-weighted decibels (dBA).

Row ID	Traffic Analysis Conditions	Location E[*]		Location F[*]		Location G[*]	
		AM	PM	AM	PM	AM	PM
A	Existing (Measured)[†]	55.3	50.4	53.5	48.2	N/A	N/A
B	Future With Project Scenario A (w Transit) (2030)	64.9	64.6	64.3	64.8	62.3	65.8
C	Future With Project Scenario B (wo Transit) (2030)	65.4	65.4	64.5	65.5	64.0	66.2
B-A	**Future Increase Due to Project Scenario A (2030)**	**9.6**	**14.2**	**10.8**	**16.6**	N/A	N/A
C-A	**Future Increase Due to Project Scenario B (2030)**	**10.1**	**15.0**	**11.0**	**17.3**	N/A	N/A
C-B	**Effect of Transit on Project**	**0.5**	**0.8**	**0.2**	**0.7**	**1.7**	**0.4**

Notes:
[*] The noise level calculations were based on the traffic study provided by the Traffic Consultant [Reference 12].
[†] The existing noise levels at Locations E and F are based on the long-term noise measurements conducted at Locations L3 and L4.
- Location E - 25 feet west of the proposed Street B edge-of-pavement
- Location F - 25 feet west of the proposed East-West Road edge-of-pavement
- Location G - 40 feet west of Kunia Road edge-of-pavement

TABLE 7:
Federal Transit Administration Transit System Source Reference Sound Exposure Level (SEL)

Source/Type		Reference Conditions	Reference SEL* (dBA)
Commuter Rail, At-Grade	Locomotives	Diesel-electric, 3000 hp, throttle 5	92
		Electric	90
	Cars	Ballast, welded rail	82
Rail Transit		At-grade, ballast, welded rail	82
AGT	Steel Wheel	Aerial, concrete, welded rail	80
	Rubber Tire	Aerial, concrete guideway	78
Monorail		Aerial, straddle beam	82
Maglev		Aerial, open guideway	72
Automobiles and Vans		Normal roadway surface conditions	73
City Buses		Normal roadway surface conditions	84
Commuter Buses		Normal roadway surface conditions	88
Rail System	Yards and Shops	20 train movements in peak activity hour	118
	Layover Tracks (commuter rail)	One train with diesel locomotive idling for one hour	116
Bus System	Storage Yard	100 buses accessing facility in peak activity hour	111
	Operating Facility	100 buses accessing facility, 30buses serviced and cleaned in peak activity hour	114
	Transit Center	20 buses in peak activity hour	101
Parking Garage		1000 cars in peak activity hour	92
Park and Ride Lot		12 buses, 1000 cars in peak activity hour	101

Note: Measured 50 feet from centerline of guideway/roadway for mobile sources at 50 mph; 50 feet from center of noise-generating activity for stationary sources..

Source: Chapter 5: General Noise Assessment, Table 5-1, 5-3, 5-5. *Transit Noise and Vibration Impact Assessment*, Office of Planning, Federal Transit Administration, April 1995.

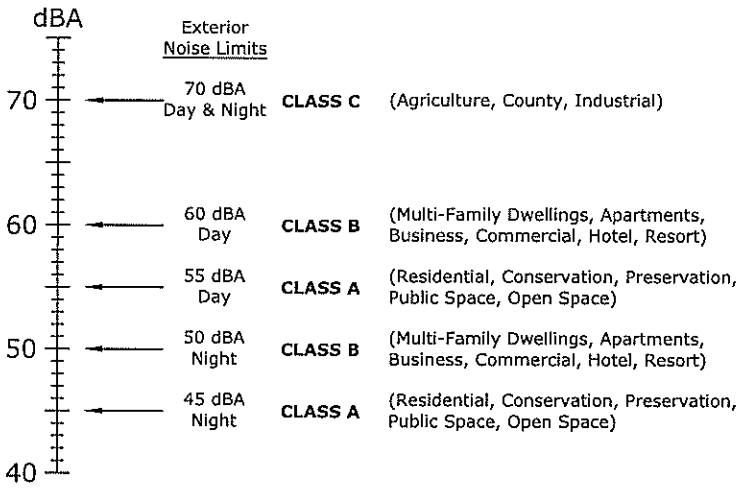
TABLE 8:
Federal Transit Administration Screening Distances for Noise Assessments

Type of Project		Screening Distance* (ft)	
		Unobstructed	Intervening Buildings
Fixed Guideway Systems:			
Commuter Rail Mainline		750	375
Commuter Rail Station		450	225
Rail Transit Guideway		700	350
Rail Transit Station		200	100
Access Roads		100	50
Low-and Intermediate-Capacity Transit	Steel Wheel	200	100
	Rubber Tire	125	75
	Monorail	300	150
Yards and Shops		2000	1000
Parking Facilities		150	75
Access Roads		100	50
Ancillary Facilities			
Ventilation Shafts		200	100
Power Substations		250	125

Note: Measured from centerline of guideway/roadway for mobile sources; from center of noise-generating activity for stationary sources.

Source: Chapter 4: Noise Screening Procedure, Table 4-1. *Transit Noise and Vibration Impact Assessment*, Office of Planning, Federal Transit Administration, April 1995.

Zoning District	Day Hours (7 AM to 10 PM)	Night Hours (10 PM to 7 AM)
CLASS A Residential, Conservation, Preservation, Public Space, Open Space	55 dBA (Exterior)	45 dBA (Exterior)
CLASS B Multi-Family Dwellings, Apartments, Business, Commercial, Hotel, Resort	60 dBA (Exterior)	50 dBA (Exterior)
CLASS C Agriculture, Country, Industrial	70 dBA (Exterior)	70 dBA (Exterior)



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Hawaii Maximum Permissible Sound Levels for Various Zoning Districts

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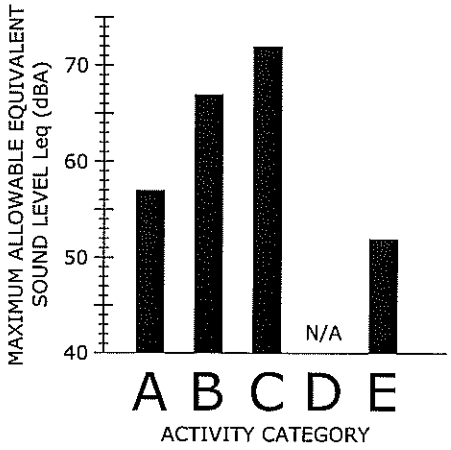
Not to Scale

Date: February 2008 | Project No.: 06-34 | Drawn By: TRB

Figure No 1

ACTIVITY CATEGORY	ACTIVITY CATEGORY DESCRIPTION	MAXIMUM EQUIVALENT SOUND LEVEL $L_{eq(h)}$
A	LANDS ON WHICH SERENITY AND QUIET ARE OF EXTRAORDINARY SIGNIFICANCE AND SERVE AN IMPORTANT PUBLIC NEED AND WHERE THE PRESERVATION OF THOSE QUALITIES IS ESSENTIAL IF THE AREA IS TO CONTINUE TO SERVE ITS INTENDED PURPOSE.	57 dBA (EXTERIOR)
B	PICNIC AREAS, RECREATION AREAS, PLAYGROUNDS, ACTIVE SPORT AREAS, PARKS, RESIDENCES, MOTELS, HOTELS, SCHOOLS, CHURCHES, LIBRARIES, AND HOSPITALS.	67 dBA (EXTERIOR)
C	DEVELOPED LANDS, PROPERTIES, OR ACTIVITIES NOT INCLUDED IN ACTIVITY CATEGORIES A OR B ABOVE.	72 dBA (EXTERIOR)
D	UNDEVELOPED LAND	N/A
E	RESIDENCES, MOTELS, HOTELS, PUBLIC MEETING ROOMS, SCHOOLS, CHURCHES, LIBRARIES, HOSPITALS, AND AUDITORIUMS.	52 dBA (INTERIOR)



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Federal Highways Administration Recommended Equivalent Hourly Sound Levels Based on Land Use

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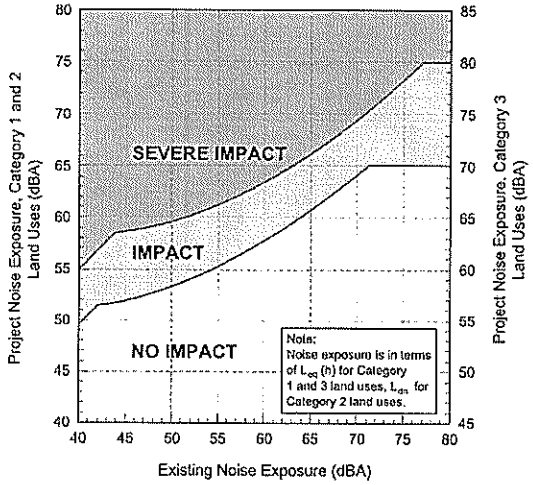
Date: February 2008 | Project No.: 06-34 | Drawn By: TRB

Figure No 2

LAND USE CATEGORY	LAND USE CATEGORY DESCRIPTION	NOISE METRIC (dBA)
1	TRACTS OF LAND WHERE QUIET IS AN ESSENTIAL ELEMENT IN THEIR INTENDED PURPOSE. THIS CATEGORY INCLUDES LANDS SET ASIDE FOR SERENITY AND QUIET, AND SUCH LAND USES AS OUTDOOR AMPHITHEATERS AND CONCERT PAVILIONS, AS WELL AS NATIONAL HISTORIC LANDMARKS WITH SIGNIFICANT OUTDOOR USE.	OUTDOOR Leq(h)
2	RESIDENCES AND BUILDINGS WHERE PEOPLE NORMALLY SLEEP. THIS CATEGORY INCLUDES HOMES, HOSPITALS AND HOTELS WHERE A NIGHTTIME SENSITIVITY TO NOISE IS ASSUMED TO BE OF UTMOST IMPORTANCE.	OUTDOOR Ldn
3	INSTITUTIONAL LAND USES WITH PRIMARILY DAYTIME AND EVENING USE. THIS CATEGORY INCLUDES SCHOOLS, LIBRARIES, AND CHURCHES WHERE IT IS IMPORTANT TO AVOID INTERFERENCE WITH SUCH ACTIVITIES AS SPEECH, MEDITATION, AND CONCENTRATION ON READING MATERIAL. BUILDINGS WITH INTERIOR SPACES WHERE QUIET IS IMPORTANT, SUCH AS MEDICAL OFFICES, CONFERENCE ROOMS, RECORDING STUDIOS AND CONCERT HALLS FALL INTO THIS CATEGORY. PLACES FOR MEDITATION OR STUDY ASSOCIATED WITH CEMETERIES, MONUMENTS, MUSEUMS. CERTAIN HISTORICAL SITES, PARKS, AND RECREATIONAL FACILITIES ARE ALSO INCLUDED.	OUTDOOR Leq(h)



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Federal Transit Administration Noise Impact Criteria for Transit Projects

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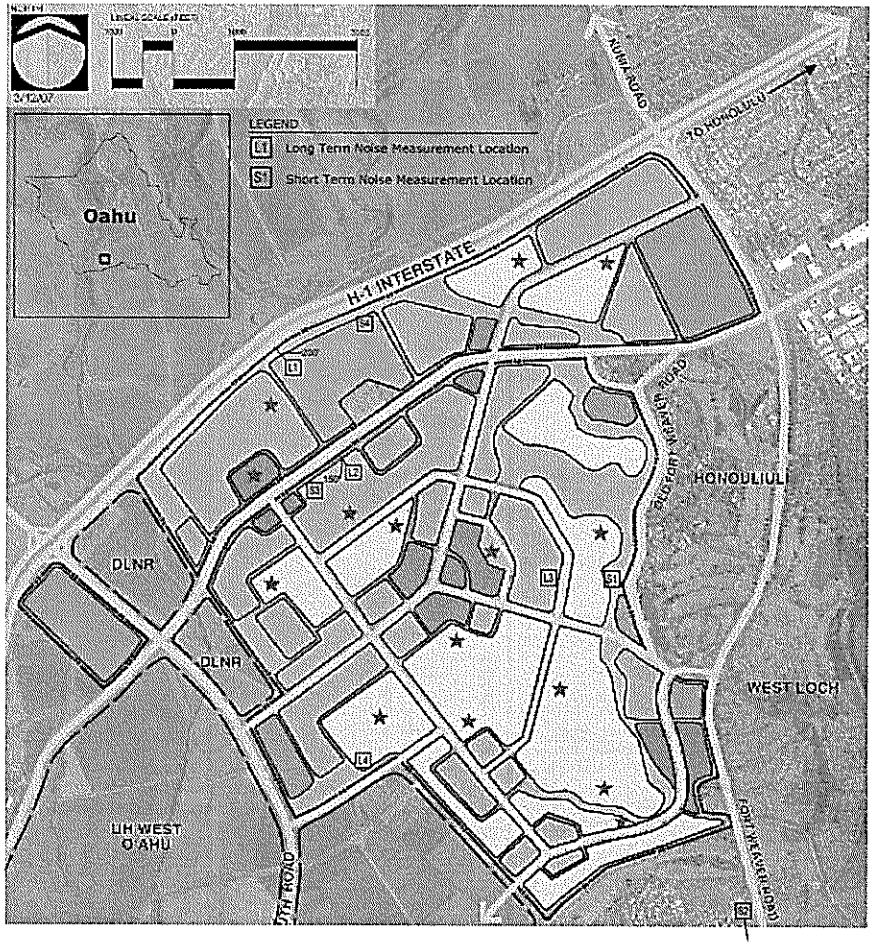
Figure No 3

Date	Project No.	Drawn By
February 2008	06-34	DFD



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Project Site and Noise Measurement Locations

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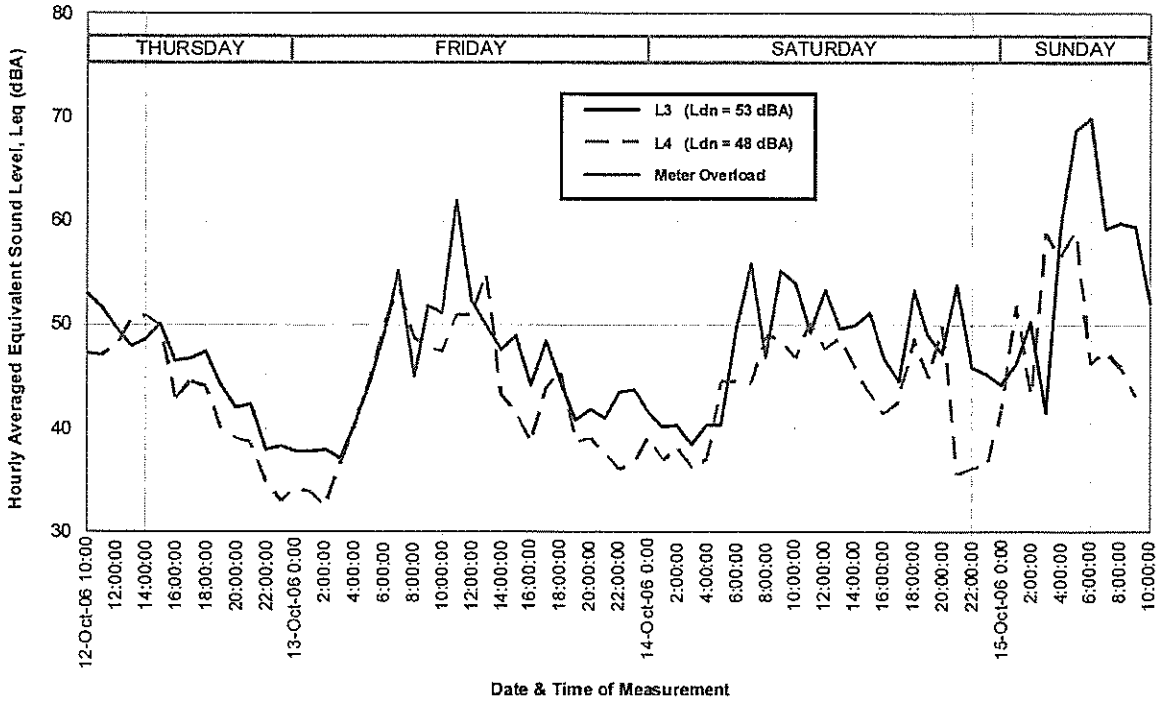
Figure No 4

Date	Project No.	Drawn By
February 2008	06-34	DFD



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Graph of Long Term Noise Measurements (L3 and L4)

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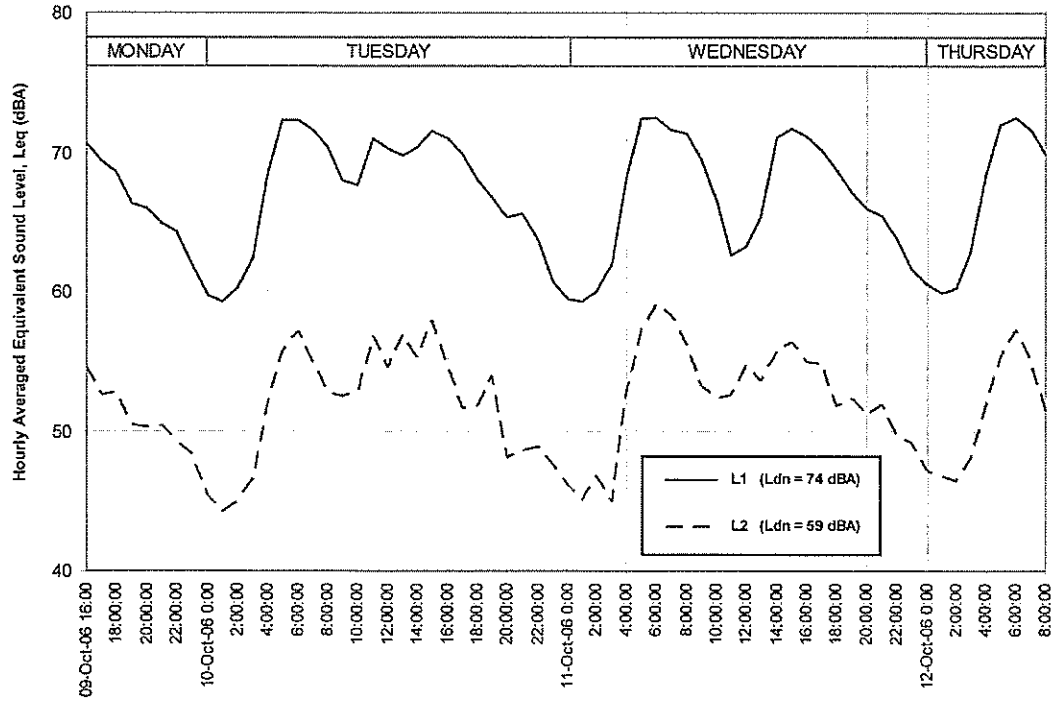
Not to Scale

Date: February 2008 | Project No.: 06-34 | Drawn By: DFD

Figure No 6



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Graph of Long Term Noise Measurements (L1 and L2)

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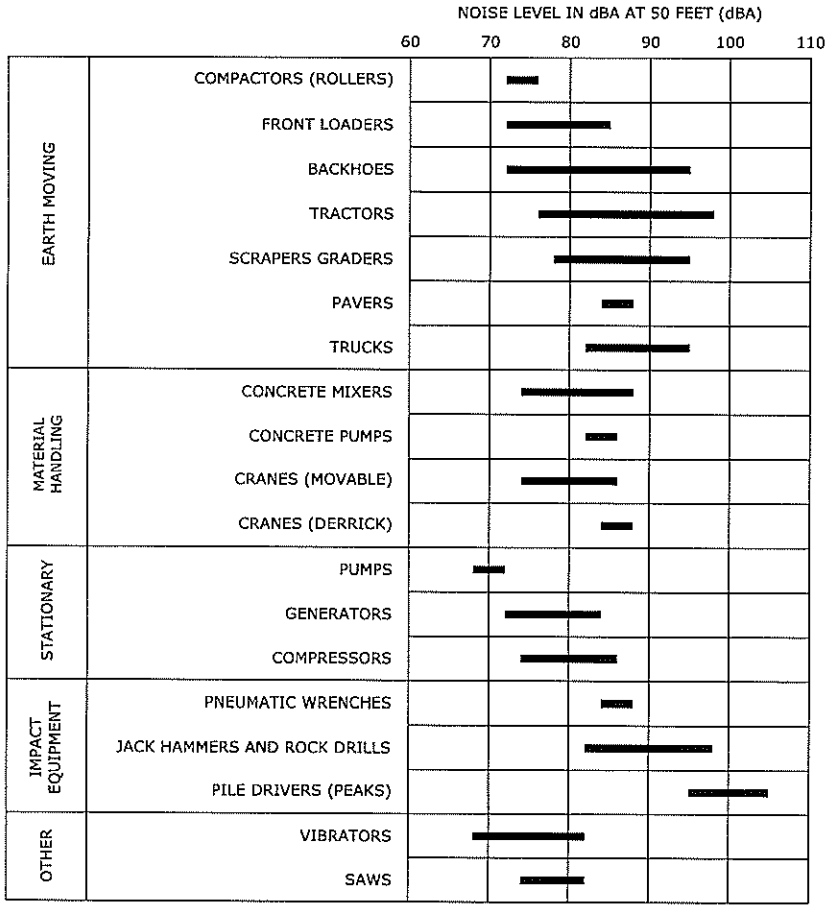
Not to Scale

Date: February 2008 | Project No.: 06-34 | Drawn By: DFD

Figure No 5



NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

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Typical Sound Levels from Construction Equipment

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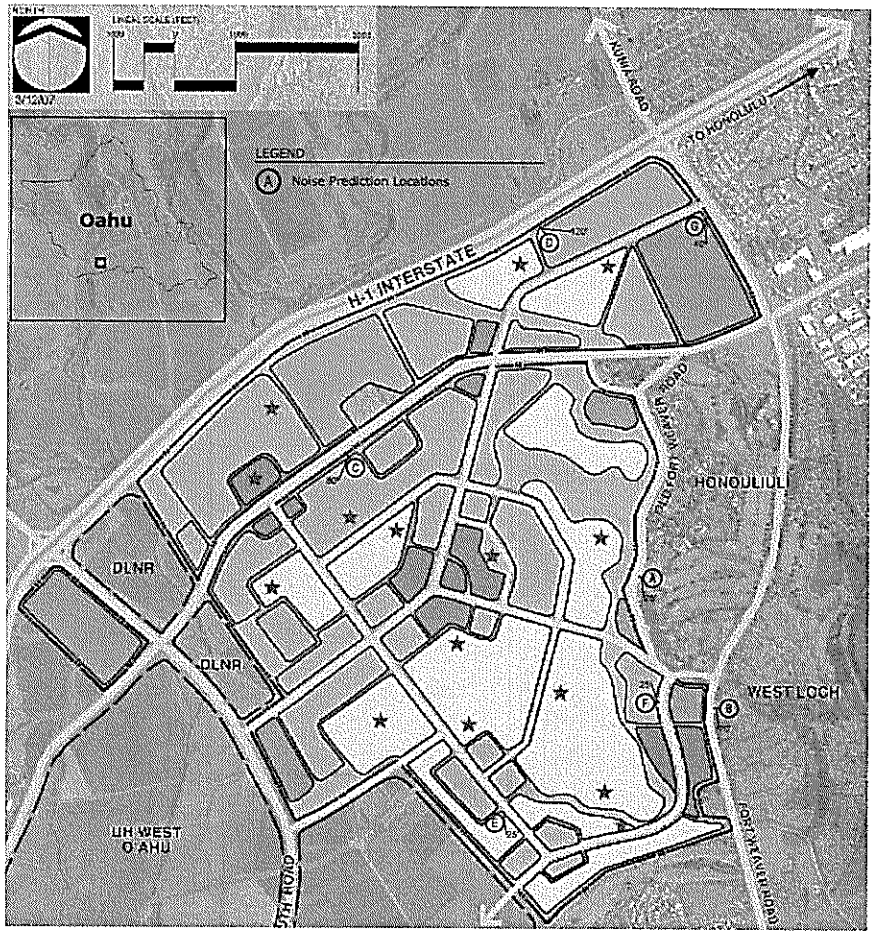
Figure No 7

Date	Project No.	Drawn By
February 2008	06-34	TRB



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Noise Prediction Locations

Ho'opili

Not to Scale

Figure No 8

Date	Project No.	Drawn By
February 2008	06-34	DFD

APPENDIX A

Acoustic Terminology

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 μPa, which is approximately the lowest sound pressure that can be detected by the human ear. For example:

If P = 20 μPa, then SPL = 0 dB
If P = 200 μPa, then SPL = 20 dB
If P = 2000 μPa, then SPL = 40 dB

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[1] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the

[1] D.W. Robinson and R.S. Dadson, "A Re-Determination of the Equal-Loudness Relations for Pure Tones," *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226.

human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

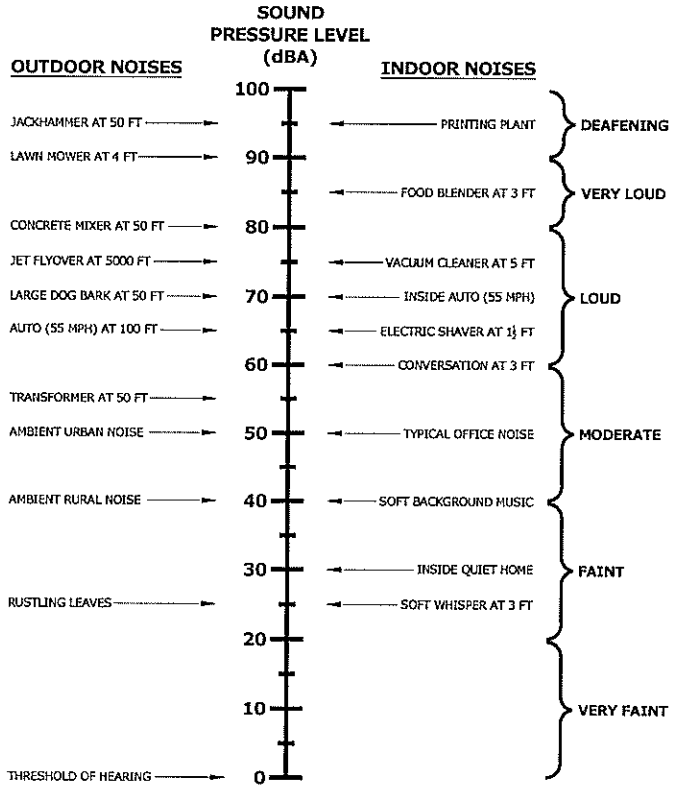


Figure A-1. Common Outdoor/Indoor Sound Levels

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

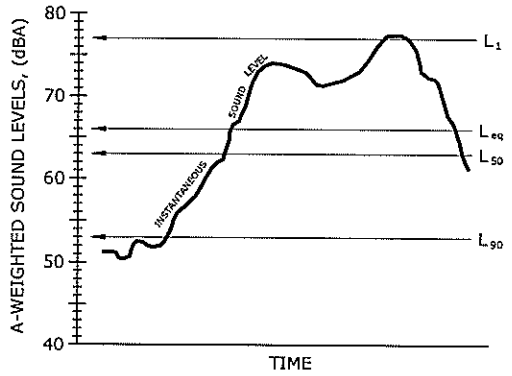


Figure A-2. Example Graph of Equivalent and Statistical Sound Levels

Statistical Sound Level

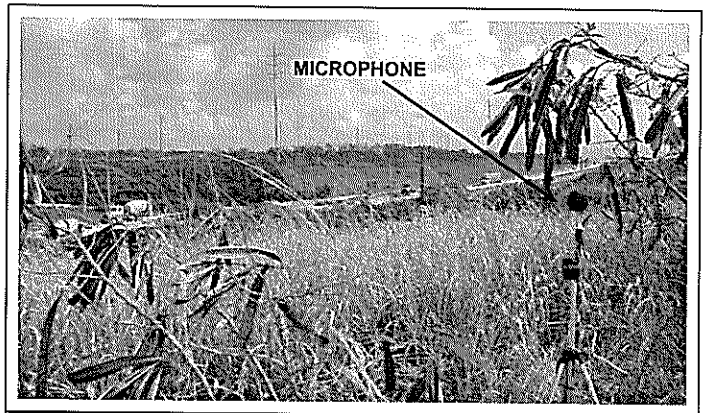
The sound levels of long-term noise producing activities such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels has been developed. It is known as the Exceedence Level, L_n. The L_n represents the sound level that is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration of the measurement period, the sound level exceeded 60 dBA 10% of the time. Typically, in noise regulations and standards, the specified time period is one hour. Commonly used Exceedence Levels include L_{01}, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

Day-Night Equivalent Sound Level

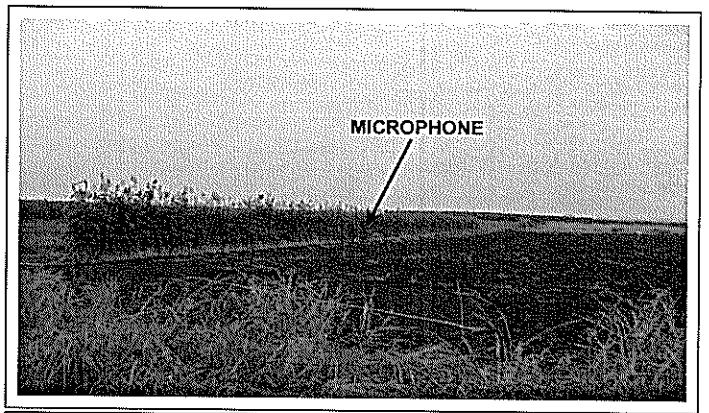
The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 p.m. and 7 a.m. to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations.

APPENDIX B

Photographs at Project Site

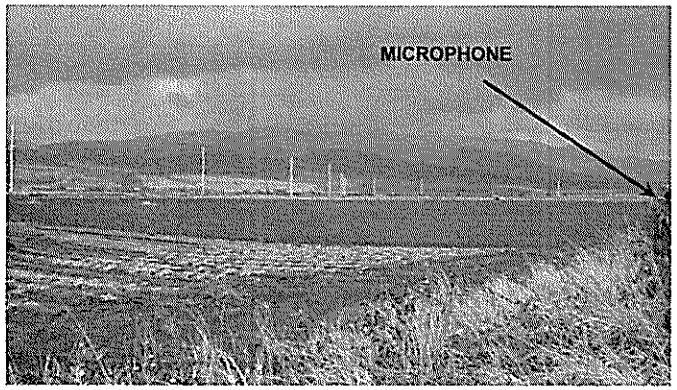


Location L1
Located 200 feet south of the H-1 Freeway



Location L2
Located 150 feet south of Farrington Highway

Location L3
Located at the southeastern edge of Ho'opili project site



Location L4
Located at the southwestern edge of Ho'opili project site nearby the future North-South Road

APPENDIX H
Air Quality Study

AIR QUALITY STUDY

FOR THE PROPOSED

HO'OPILI PROJECT

EWA, OAHU, HAWAII

Prepared for:

D.R. Horton – Schuler Division

February 2008

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1.0 SUMMARY

D.R. Horton-Schuler Division is proposing to develop the Ho'opili Project on approximately 1,555 acres of land at Ewa, Oahu. The proposed project will include approximately 11,750 dwelling units, 2.8 million square feet of retail/office space, and 0.9 million square feet of industrial floor area. Development of the project is expected to be completed and fully occupied by 2030. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are comparable to the national standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the Ewa area is very much affected by its leeward and coastal situation. Winds are predominantly trade winds from the east northeast except for occasional periods when kona storms may generate strong winds from the south or when the trade winds are weak and landbreeze-seabreeze circulations may develop. Wind speeds typically vary between about 5 and 15 miles per hour providing relatively good ventilation much of the time. Temperatures in the leeward Oahu area are generally very moderate with average daily temperatures ranging from about 65°F to 84°F.

The extreme minimum temperature recorded at the nearby (former) Ewa Plantation is 47°F, while the extreme maximum temperature is 93°F. This area of Oahu is one of the drier locations in the state with rainfall often highly variable from one year to the next. Monthly rainfall has been measured to vary from as little as a trace to as much as 15 inches. Average annual rainfall amounts to about 21 inches with summer months being the driest.

The present air quality of the project area appears to be reasonably good based on nearby air quality monitoring data. Air quality data from the nearest monitoring stations operated by the Hawaii Department of Health suggest that all national air quality standards are currently being met, although occasional exceedances of the more stringent state standards for carbon monoxide may occur near congested roadway intersections.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically

stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development could potentially result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, an air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at roadway intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations in the project area are within the national ambient air quality standards, but they may occasionally exceed the more stringent state standards at some locations. In the year 2030 without the project, carbon monoxide concentrations were predicted to decrease (improve) in the project area despite the increase in traffic volumes that is expected. This is primarily due to the assumed retirement of older motor vehicles that emit more air pollution. With the project in the year 2030 and assuming that the roadway improvements recommended in the project traffic study are implemented, carbon monoxide concentrations were estimated to increase substantially at many locations in the project area. With the transit corridor alternative, the increase would be smaller at many of the locations studied. However, with or without the transit corridor, worst-case concentrations with the project should

remain within both national and state standards through the year 2030.

Options available to mitigate long-term, traffic-related air pollution are generally to further improve roadways, to reduce traffic or to reduce individual vehicular emissions. Based on the air quality modeling results, worst case carbon monoxide concentrations in the future with the project should be lower (better) than the existing levels and within the national and state standards. Thus, implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any impacts will likely be negligible.

2.0 INTRODUCTION

D.R. Horton-Schuler Division is proposing to develop the Ho'opili Project on approximately 1,555 acres of vacant lands in Ewa on the island of Oahu (see Figure 1 for project location). The project site is located adjacent to and south of the H-1 Freeway and west of Fort Weaver Road. The development will include approximately 11,750 dwelling units, 2.8 million square feet of retail/office space, and 0.9 million square feet of industrial building floor area. Construction of the project is expected to commence during 2009, and full development and occupancy is planned by 2030.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate impacts by the project are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit. The U.S. Environmental Protection Agency (EPA) is currently working on a plan to phase out the national 1-hour ozone standard in favor of the new (and more stringent) 8-hour standard.

The Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards were challenged in federal court. A Supreme Court ruling was issued during February 2001, and as a result, the new standards for particulate were implemented during 2005. To date, the Hawaii Department of Health has not updated the state particulate standards. In September 2001, the state

vacated the state 1-hour standard for ozone and an 8-hour standard was adopted.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affects the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. On the island of Oahu, the Koolau and Waianae Mountain Ranges are oriented almost perpendicular to the trade winds, which accounts for much of the variation in the local climatology of the island. The site of the proposed project is located on the Ewa Plain, which is generally leeward of the Koolau Range at an elevation of about 50 ft.

Wind frequency data for Honolulu International Airport (HIA), which is located about 7 miles to the southeast of the project site, are given in Table 2. These data can be expected to be only semi-representative of the project area due to the differences in exposure and terrain effects. Wind frequency for HIA show that the annual prevailing wind direction for this area of Oahu is east northeast. On an annual basis, 34.7 percent of the time the wind is from this direction, and more than 70 percent of the time the wind is in the northeast quadrant. Winds from the south are

infrequent occurring only a few days during the year and mostly in winter in association with kona storms. Wind speeds average about 10 knots (12 mph) and mostly vary between about 5 and 15 knots (6 and 17 mph).

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depend to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project's inland, higher-elevation location results in a relatively moderate temperature profile compared to other coastal locations around Oahu and the state. Based on more than 50 years of data collected at the former Ewa Plantation a few miles away, average annual daily minimum and maximum temperatures in the Ewa Plain area are 65°F and 84°F, respectively [1]. The extreme minimum temperature on record is 47°F, and the extreme maximum is 93°F at this location. Temperatures at the project site can be expected to be a few degrees cooler due to the higher elevation.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is oftentimes measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 the

least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the project area, stability class 5 or 6 is generally the highest stability class that occurs, developing during clear, calm nighttime or early morning hours when temperature inversions form due to radiation cooling and mountain drainage flows. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the strength of the trade winds.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The Ewa Plain is one of the driest areas on Oahu due to its leeward and near sea level location. Average annual rainfall amounts to about 21 inches but may vary from about 10 inches during a dry year to more than 40

inches during a wet year [1]. Most of the rainfall usually occurs during the winter months. Monthly rainfall may vary from as little as a trace to as much as 15 inches or more.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from motor vehicles, industrial sources, agricultural operations and to a lesser extent by natural sources. Table 3 presents an air pollutant emission summary for the island of Oahu for calendar year 1993. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the particulate emissions on Oahu originate from area sources, such as the mineral products industry and agriculture. Sulfur oxides are emitted almost exclusively by point sources, such as power plants and refineries. Nitrogen oxides emissions emanate predominantly from industrial point sources, although area sources (mostly motor vehicle traffic) also contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources. Based on previous emission inventories that have been reported for Oahu, emissions of particulate and nitrogen oxides may have increased during the past several years, while emissions of sulfur oxides, carbon monoxide and hydrocarbons probably have declined.

The H-1 Freeway, which passes through the project area to the north, is a major arterial roadway that presently carries moderate to heavy levels of vehicle traffic during peak traffic hours. Emissions from motor vehicles using this roadway, primarily nitrogen oxides and carbon monoxide, will tend to be carried away from the project site by the prevailing winds.

Several sources of industrial air pollution are located in the Campbell Industrial Park, which is located at Barbers Point about 6 miles to the southwest of the project site. Industries currently operating there include the Chevron and BHP refineries, H-Power, Kalaeloa Partners, Applied Energy Services, Hawaiian Cement and others. Hawaiian Electric Company's Waiau Generating Station is located a few miles to the south at Pearl City. These industries emit large amounts of sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide and other air pollutants. Prevailing winds from the east or northeast will carry these emissions away from the project site most of the time.

Until recently, air pollution in the project area originating from agricultural sources could mainly be attributed to sugar cane operations in the Ewa area and to pineapple cultivation in the central Oahu area. Emissions from both the sugar mill and the canefield operations in the area have now been eliminated with the closure of the Oahu Sugar Company, and much of the former sugarcane lands are currently being used as pastureland or for diversified agriculture. Pineapple cultivation has been significantly reduced. Thus, air pollution from agricultural sources in the project area has been substantially reduced during the past several years.

Natural sources of air pollution emissions that also could affect the project area but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the island of Hawaii.

The State Department of Health operates a network of air quality monitoring stations at various locations on Oahu. Each station, however, typically does not monitor the full complement of air quality parameters. Table 4 shows annual summaries of air quality measurements that were made nearest to the project area for several of the regulated air pollutants for the period 2001 through 2005. These are the most recent data that are currently available.

During the 2001-2005 period, sulfur dioxide was monitored by the State Department of Health at an air quality station located at Kapolei, which is about 2 miles southwest of the project site. Concentrations monitored were consistently low compared to the standards. Annual second-highest 3-hour concentrations (which are most relevant to the air quality standards) ranged from 12 to 28 $\mu g/m^3$, while the annual second-highest 24-hour concentrations ranged from 6 to 9 $\mu g/m^3$. Annual average concentrations were only about 1 to 2 $\mu g/m^3$. There were no exceedances of the state/national 3-hour or 24-hour AAQS for sulfur dioxide during the 5-year period.

Particulate matter less than 10 microns in diameter (PM-10) is measured at Pearl City, about 5 miles to the east of the project site. Annual second-highest 24-hour PM-10 concentrations ranged from 27 to 100 $\mu g/m^3$ between 2001 and 2005. Average annual concentrations ranged from 15 to 16 $\mu g/m^3$. One exceedance each of the 24-hour standard was reported in 2001 and 2005. These exceedances were related to fireworks activity on New Years Day.

Carbon monoxide measurements were also made at the Kapolei monitoring station. The annual second-highest 1-hour concentrations ranged from 1.6 to 2.0 mg/m^3. The annual second-highest 8-hour concentrations ranged from 0.8 to 1.8 mg/m^3. No exceedances of the state or national 1-hour or 8-hour AAQS were reported.

Nitrogen dioxide is also monitored by the Department of Health at the Kapolei monitoring station. Annual average concentrations of this pollutant ranged from 8 to 9 $\mu g/m^3$, safely inside the state and national AAQS.

The nearest available ozone measurements were obtained at Sand Island (about 11 miles southeast of the project area). The second-highest 8-hour concentrations for the period 2002 through 2005 ranged between 77 and 108 $\mu g/m^3$, which is well inside the state and federal standards. The 8-hour standard for ozone did not exist prior to 2002. Prior to 2002, the now obsolete state 1-hour standard was typically exceeded several times each year.

Although not shown in the table, the nearest and most recent measurements of ambient lead concentrations that have been reported were made at the downtown Honolulu monitoring station between 1996 and 1997. Average quarterly concentrations were near or below the detection limit, and no exceedances of the state AAQS were recorded. Monitoring for this parameter was discontinued during 1997.

Based on the data and discussion presented above, it appears likely that the State of Hawaii AAQS for sulfur dioxide, nitrogen dioxide, ozone and lead are currently being met at the project site. Concentrations of particulate matter normally comply with the standards except possibly during holiday fireworks activity. While carbon monoxide measurements at the Kapolei monitoring

station suggest that concentrations are within the state and national standards, local "hot spots" may exist near traffic-congested intersections. The potential for this within the project area is examined later in this report.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled

fugitive dust emissions at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from

diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities will also likely obstruct the normal flow of traffic at times to such an extent that overall vehicular emissions in the project area will temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, which will

begin to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 30 to 40 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, four scenarios were selected for the carbon monoxide modeling study: (1) year 2007 with present conditions, (2) year 2030 without the project, (3) year 2030 with the project and with the transit corridor alternative, and (4) year 2030 with the project but without the transit corridor. To begin the modeling study of the four scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, several of the key intersections identified in the traffic study were also selected for air quality analysis. These included

the following intersections:

- Farrington Highway at Fort Weaver Road northbound ramps
- Farrington Highway at Leoku Street
- Fort Weaver Road at Old Fort Weaver Road
- Fort Weaver Road at Renton Road
- Farrington Highway at Fort Barrette Road
- North-South Road at H-1 eastbound ramps
- North-South Road at Farrington Highway
- North-South Road at Kapolei Parkway

The traffic impact report for the project [4] describes the projected future traffic conditions and laneage configurations of these intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the four scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 39.5% light-duty gasoline-powered automobiles, 47.6% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.5% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change somewhat with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE6 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was

thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings. All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6 based on assumed free-flow vehicle speeds corresponding to the posted speed limits.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is

usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at relatively low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 1.0 ppm to all predicted concentrations for 2007. Although increased traffic is expected to occur within the project area during the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual

emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 1.0 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 5 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for each of the four study scenarios: year 2007 with existing traffic, year 2030 without the project, year 2030 with the project and with the transit corridor alternative, and year 2030 with the project but without the transit corridor. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2007) case was 12.1 mg/m^3. This was projected to occur during the morning peak traffic hour near the intersection of Fort Weaver Road and Renton Road. Concentrations at other locations and times studied ranged downward from 11.0 mg/m^3 during the morning at intersection of Fort Weaver Road and Old Fort Weaver Road to 4.6 mg/m^3 during the afternoon at Farrington Highway and the Fort Weaver Road northbound ramps. All predicted worst-case 1-hour concentrations for the 2007 scenario were within the national AAQS of 40 mg/m^3, but concentrations exceeded the more stringent state standard of 10 mg/m^3 at two locations in the project area (Fort Weaver Road at Renton Road and Fort Weaver Road at Old Fort Weaver Road).

In the year 2030 without the proposed project, the highest worst-case 1-hour concentration was predicted to occur during the morning at the intersection of Farrington Highway and Fort Barrette Road. A value of 7.7 mg/m^3 was predicted to occur at this location and time. Peak-hour worst-case values at the other locations and times studied for the 2030 without project scenario ranged between 3.2 and 7.4 mg/m^3. Compared to the existing case, concentrations decreased despite the higher traffic volumes, reflecting the reduced emissions from more effective vehicular emission controls. All projected worst-case concentrations for this scenario remained within both the state and the national standards.

In the year 2030 with the proposed project and with the transit corridor alternative, the predicted highest worst-case 1-hour concentration occurred during the morning at the intersection of the North-South Road and Farrington Highway with a value of 8.2 mg/m^3. Other concentrations for this scenario ranged between 4.6 and 7.8 mg/m^3. With the project and with the transit corridor (and assuming the recommended roadway improvements), carbon monoxide concentrations were predicted to increase substantially at several of the intersections studied compared to the without project scenario. At some locations, such as Farrington Highway at Fort Barrette Road, concentrations would remain about the same or decrease slightly. However, even with the predicted increase in concentrations at several of the study intersections, all locations were predicted to remain within the state and the national standards.

In the year 2030 with the project but without the transit corridor, concentrations would remain about the same or increase somewhat compared to the alternative with the project and with the transit corridor. Worst-case 1-hour concentrations in the project

area were predicted to range between 4.6 and 8.9 mg/m^3 for this alternative. Although concentrations would be somewhat higher in this alternative, the values would comply with the state and the national standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [11] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 6. For the 2007 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the five locations studied ranged from 3.1 mg/m^3 at Farrington Highway and Fort Weaver Road northbound ramps to 6.0 mg/m^3 at the intersection of Fort Weaver Road and Renton Road. The estimated worst-case

concentrations for the existing case were within the national limit of 10 mg/m^3 but exceeded the state standard of 5 mg/m^3 at three of the five intersections studied.

For the year 2030 without project scenario, worst-case concentrations ranged between 2.0 and 3.7 mg/m^3, with the highest concentration occurring at Fort Weaver Road and Renton Road. All predicted concentrations were within both the national and the state standards.

For the 2030 with-project scenario and with the transit corridor alternative, worst-case concentrations increased at all locations studied except at Fort Weaver Road and Renton Road where a moderate decrease was predicted. The analysis assumes all traffic mitigation measures recommended in the project traffic study would be implemented. The worst-case concentrations ranged from 2.8 to 4.1 mg/m^3. All predicted 8-hour concentrations for this scenario were within both the national and the state AAQS.

With the project in the year 2030 and without the transit corridor, worst-case concentrations at intersections in the project area would likely increase slightly at most locations with concentrations ranging from 2.8 to 4.4 mg/m^3. However, all predicted 8-hour concentrations remained within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-

case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The peak electrical demand of the project when fully developed is expected to reach about 140 megawatts [12]. Assuming the average demand is approximately one-half the peak demand, the annual electrical demand of the project will reach approximately 612 million kilowatt-hours. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities located on Oahu, but some of the project power could also come from sources burning other fuels, such as H-Power and the AES coal-fired power plant at Campbell Industrial Park. In order to meet the electrical power needs of the proposed project, power generating facilities will be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 7 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at Oahu's power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 3. The estimated indirect emissions from project electrical demand amount to less than 1 percent of the present air pollution emissions occurring on Oahu. If power is

supplied instead or in part by coal or solid waste burning facilities, emissions will likely be higher than the values given in Table 7.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 60 tons per day [13]. Most project refuse will likely be hauled away and burned at the H-Power facility at Campbell Industrial Park to generate electricity. Burning of the waste to generate electricity will result in emissions of particulate, carbon monoxide and other contaminants, but these will be offset to some extent by reducing the amount of fuel oil that would be required to generate electricity for the project. Table 8 gives emission estimates assuming all project solid waste is burned at H-Power. These values can be compared to the island-wide emission estimates for 1993 given in Table 3. The estimated potential indirect emissions from project solid waste disposal demand amount to less than 0.1 percent of the present air pollution emissions occurring on Oahu.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive

areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After construction of the proposed project is completed and it is fully occupied and assuming the transit corridor alternative is implemented, carbon monoxide concentrations in the project area will likely increase substantially at several locations in the project area compared to the without-project case. This assumes that the roadway improvements recommended in the project traffic study are implemented. Without the transit corridor but with the recommended project traffic mitigation measures, worst-case concentrations would increase slightly at several locations in the project area compared to without the transit corridor. However, with or without the transit corridor, worst-case

concentrations should remain within both the state and the national ambient air quality standards.

Aside from further improving roadways, air pollution impacts from motor vehicle emissions could conceivably be mitigated by reducing traffic volumes through the promotion of bus service and car pooling and/or by adjusting local school and business hours to begin and end during off-peak times. However, this mitigation measure is generally considered only partially successful. Reduction of emissions from individual vehicles would have to be achieved through the promulgation of county, state or federal air pollution control regulations. For example, Hawaii currently does not require annual inspections of motor vehicle air pollution control equipment. At the present time, there is no indication that the state is contemplating adopting such rules.

Another potential mitigation measure would be to provide added buffer zones between walkways and roadways in areas where space is available. Technically, however, the public would have to somehow be excluded from the buffer zones. The predicted worst-case concentrations in this report are based on a separation distance of 3 m (10 ft) between walkways and roadways. Doubling this distance to about 6 m (20 ft) would in many cases reduce maximum concentrations by about 10 to 15 percent.

While carbon monoxide concentrations in the project area will likely increase with the project, the worst-case concentration levels should be lower than the existing levels and within both the state and national ambient air quality standards. Thus, implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of waste materials generated by the project will likely be negligible based on the magnitudes of the estimated emissions compared to the current island-wide emissions.

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Figure 1 - Project Location

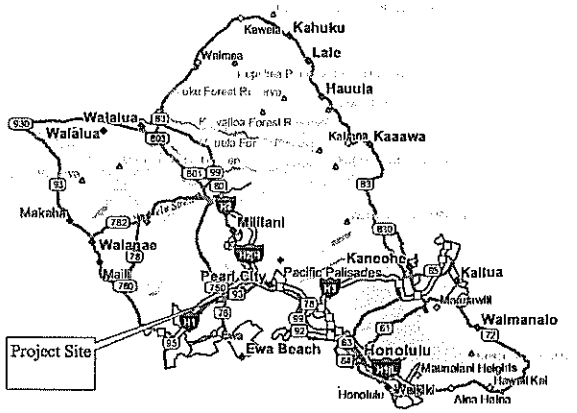

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	$\mu g/m^3$	Annual 24 Hours	50[a] 150[b]	50[a] 150[b]	50 150[c]
Particulate Matter (<2.5 microns)	$\mu g/m^3$	Annual 24 Hours	15[a] 65[d]	15[a] 65[d]	- -
Sulfur Dioxide	$\mu g/m^3$	Annual 24 Hours 3 Hours	80 365[c] -	- - 1300[c]	80 365[c] 1300[c]
Nitrogen Dioxide	$\mu g/m^3$	Annual	100	100	70
Carbon Monoxide	mg/m^3	8 Hours 1 Hour	10[c] 40[c]	- -	5[c] 10[c]
Ozone	$\mu g/m^3$	8 Hours 1 Hour	157[e] 235[f]	157[e] 235[f]	157[e] -
Lead	$\mu g/m^3$	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	$\mu g/m^3$	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.

[b] 99th percentile value averaged over three years.

[c] Not to be exceeded more than once per year.

[d] 98th percentile value averaged over three years.

[e] Three-year average of fourth-highest daily 8-hour maximum.

[f] Standard is attained when the expected number of exceedances is less than or equal to 1.

Table 2

ANNUAL WIND FREQUENCY FOR HONOLULU INTERNATIONAL AIRPORT (%)

Wind Direction	Wind Speed (knots)									Total
	0-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	>40	
N	0.5	2.5	1.3	0.5	0.0	0.0	0.0	0.0	0.0	4.8
NNE	0.3	1.2	1.6	1.5	0.2	0.0	0.0	0.0	0.0	4.7
NE	0.3	2.1	6.1	11.0	3.2	0.3	0.0	0.0	0.0	23.0
ENE	0.2	2.5	10.9	16.6	4.1	0.3	0.0	0.0	0.0	34.7
E	0.1	1.0	2.5	2.8	0.5	0.0	0.0	0.0	0.0	7.0
ESE	0.0	0.3	0.4	0.3	0.0	0.0	0.0	0.0	0.0	1.1
SE	0.0	0.3	0.8	1.0	0.1	0.0	0.0	0.0	0.0	2.2
SSE	0.1	0.4	1.2	0.7	0.1	0.0	0.0	0.0	0.0	2.4
S	0.1	0.5	1.4	0.6	0.1	0.0	0.0	0.0	0.0	2.7
SSW	0.0	0.3	0.8	0.3	0.0	0.0	0.0	0.0	0.0	1.5
SW	0.0	0.2	0.8	0.4	0.0	0.0	0.0	0.0	0.0	1.5
WSW	0.0	0.3	0.5	0.4	0.0	0.0	0.0	0.0	0.0	1.2
W	0.1	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1
WNW	0.2	1.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.0
NW	0.4	2.3	0.8	0.1	0.0	0.0	0.0	0.0	0.0	3.8
NNW	0.5	2.3	0.8	0.2	0.0	0.0	0.0	0.0	0.0	3.8
Calm	2.5									2.5
Total	5.4	18.3	30.6	36.5	8.5	0.7	0.0	0.0	0.0	100.0

Source: Climatography of the United States No. 90 (1965-1974), Airport Climatological Summary, Honolulu International Airport, Honolulu, Hawaii, U.S. Department of Commerce, National Climatic Center, Asheville, NC, August 1978.

Table 3

AIR POLLUTION EMISSIONS INVENTORY FOR
ISLAND OF OAHU, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	25,891	49,374	75,265
Sulfur Oxides	39,230	nil	39,230
Nitrogen Oxides	92,436	31,141	123,577
Carbon Monoxide	28,757	121,802	150,559
Hydrocarbons	4,160	421	4,581

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 4

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR
MONITORING STATIONS NEAREST HO'OPILI PROJECT

Parameter / Location	2001	2002	2003	2004	2005
Sulfur Dioxide / Kapolei					
3-Hour Averaging Period:					
No. of Samples	2511	2420	2461	2504	2396
Highest Concentration ($\mu g/m^3$)	24	47	26	17	64
2nd Highest Concentration ($\mu g/m^3$)	15	19	19	12	28
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	359	344	351	355	333
Highest Concentration ($\mu g/m^3$)	7	9	9	7	21
2nd Highest Concentration ($\mu g/m^3$)	6	7	9	6	9
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	2	2	1	1	2
Particulate (PM-10) / Pearl City					
24-Hour Averaging Period:					
No. of Samples	354	243	329	335	336
Highest Concentration ($\mu g/m^3$)	167	66	30	32	195
2nd Highest Concentration ($\mu g/m^3$)	100	63	27	31	99
No. of State AAQS Exceedances	1	0	0	0	1
Annual Average Concentration ($\mu g/m^3$)	15	15	15	15	16
Carbon Monoxide / Kapolei					
1-Hour Averaging Period:					
No. of Samples	8577	8354	8559	8507	8556
Highest Concentration (mg/m^3)	2.3	2.2	2.2	2.4	1.7
2nd Highest Concentration (mg/m^3)	1.9	2.0	1.6	1.7	1.6
No. of State AAQS Exceedances	0	0	0	0	0
8-Hour Averaging Period:					
No. of Samples	1073	1044	n/a	n/a	8551
Highest Concentration (mg/m^3)	1.6	1.8	0.8	1.0	1.0
2nd Highest Concentration (mg/m^3)	1.3	1.8	0.8	1.0	1.0
No. of State AAQS Exceedances	0	0	0	0	0
Nitrogen Dioxide / Kapolei					
Annual Average Concentration ($\mu g/m^3$)	8	9	9	9	9
Ozone / Sand Island					
8-Hour Averaging Period:					
No. of Samples	-	8549	8641	8474	8670
Highest Concentration (mg/m^3)	-	89	79	110	92
2nd Highest Concentration (mg/m^3)	-	88	77	108	92
No. of State AAQS Exceedances	-	0	0	0	0

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2001 - 2005"

Table 6

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR HO'OPILI PROJECT
(milligrams per cubic meter)

Roadway Intersection	Year/Scenario			
	2007/Present	2030/Without Project	2030/With Project[a]	2030/With Project[b]
Farrington Highway at Fort Weaver Rd NB Ramps	3.1	2.0	2.9	3.3
Farrington Highway at Leoku Street	3.7	2.4	2.8	2.8
Fort Weaver Road at Old Fort Weaver Road	5.5	2.7	3.9	4.2
Fort Weaver Road at Renton Road	6.0	3.7	3.2	3.2
Farrington Highway at Fort Barrette Road	5.0	3.4	3.8	3.9
North-South Road at H-1 EB Ramps	-	3.0	3.7	3.8
North-South Road at Farrington Highway	-	3.0	4.1	4.4
North-South Road at Kapolei Parkway	-	3.0	3.6	3.4

[a]Assumes transit corridor and mitigation recommended in traffic study
[b]Assumes mitigation recommended in traffic study (but without transit corridor)

Table 5

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR HO'OPILI PROJECT
(milligrams per cubic meter)

Roadway Intersection	Year/Scenario							
	2007/Present		2030/Without Project		2030/With Project[a]		2030/With Project[b]	
	AM	PM	AM	PM	AM	PM	AM	PM
Farrington Highway at Fort Weaver Rd NB Ramps	6.2	4.6	3.9	3.8	5.8	5.0	6.6	5.1
Farrington Highway at Leoku Street	7.4	6.9	4.8	4.7	5.6	5.5	5.6	5.5
Fort Weaver Road at Old Fort Weaver Road	11.0	6.3	5.4	5.1	7.8	6.2	8.3	6.3
Fort Weaver Road at Renton Road	12.1	7.8	7.4	5.1	6.3	5.4	6.4	5.3
Farrington Highway at Fort Barrette Road	10.0	7.2	7.7	5.2	7.6	5.4	7.8	5.4
North-South Road at H-1 EB Ramps	-	-	6.1	3.2	7.4	4.6	7.6	4.6
North-South Road at Farrington Highway	-	-	5.9	4.8	8.2	5.9	8.9	6.9
North-South Road at Kapolei Parkway	-	-	5.9	4.6	7.2	6.0	6.8	6.0

[a]Assumes transit corridor and mitigation recommended in traffic study
[b]Assumes mitigation recommended in traffic study (but without transit corridor)

Table 7

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM HO'OPILI PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	17
Sulfur Dioxide	210
Carbon Monoxide	17
Volatile Organics	1
Nitrogen Oxides	87

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes electrical demand of 612 million kilowatt-hrs per year and low-sulfur oil used to generate power.

Table 8

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM HO'OPILI PROJECT SOLID WASTE DISPOSAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	1
Sulfur Dioxide	5
Carbon Monoxide	21
Nitrogen Oxides	55
Lead	<1

[a]Assumes solid waste disposal demand of 60 tons per day and that solid waste is burned in a refuse-derived fuel-fired power plant equipped with spray dryer and fabric filter. Emission rates based on U.S. EPA emission factors for refuse-derived fuel-fired combustors [2].

APPENDIX I
Social Impact Assessment

July 9, 2008
2006.33.8500 / 08P-248

VIA ELECTRONIC MAIL and U.S. MAIL
vshigekuni@pbrhawaii.com

Mr. Vincent Shigekuni, Vice President
PBR Hawaii & Associates, Inc.
ASB Tower, Suite 650
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. Shigekuni:

Social Impact Assessment (November 2007)

Per comments received from the Leeward – Central Community Roundtable (aka Leeward – Central Community Forum) during the public review period of the Ho'opili Draft Environmental Impact Assessment, we concur that the fourth paragraph of Section 4.4, *Community Development on the Ewa Plain* of the Social Impact Assessment (November 2007) could be clarified with the sentence underlined below.

> Ho'opili will contribute to the growth of the urban community life in 'Ewa by providing new job locations, recreational areas, and schools as well as housing. It is designed as a community in which many residents will not need to drive to Honolulu often. Its transportation planning will work to address the region's serious traffic congestion problems. It will help to link existing and new communities, serving its neighbors as well as its residents.

Should you have any questions, please do not hesitate to contact me.

Sincerely,

BELT COLLINS HAWAII LTD.

John Kirkpatrick
Senior Socio-Economic Analyst

JK:lf

Belt Collins Hawaii Ltd.
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SOCIAL IMPACT ASSESSMENT

HO'OPILI
'EWA, O'AHU, HAWAI'I

Prepared for

D.R. Horton – Schuler Division
PBR Hawaii

Prepared by

Belt Collins Hawaii Ltd.

November 2007

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ACRONYMS AND ABBREVIATIONS

CDPs	Census Designated Places
DHHL	Department of Hawaiian Homelands
EIS	Environmental Impact Statement
HCDA	Hawai'i Community Development Authority
msl	mean sea level
NAS	Naval Air Station
TMK	Tax Map Key
UHWO	University of Hawai'i, West O'ahu

CHAPTER ONE
INTRODUCTION

1.1 PROPOSED ACTION

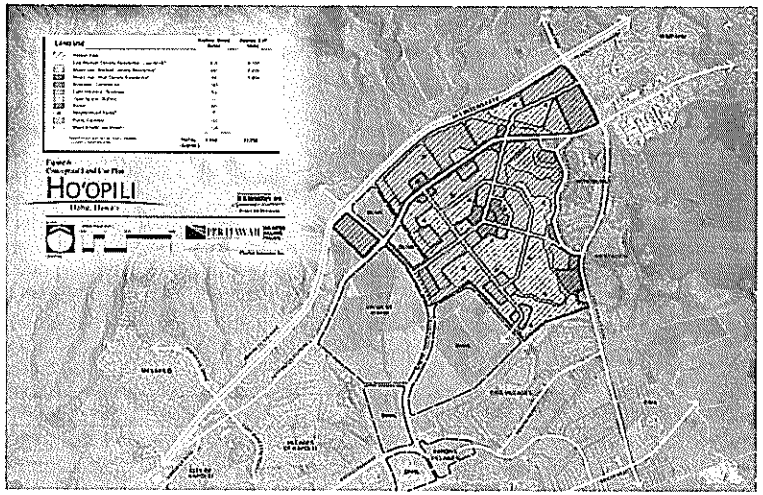
The Ho'opili project site consists of approximately 1,555 acres of land on the 'Ewa Plain, in the 'Ewa Development Plan area, City and County of Honolulu. The land has long been owned by the Estate of James Campbell but was acquired by D.R. Horton - Schuler Division in 2006. Figure 1 shows the project location. The site is *makai* (seaward) of the H-1 Freeway, and extends along Farrington Highway and old Fort Weaver Road. To the west, between the site and the Villages of Kapolei, lies an area that the State plans to develop. The State acreage will include the University of Hawai'i, West O'ahu (UHWO) campus, Department of Hawaiian Home Lands (DHHL) housing areas, and other facilities supporting the UHWO development.

The D.R. Horton - Schuler Division project will include about 11,750 residential units, as well as commercial and industrial uses, parks, schools, public facilities, roads, and open space. Figure 1 shows the project's conceptual plan, and acreages to be devoted to major land uses. Table 1 specifies the proposed housing unit count and square footage for commercial and industrial uses.

The Ho'opili project is intended to respond to the continuing strong demand for affordable housing on O'ahu. It has been designed to encourage urban community life, with residents relying far less on their automobiles than residents of more conventional residential subdivisions in the region.

Schuler Homes, Inc., now a division of D.R. Horton, proposed reclassification of some 793 acres of land owned by the Campbell Estate and the State of Hawai'i in 1996. That petition was withdrawn. The current proposed action incorporates planning concepts derived in part from "Transit-Oriented Development," "New Urbanism," and "Smart Growth" initiatives, and have not yet been implemented in O'ahu communities.

Figure 1: Project Concept Plan



SOURCE: PBR Hawaii, 2006.

Table 1: Major Land Uses

	Homes	Space	
Residential			
Low-Medium Density Residential/Live-Work (Combined R5 & AMX2)	5,100		
Mixed Use/Medium Density Residential	5,200		
Mixed Use/High Density Residential	1,450		
Total	11,750		
Retail		2,240,000	sq. ft.
Office		720,000	sq. ft.
Industrial		800,000	sq. ft.

SOURCE: PBR Hawaii, 2007.

Purpose and Scope of This Study

This study is written for review by stakeholders, public agencies, and decision-makers. It will appear as part of the Environmental Impact Statement (EIS) on the proposed Ho'opili development.

The report deals with the social impacts of the project. It takes into account both existing conditions and likely future trends. It deals both with direct impacts and the cumulative impact of the project and other likely developments. The report is organized in four sections:

1. This introduction;
2. An account of the socio-economic context of the project;
3. A discussion of community issues and concerns; and
4. An analysis of social impacts, followed by discussion of mitigation measures and processes, to the extent that these are justified.

1.2 Study Area

The project is planned as a major mixed-use project, responding to a lack of housing for residents of many income levels throughout O'ahu, and the need to further realize the vision of a secondary urban center. It is widely recognized that the island forms a single real estate market, so the potential impact area is islandwide. The most general study area for this report is the City and County of Honolulu, i.e., the island of O'ahu.

Impacts can also be anticipated for the region. The project site lies at the northeastern corner of the 'Ewa Development Plan area. Its area of potential influence is larger, inasmuch as it is close to the town of Waipahu. On a broader scale, it is sometimes argued that residential growth in any part of the 'Ewa region affects traffic on the H-1 Freeway to and from Honolulu, and hence can affect the entire Leeward region (including Central O'ahu and, arguably, Wai'anae and the North Shore).

The application of particular impacts to particular areas will be specified in the course of the analysis. (Figure 2 shows the Development Plan areas.)

The name "'Ewa" is used in overlapping ways in Hawai'i. The 'Ewa Plain, between Waipahu and Kalaeloa, makes up about half of the 'Ewa Development Plan area. The Development Plan Area includes two Neighborhood Board areas, which elect separate advisory boards. After the Makakilo/Kapolei/Honokai Hale Neighborhood Board was created for western 'Ewa, the existing board, serving the communities along Fort Weaver Road, retained the name "'Ewa Neighborhood Board." (In Figure 3, Ho'opili is shown as in the 'Ewa Neighborhood Board area.) The State's 'Ewa Judicial

District, however, is much larger and includes most of Central O'ahu. No further reference is made here to the judicial district.

Because 'Ewa has been an area of rapid growth, it is difficult to compare the population of smaller communities over time. Census tract boundaries have shifted from count to count. Demographic data for Census Designated Places (CDPs) are useful to characterize parts of the region, but important sites, such as Kapolei, were not identified as CDPs by the year 2000. (Figure 1 shows the location of 'Ewa CDPs.)

The term "East Kapolei" has also been used in several ways. In the mid-1990s, Schuler Homes (now a division of D.R. Horton) proposed development of approximately 793 acres within the site designated in this study as Ho'opili (Helber, Hastert & Fee, Planners 1996). The State of Hawai'i has also termed its development area, where the UHWO and DHHL subdivisions are being planned, as "East Kapolei" (PBR Hawaii, 1998). The City and County of Honolulu Department of Planning and Permitting has identified a "subarea" of the 'Ewa Development Plan area as "Kapolei East," including the Ho'opili project site, adjacent DHHL lands, and the UHWO site between Ho'opili and the Villages of Kapolei.

Figure 2: Development Plan Areas

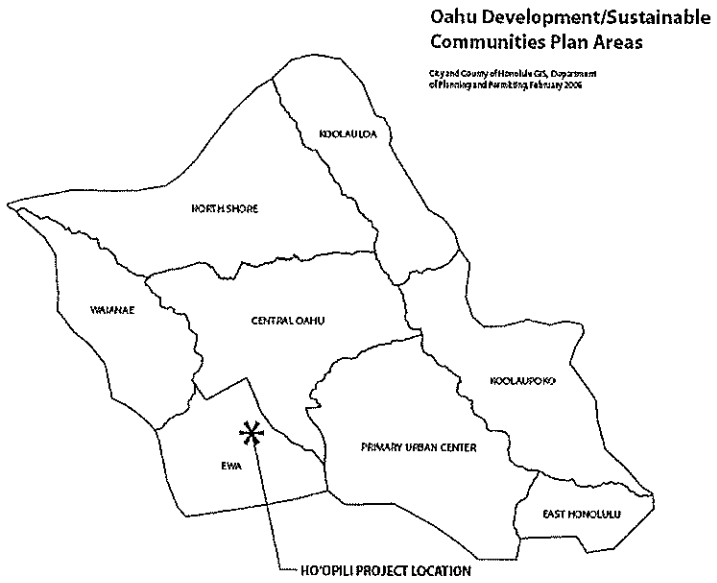
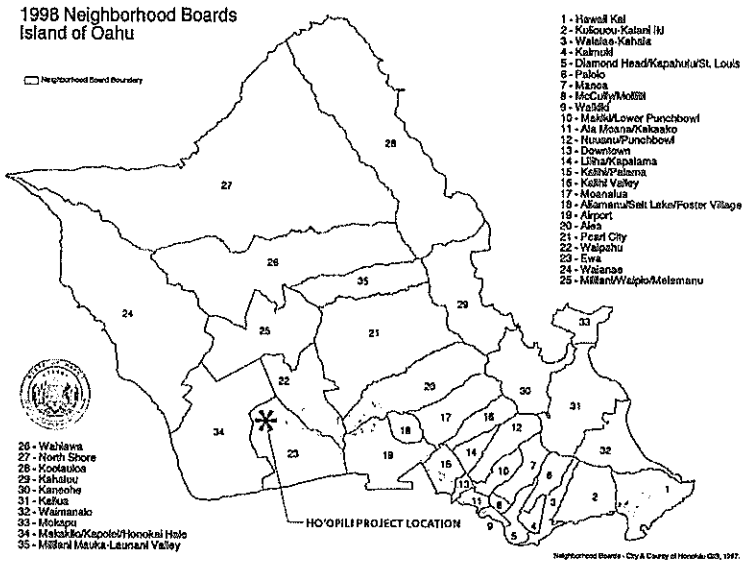


Figure 3: Neighborhood Board Areas



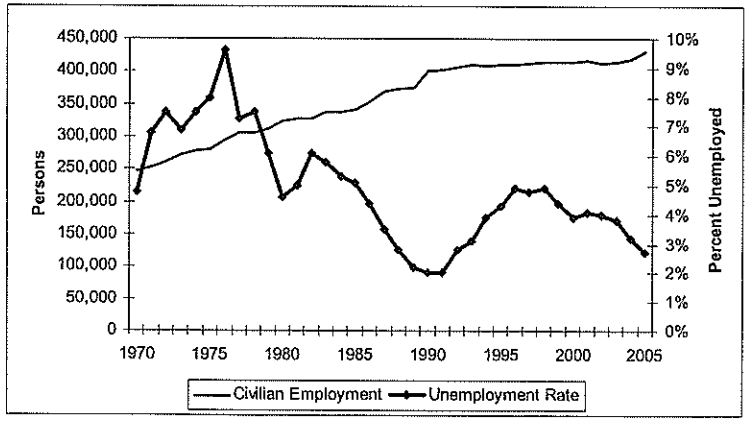
CHAPTER TWO
SOCIAL AND ECONOMIC CONTEXT

2.1 ISLAND AND REGIONAL ECONOMY

O'ahu is the economic and demographic center of Hawai'i. As such, it has seen steady economic growth over recent decades. It gained in population at the expense of other counties immediately after World War II. More recently, economic and population growth have picked up in the Neighbor Islands.

The 1990s were a difficult economic period for Hawai'i. Job growth slowed and housing starts and prices declined. O'ahu was not affected as much as other areas, as the low unemployment rates shown in Figure 4 indicate. O'ahu and Hawai'i have emerged with much lower unemployment rates than for the nation as a whole.

Figure 4: Island Economic Trends, 1970 through 2005



SOURCE: Historical and current statistics; State Department of Labor and Industrial Relations available through http://www.hiwi.org.

The island economy depended on a mix of tourism, military activity, construction, and plantation agriculture at the beginning of the 1970s. Since then, military activity declined but remained an important factor in the local economy. Plantation agriculture declined throughout the period. For the region surrounding Ho'opili, this development has been important.

- The O'ahu Sugar Company had used much of the 'Ewa Plain for sugar cultivation. As it closed operations (by 1995), land became available for urban development.
- With the closing of the plantation, many families in Waipahu and the 'Ewa Villages lost a major source of income. Many older workers retired. Others have retrained for other jobs.
- With the land and water released from sugar cultivation, 'Ewa has become a truck farming area, with Aloun Farms operating in the project site, emerging as the island's leading producer of vegetables.

The Kapolei area was designated as O'ahu's "Second City" decades ago. James Campbell Industrial Park was created as the island's leading heavy industrial area. The urban center was slower to develop. Commercial areas began to be built in the 1990s, and construction of residential areas began. Residential and retail growth has boomed since 2000. The major landowner in the region, Campbell Estate,[1] reports nearly 25,000 jobs in the 'Ewa Development Plan area, and expects that number to grow to about 65,000 by 2025 (http://www.kapolei.org). The industrial park has seen significant recent growth, including construction of a new *Honolulu Advertiser* printing plant. The resort area of Ko 'Olina now includes a hotel, a timeshare resort, and high-end vacation homes and condos. Kapolei itself has office buildings with State, City, and Bank of Hawai'i workers, as well as extensive retail areas.

In 2000, the workforce in the 'Ewa Development Plan Area was modest. Naval Air Station (NAS) Barbers Point had recently closed. The civilian job count in the Development Plan area (the combined 'Ewa and Makakilo/Kapolei/Honokai Hale Neighborhood Board areas) totaled about 15,000. The largest industry cluster, in terms of the number of local jobs, was education and health services, as shown in Table 2. About four-fifths of the jobs were on the western side of the 'Ewa Development Plan area. In Waipahu, which is closer to the Primary Urban Center, retail trade is the largest job sector.

[1] The Estate of James Campbell has been converted into successor firms including Aina Nui corporation and the James Campbell Company LLC.

Table 2: Jobs on O'ahu and Selected Neighborhood Board Areas, 2000

	City and County of Honolulu	Ewa	Makakilo, Kapolei, Honokai Hale	Waipahu
Total Workers, 2000	393,245	3,010	11,560	11,165
Agriculture, forestry, mining	3,664	20	573	60
Construction	17,954	174	1,495	950
Manufacturing	12,671	59	1,160	453
Wholesale trade	11,468	20	684	944
Retail trade	43,506	265	834	2,378
Transportation, warehousing, utilities	22,476	109	718	509
Information	9,897	30	90	120
Finance, insurance, real estate	27,335	160	879	505
Professional, management, administrative services	34,416	179	749	574
Educational, health and social services	72,262	1,210	1,760	2,200
Entertainment, accommodations, food services	49,541	369	1,365	1,215
Other services (except public)	16,063	125	235	835
Public administration	34,905	165	810	419
Armed forces	36,927	136	194	0

SOURCE: US Census, Census Transportation Planning Package, organized by Census Tract by University of Wisconsin, Milwaukee; tracts combined to Neighborhood Board areas by Belt Collins (http://www.uwm.edu/Dept/ETI/drilldowns/index.html).

The island economy has grown steadily. Unemployment continues at very low rates (2.3% for the City and County of Honolulu, for the year 2006, according to the State Department of Labor and Industrial Relations, www.hiwi.org.) State tax revenues grew by 11% in FY2006, compared to FY2005 (Department of Taxation, 2006).

In 'Ewa, the expanding economy is visible in new store openings, construction in industrial areas, and investment by U.S. mainland real estate investors in industrial and commercial properties in the region.

2.2 Island and Regional Demographics

As a matter of policy, the Primary Urban Center, 'Ewa, and Central O'ahu have been identified as "development" areas, and the other Development Plan areas are termed "sustainable communities." New housing and population are to be channeled in the three development areas. 'Ewa has had the fastest growth, while the population has increased by larger numbers in Central O'ahu, as shown in Table 3.

Table 3: Historical Population Growth, O'ahu and Development Plan Areas

	1980	1990	2000	Average Annual Increase, 1980 - 2000
Primary Urban Center	417,240	432,023	419,338	0.0%
Ewa	35,523	42,931	68,718	3.4%
Central Oahu	101,685	130,526	148,186	1.9%
East Honolulu	43,213	45,654	46,735	0.4%
Koolaupoko	109,373	117,694	117,994	0.4%
Koolauloa	10,983	14,263	14,546	1.4%
North Shore	13,061	15,729	18,380	1.7%
Waianae	31,487	37,411	42,259	1.5%
Total Population	762,565	836,231	876,156	0.7%

SOURCE: Honolulu Department of Planning and Permitting, 2005.

In 2000, residential areas in the 'Ewa Development Plan Area were largely inhabited by young families. In the newer subdivisions, home ownership is much higher than for the island as a whole. However, military housing areas – Kalaeloa, which used to be NAS Barbers Point, and Iroquois Point – stand out as areas where housing is rented. Throughout these communities, vacation housing, for rent or sale, is rare. (However, it is becoming common in Ko 'Olina.)

Table 4: County and Local Demographics, 2000

	City and County of Honolulu	Ewa CDPs: Ewa Villages	Ewa Gentry	Ewa Beach	Iroquois Point	Barbers Point	Makakilo	Central Oahu CDPs (selected): Waipahu	Village Park	Waipio
Population										
Total	876,156	4,741	4,939	14,650	2,462	67	13,156	33,108	9,625	11,672
Age										
Under 5 years	56,849	347	512	1,052	392	14	1,128	2,271	699	756
5-17 years	151,909	971	899	3,221	703	20	2,685	5,483	2,227	2,302
18-64 years	549,681	2,770	3,319	8,789	1,365	33	8,343	19,111	6,190	7,852
65 years and over	117,737	653	209	1,588	2	-	900	5,243	509	762
Median age (years)	35.7	33.3	31.9	32.7	25.5	17.8	32.4	35.5	31.4	33.9
In households	96.5%	99.9%	100.0%	99.1%	100.0%	100.0%	99.8%	96.6%	99.0%	99.4%
In group quarters	3.5%	0.1%	0.0%	0.9%	0.0%	0.0%	0.2%	3.4%	0.1%	0.6%
Households										
Total	286,450	1,178	1,734	3,305	675	16	3,858	7,566	2,628	3,974
Family households	205,672	1,004	1,239	2,841	660	16	3,225	6,430	2,280	2,873
With own children under 18	91,622	466	770	1,251	564	14	1,360	2,740	1,308	1,535
With persons under 18	108,247	613	814	1,830	566	14	2,005	3,831	1,484	1,735
With persons 65 and over	80,464	477	21	1,099	2	-	569	3,181	392	545
Average household size	2.95	4.02	2.85	4.39	3.65	4.19	3.37	4.23	3.66	2.92
Housing units										
Total	315,958	1,274	1,843	3,315	1,035	127	4,119	8,033	2,776	4,110
Occupied	286,450	1,178	1,734	3,305	675	16	3,858	7,566	2,628	3,974
Owner	54.6%	81.0%	68.3%	68.9%	1.3%	0.0%	79.5%	53.4%	72.1%	64.3%
Renter	45.4%	19.0%	31.7%	31.1%	98.7%	100.0%	29.5%	46.6%	27.9%	35.7%
Vacant	29,508	96	109	210	360	111	221	467	148	136
Seasonal, recreational use	6,655	1	4	10	-	-	6	4	3	2
Seasonal, etc., as % of all units	2.2%	0.1%	0.2%	0.3%	0.0%	0.0%	0.2%	0.0%	0.1%	0.0%

NOTE: For more on the CDPs, see section 2.4.2.

SOURCE: US Census, compiled in community profiles, accessed through http://www.hawaii.gov/dbedt/census2k/profile-honolulu/index.html.

While about 9% of the island workforce is in the military, the military share of most communities in the 'Ewa Development Plan Area was much smaller in 2000, except for Barbers Point and Iroquois Point, where the military formed the majority of the workforce. Agricultural workers were numerous in the 'Ewa Villages, but not elsewhere in the region.

Table 5: County and Local Workforce Distribution by Place of Residence, 2000

	City and County of Honolulu	Ewa CDPs						Central Oahu CDPs (selected)		
		Ewa Villages	*Ewa Gentry*	*Ewa Beach*	*Iroquois Point*	*Barbers Point*	*Makakilo*	*Waipahu*	*Village Park*	*Waipio*
Employment status										
Population 16 and over	691,015	3,538	3,759	10,985	1,440	42	9,523	25,349	7,051	8,989
In labor force	447,320	1,985	2,820	6,877	951	24	7,014	14,803	5,354	7,030
Civilian	408,638	1,982	2,555	6,718	359	2	6,698	14,446	5,095	6,442
Employed	55.4%	52.0%	65.5%	56.8%	20.9%	4.8%	68.7%	51.6%	68.3%	68.1%
Unemployed	3.7%	4.0%	2.4%	4.4%	4.0%	0.0%	3.6%	5.2%	3.6%	3.5%
Armed Forces	38,682	6	265	159	592	52	316	155	259	588
Industry										
Agriculture, forestry, mining	1.1%	30.0%	0.8%	0.8%	3.0%	0.0%	0.5%	1.9%	0.6%	0.0%
Construction	8.1%	7.2%	5.1%	5.6%	2.3%	0.0%	8.5%	6.6%	6.9%	5.3%
Manufacturing	3.8%	7.6%	6.0%	6.2%	2.7%	0.0%	4.3%	6.2%	3.3%	4.3%
Wholesale trade	3.4%	3.5%	1.1%	4.1%	0.0%	0.0%	2.8%	4.4%	4.4%	3.6%
Retail trade	12.1%	14.8%	10.3%	17.5%	16.6%	0.0%	13.7%	13.1%	16.8%	13.3%
Transportation, utilities	6.5%	6.2%	8.1%	6.0%	0.0%	0.0%	8.8%	5.8%	5.9%	8.0%
Information	2.7%	0.0%	2.5%	1.8%	0.0%	0.0%	2.6%	1.8%	2.2%	4.1%
Finance, insurance, real estate	7.5%	4.1%	5.0%	5.7%	8.3%	0.0%	8.8%	5.8%	8.6%	7.7%
Professional, management, waste services	9.9%	9.5%	6.5%	9.9%	7.0%	0.0%	9.1%	8.1%	9.4%	8.2%
Educational, health, social services	19.9%	16.7%	18.8%	17.5%	38.9%	0.0%	16.9%	16.4%	18.3%	16.0%
Accommodation, food, recreation services	13.9%	15.7%	15.5%	13.6%	1.7%	100.0%	8.4%	18.7%	12.2%	13.0%
Other services (except public)	4.5%	7.4%	4.9%	4.9%	0.0%	0.0%	3.2%	5.4%	2.5%	3.3%
Public administration	9.3%	6.7%	12.4%	6.3%	21.6%	0.0%	12.5%	5.7%	11.0%	13.0%

SOURCE: US Census, compiled in community profiles, accessed through http://www.hawaii.gov/dbedt/census2k/profile-honolulu/index.html.

2.3 ISLAND AND REGIONAL HOUSING DEMAND

Hawai'i is recognized as struggling with a housing crisis. It is marked by a surge in prices in recent years, followed by rental increases. New housing production goes far toward meeting demand for housing for sale, but little new rental housing is being built. At the same time, some older low-income rental projects can now convert to market rentals or condominiums, reducing the inventory within reach of low-income families.

In 2000, the local housing market was sluggish. In much of the 'Ewa Development Plan Area, the cost of home ownership was below the island average. Still, the share of homeowners paying a large share of income for housing was as high or higher than the average. Rents in 'Ewa communities varied greatly, with the old plantation community of 'Ewa Villages offering low rents for retired workers, and other communities having higher rents on average than islandwide. (The 'Ewa Development Plan Area inventory also includes a much larger share of single-family rentals than in most areas of O'ahu.)

Table 6: County and Local Housing Indicators, 2000

	City and County of Honolulu	Ewa CDPs						Central Oahu CDPs (selected)		
		Ewa Villages	*Ewa Gentry*	*Ewa Beach*	*Iroquois Point*	*Barbers Point*	*Makakilo*	*Waipahu*	*Village Park*	*Waipio*
Household income in 1999										
Less than $25,000	21.3%	22.4%	8.4%	16.5%	15.2%	0.0%	9.0%	25.8%	5.8%	8.6%
$25,000 to $49,999	26.5%	24.7%	25.8%	24.5%	44.5%	27.3%	22.8%	24.7%	25.5%	30.5%
$50,000 to $74,999	20.6%	29.2%	32.8%	26.5%	20.3%	40.9%	28.0%	20.5%	25.3%	25.0%
$75,000 to $99,999	13.4%	16.9%	20.4%	16.3%	15.5%	0.0%	20.2%	11.5%	24.5%	15.0%
$100,000 or more	18.1%	6.8%	12.7%	16.2%	4.4%	31.8%	20.0%	17.5%	18.8%	20.7%
Median household income	$51,914	$51,451	$61,462	$57,073	$44,200	$65,625	$67,267	$49,444	$70,302	$61,276
Poverty status (below poverty level)										
Individuals	83,937	403	131	1,430	45	-	653	4,478	491	471
Related children under 18	25,080	134	13	505	20	-	261	1,387	191	150
Persons 65 and over	8,614	97	-	98	-	-	31	722	8	56
Crowding (share of households)										
1.01 to 1.50 persons/room	7.9%	18.5%	9.4%	16.4%	4.8%	0.0%	9.3%	17.0%	15.6%	8.3%
1.51 or more	8.2%	16.4%	11.0%	11.6%	-	-	7.3%	15.6%	12.1%	4.8%
Housing costs										
Owners, with a mortgage	81,606	778	618	1,583	-	-	1,754	2,443	1,497	1,747
Median owner costs, with mortgage	$1,053	$1,300	$1,713	$1,517	$0	$0	$1,653	$1,622	$1,657	$1,669
Owner costs as share of income										
30 to 34.9%	7.5%	17.5%	12.3%	10.8%	0.0%	0.0%	12.5%	6.4%	18.5%	9.2%
35% or more	22.0%	24.9%	37.6	23.6%	0.0%	0.0%	26.4	22.0%	25.9%	23.6%
Rented units										
Median gross rent	$802	$244	$957	$931	$1,162	$1,542	$1,056	$954	$1,016	$931
Gross rent as share of income										
30 to 34.9%	7.5%	10.0%	14.6%	8.1%	1.3%	0.0%	9.9%	8.5%	17.1%	7.9%
35% or more	28.9%	13.4%	33.1%	33.3%	3.8%	17.5%	32.5	27.8%	31.8%	29.0%

SOURCE: US Census, compiled in community profiles, accessed through http://www.hawaii.gov/dbedt/census2k/profile-honolulu/index.html

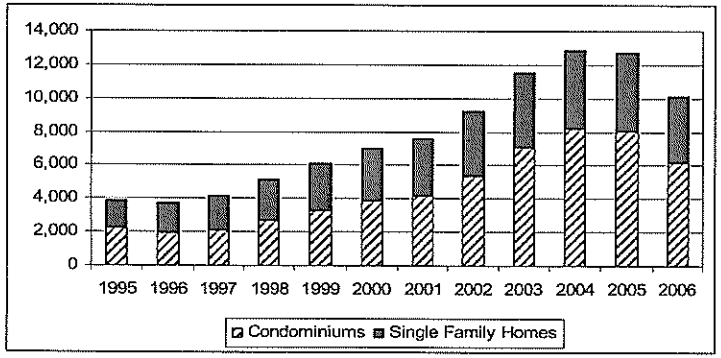
On O'ahu, the housing market typically includes about twice as many single-family home sales as condominium sales each year. Single-family homes form an even larger share of the market in Tax Map Key (TMK) Zone 9, the region including 'Ewa and Central O'ahu, where most new housing construction occurs.

Hawai'i housing prices typically have a boom phase followed by a plateau or slow retreat, as Figure 7 illustrates. In the mid-1990s, new housing production continued strong well after housing prices reached the plateau. Developers had unsold inventory. As a result, they are now much less willing to expand supply in response to short-term demand, and housing production has not returned to former levels.[2]

[2] Figure 8 and subsequent tables based on the SMS study of historical residential real property sales depend on analysis of a large sample of fee-simple units, not the entire housing inventory. The volume shown hence is not the total volume of new housing sales on O'ahu (used in Figure 7). The volume of total sales in the longer-term analysis excludes leasehold sales and some sales that may simply be ownership transfers, rather than new market transactions.

Housing prices respond to several factors, including mortgage rates, which affect the amount that families can borrow. While rates can go up or down, and buyers' resources can shrink or increase, construction costs have moved steadily upwards, limiting developers' ability to respond to changes in the market.[3]

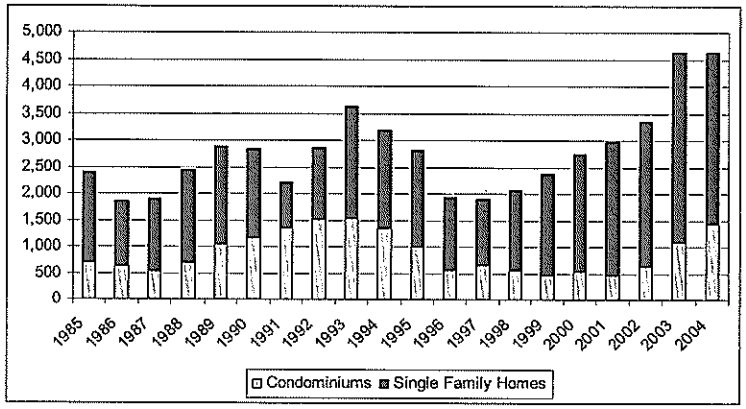
Figure 5: Volume of Residential Sales, O'ahu, 1995-2006



SOURCE: DBEDT (2007).

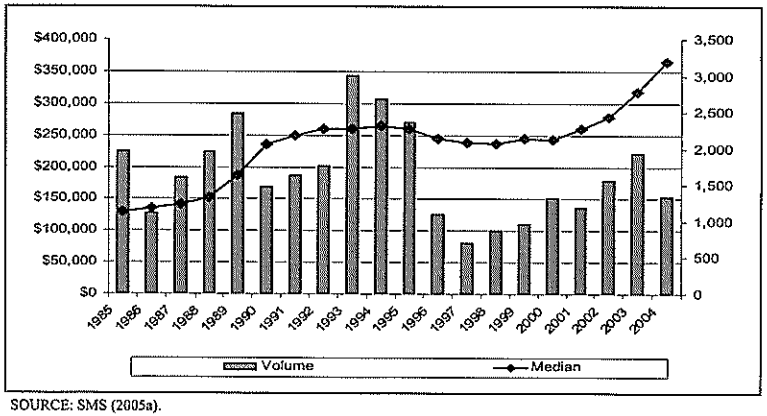
[3] The annual "affordable price" shown in Figure 8 is an estimate of the amount that a family with the median *income* could afford at prevailing interest rates in each year. It is not equivalent to the median price, i.e., the point at which half the units sold in the market are above, and half below.

Figure 6: Volume of Residential Sales, O'ahu Zone 9, 1985-2004



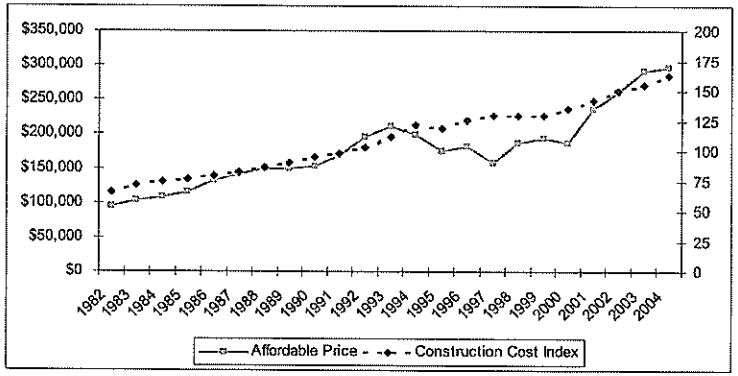
SOURCE: SMS (2005a).

Figure 7: Median Housing Prices and Volume of New Housing, O'ahu



SOURCE: SMS (2005a).

Figure 8: Affordable Housing Prices and Construction Cost Index, Honolulu

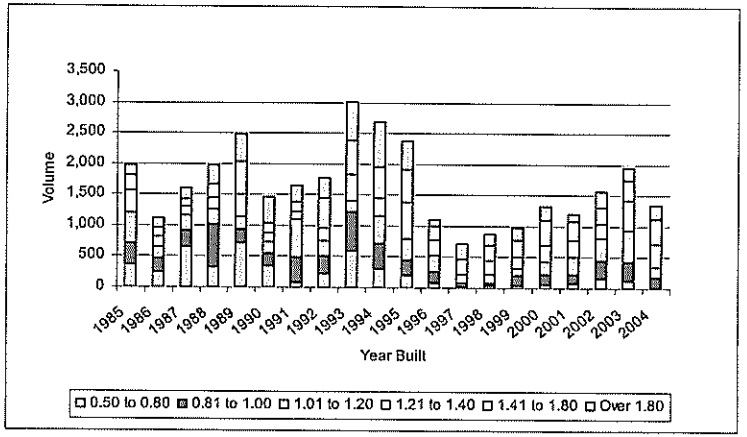


SOURCE: SMS (2005a).

When housing prices are converted to ratios of the annual affordable price, it is possible to compare the distribution of housing brought on the market from year to year. Figure 9 shows three major trends in new housing on O'ahu:

1. Nearly all new housing is being produced at prices that families with incomes higher than the median can afford. Units for sale at 80% of the affordable price have all but disappeared.
2. New housing is being produced for all sectors of the market above the 80% mark.
3. On O'ahu, the share of new units priced for families with 180% or more of the median income was highest in the early 1990s. More housing is produced for the 121% to 140% and the 141% to 180% segments.

Figure 9: Annual Distribution of New Housing by Affordability Level, O'ahu



NOTE: "Affordability level" is calculated in terms of what a household can afford to spend to pay for a mortgage on a home, in relation to the median household income for the County in a given year. The "0.50 to 0.80" entries refer to the number of units built that could be afforded by families earning 50% to 80% of the median income.

SOURCE: SMS (2005a).

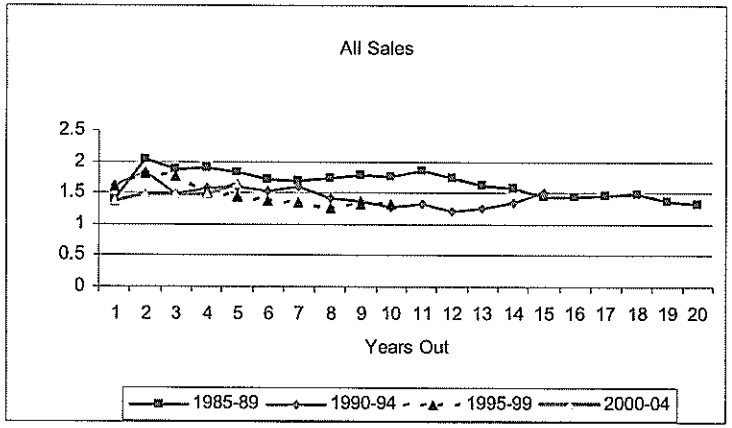
SMS used this methodology to look at resales as well as new housing production, asking whether resales increased in value (expressed in terms of housing affordability). In an active market, older homes can be expected to decline in value compared to new units. In a tight market, older homes will likely increase in value, if new units are not being produced to meet demand. Figure 10 tracks resale values for four "cohorts" of homes that first sold (within the twenty-year time frame of the study) at different times. In the short term, resale values increase. Few resales of homes occur within a year or so, unless an opportunity for a short-term profit arises. Within two or three years, this factor disappears, and the slow decline in value to be expected in an active market follows.[4] (This analysis deals with value, not price. Over the twenty years studied, the price that families can afford has risen. Consequently, a home can resell for a much higher price, but lower value, than its initial sale price.)

[4] Markets on Kaua'i and Maui show increases in value characteristic of tight markets, unlike the long-term trends reported here for O'ahu. The analysis discussed here was conducted separately for various affordability levels, as well as for the total inventory of resales. The data showed the same trends for segments as for the total inventory.

In 'Ewa and Central O'ahu (Zone 9), the long-term trend for the value of existing homes to decline over time has been stronger than for the island as a whole. However, recent sales show an increase in value over as much as five years, not just one or two. This suggests that current market conditions are tight in the area.

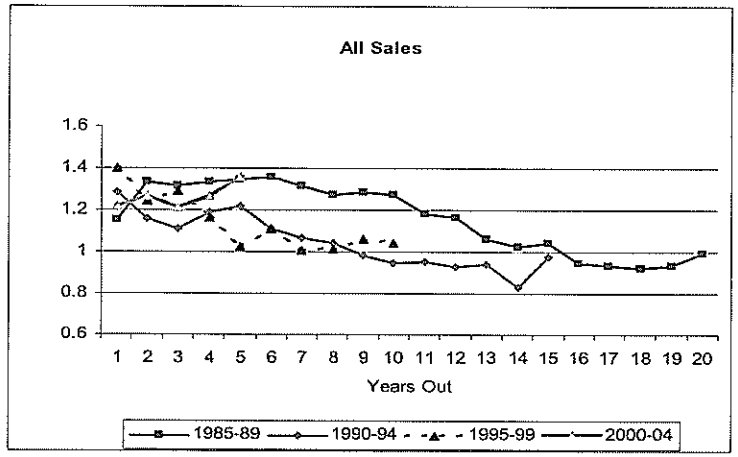
The average value of housing units sold in 'Ewa and Central O'ahu tends to be lower than for the island as a whole.

Figure 10: Resale Affordability, All Units, O'ahu, 1985-2004



SOURCE: SMS (2005a).

Figure 11: Resale Affordability, All Units, O'ahu Zone 9



SOURCE: SMS (2005a).

2.4 DEVELOPMENT OF 'EWA REGION

2.4.1 Geography and History

The two major land forms in the 'Ewa region are the 'Ewa Plain and Makakilo upland. The H-1 Freeway and Farrington Highway run along the boundary between the two land areas. The 'Ewa Plain is an elevated coral reef covered by alluvium. Elevations vary from about 50 feet above mean sea level (msl) near the southern boundary at Kalaeloa (formerly NAS Barbers Point), to 2,300 feet msl at Pu'u Manawahua, the highest peak in the 'Ewa region.

The climate is dry in 'Ewa. However, the land was arable in earlier times. There were once large terraced areas near West Loch referred to as 'Ewa taro lands. Hawaiians used pits in the coral for planting. Before contact with Europeans, settlement and agriculture on the plain were concentrated on the eastern, Pearl Harbor side.

Kamehameha III awarded the 'ahupua'a of Hono'uli'uli – including nearly all of the 'Ewa Development Plan area – to Chief Miriam Ke'ahikuni Kekau'onohi in 1848. She in turn leased it to ranchers. James Campbell bought Hono'uli'uli

from a rancher in 1878. Campbell had the first artesian well drilled on his ranch in 1879, and subsequently developed well systems which allowed the cultivation of sugar cane in Hono'uli'uli. Campbell leased approximately 2,000 acres of land to Castle and Cooke in 1890 to grow sugar. A plantation settlement was established around the mill site on Renton Road and 'Ewa became a plantation community. 'Ewa's sugar and plantation communities flourished for decades.

After World War II, no new investment was made in the plantation villages. Castle and Cooke dissolved the Ewa Sugar Company in 1970 and sold its operations to AMFAC, thus merging 'Ewa Plantation with O'ahu Sugar Company. Cane cultivation continued but processing was done at O'ahu Sugar's Waipahu mill. O'ahu Sugar Company's lease with Campbell Estate, and sugar production in 'Ewa ended in 1995.

Harland Bartholomew and Associates prepared the first 'Ewa Master Plan in 1955 for Campbell Estate. The plan was revised in the early 1960s, and updated in 1974. By then, the concept of a self-contained city evolved. In 1986, Campbell Estate proposed a detailed implementation plan for a city center, bordered by Makakilo, Campbell Industrial Park, and NAS Barbers Point and renamed it Kapolei. The city center concept accorded with General Plan policies to develop a secondary urban center in west O'ahu.

The closure of O'ahu Sugar Company opened up land on both sides of the 'Ewa plain for redevelopment. Major developers on the east side were the City and County of Honolulu, the Gentry Companies, and HASEKO. On the western side, the State of Hawai'i housing development agency took the lead as master developer of the Villages of Kapolei, while the Campbell Estate developed its commercial and industrial lands. The Ko 'Olina resort area was planned and its key infrastructure was built by a consortium headed by Hawai'i developer Herbert Horita. When the economy slowed, the project stalled, and the Ko 'Olina lands were acquired by others. Recently, Aina Nui Corporation has petitioned for redesignation of "Kapolei West," land in Ko 'Olina on which the Ko 'Olina resort did not exercise options to develop. The City and County has withdrawn from the role of housing developer. The State's role is much reduced. The U.S. Navy had maintained NAS Barbers Point, housing areas at Iroquois Point and Pu'uloa, and ammunition storage areas in Pu'uloa. It has transferred limited rights to Iroquois Point to a private development partner. In 2002, the Hawai'i Community Development Authority was designated as responsible for redevelopment of Kalaeloa (Barbers Point). It recently completed a Master Plan for the site (2005).

2.4.2 Communities Surrounding the Ho'opili Project Area

This section provides brief accounts of the surrounding communities, with an emphasis on their role in the emerging Leeward O'ahu urban area. Existing

communities include Waipahu, Central O'ahu, a series of developments along Fort Weaver Road, and the residential areas to the west, reached from the H-1 Freeway via the current Makakilo/Kapolei interchange.

Most of the area in the eastern and western sections of the 'Ewa Plain is currently either in interim use as crop land or pasturage. Above the H-1 Freeway, Grace Pacific has one of the island's few major working quarries, reached by way of Farrington Highway.

2.4.2.1 Waipahu

The term "Waipahu" originally applied to a spring in the Waikele ahupua'a. The term was applied to land areas ('ili) surrounding the spring by the mid-nineteenth century (Nedbalek 1984), and later to the mill up the hill from the spring and to the town that spread around the mill.

Waipahu grew as a mill town. However, many residents took service and professional jobs in Pearl City and Honolulu by the 1980s. As sugar lands were taken out of agriculture, new residential and commercial development has surrounded the older town. Land at the mill site has been redeveloped and includes a Filipino Community Center, the Leeward headquarters of the YMCA, and an industrial park. The mill's smokestack remains as a landmark.

In 2000, the Waipahu CDP included more than 33,000 residents. The average household size, 4.23, is large, in part due to multifamily and multigenerational households.

2.4.2.2 West Loch

The first phase of this 491-acre City-sponsored project was completed in 1990 at the northern end of Fort Weaver Road. West Loch contains single and multifamily housing, a golf course, and parks. Some 60% of the homes were developed as "affordable" for families earning 120% of the median county income or less at the time of sale. This community is fully built out, with mature landscaping.

2.4.2.3 'Ewa Villages

The 'Ewa mill was built on Renton Road in the 1890s, and plantation villages were built nearby over the next decades. At one time there were eight villages, housing immigrant plantation workers from Portugal, Spain, Korea, Japan, and the Philippines. Some 1,200 housing units were built. Four of the newer villages – Renton, Tenney, Varona, and Fernandez – are still standing, while "C," Mill, Middle, and Lower Villages have been razed.

Renton Village, built between 1913 and 1938, is the core of the villages. It included the mill, post office, school, and hospital. Churches built in the plantation era are still standing.

In 1990, this was an old plantation community. Almost half of the Village households received Social Security income, and one-third received retirement income. Since then, the Villages have been redeveloped through a mixture of renovation, infill development, and creation of new subdivisions. Still, 35% of households in the 'Ewa Villages CDP were mildly or severely crowded in 2000. The 2000 Census showed that nearly half the residents had moved into 'Ewa Villages after 1995.

The City's housing development efforts were reduced before 2000. First, the slow economy curtailed housing prices and sales of new units. Next, embezzlement by City officials responsible for moving residents and shops in the existing Villages was uncovered. In the City's reorganization in 1998, the Department of Housing and Community Development was dissolved, and the City is no longer active as a developer.

2.4.2.4 'Ewa by Gentry

The Gentry Companies have approvals for approximately 9,000 housing units, most of which have been built. Soda Creek, the first subdivision within the area, opened in 1988. By 2000, nearly 5,000 persons lived in 'Ewa by Gentry. Its elementary school, Holomua, opened in 1996, now has the largest K-6 enrollment in Hawai'i, with 1,444 students in 2007 (DOE Press Release, September 20, 2007, available at http://lilinote.k12.hi.us/STATE /COMM/DOEPRESS.NSF.)

2.4.2.5 'Ewa Beach

'Ewa Beach began as a weekend recreational area in the 1940s and eventually became a permanent residential community. It contained 3,426 housing units in 1990, and 3,315 is 2000 – the community has not grown while the nearby subdivisions have come into being. As in 'Ewa Villages, crowding is much more prevalent than islandwide or in the newer 'Ewa communities.

'Ewa Beach is home to 'Ilima Intermediate and Campbell High School. These served all of the 'Ewa Development Plan area until the corresponding Kapolei schools were opened in 1999 and 2000.

2.4.2.6 Ocean Pointe

Located at the southwestern end of Fort Weaver Road, Ocean Pointe has long been planned by HASEKO Hawaii. It has been developed to date as a

residential community, with 2,850 units built by mid-2004 (City and County of Honolulu, 2005), but it will also include a marina, as well as commercial and resort acreage. Ke'one'ula Elementary School opened its doors in January 2007.

2.4.2.7 Iroquois Point

Located east of 'Ewa Beach, the Iroquois Point and Pu'uloa housing areas long served the military population based at Pearl Harbor. Under the Ford Island redevelopment process, these areas are now leased to a private developer, which is renovating much of the housing stock and leasing units both to military and civilian tenants.

2.4.2.8 Kapolei

Kapolei is both the term used for much of the development area in 'Ewa and an urban center on the western side of the plain. Major components are:

- The City of Kapolei, with office buildings developed by the Estate of James Campbell and its successor firms, and by Bank of Hawaii, the State of Hawai'i, and the City and County of Honolulu.
- Extensive retail areas – shopping centers, a K-Mart, and a movieplex.
- The Villages of Kapolei, to the east of Fort Barrette Road, with 4,300 units planned. The first increments opened in 1990. As of mid-2005, more than two-thirds of the project had been built. The remaining increments are largely committed to development by DHHL for Native Hawaiians.
- Additional housing areas – Kapolei Knolls and the planned Mehana project – by D.R. Horton - Schuler Division.
- A senior housing village, Leihano, is being planned by Brookfield Homes and Kisco Senior Living.
- Public elementary, middle, and high schools, preschools, and a new non-sectarian private school.
- James Campbell Industrial Park and the Kapolei Business Park, with space for industrial, light industrial, and commercial development. The industrial park includes power plants and Hawai'i's two refineries, as well as a mix of other uses. Additional industrial space is being planned in the 345-acre Kapolei Harborside project.

Kalaeloa Harbor, located between Campbell Industrial Park and Ko 'Olina, is O'ahu's second deep-draft harbor. Previously named Barbers Point Harbor, it began development in 1990, and already handles more cargo than any Neighbor Island port. The harbor and the Industrial Park are included in Foreign Trade Zone No. 9.

The City's transit plans call for a fixed guideway alignment serving the Kapolei area.

2.4.2.9 Makakilo

Makakilo opened for occupancy in 1962, with single and multifamily, mid-priced homes. Finance Realty was the major developer at Makakilo, which encompasses 1,202 acres located above Kapolei. Makakilo stands out as the most affluent of the 'Ewa CDPs.

Makakilo had 9,828 residents in 1990 and 13,156 in 2000. It continued to grow while the older communities in eastern 'Ewa did not.

2.4.2.10 Ko 'Olina

Ko 'Olina is a planned resort community at the southwest end of the 'Ewa region. It currently has a hotel, the first increments of a timeshare complex, and residential areas. While the oldest residential area, a townhouse project, serves residents, more recent subdivisions have attracted second-home buyers. A marina has been built and is in use.

2.4.2.11 Kalaeloa (NAS Barbers Point)

Barbers Point became a major Navy air facility during World War II. The base was listed for closure in the 1993 Base Realignment and Closure process. It closed in 1999, although the Navy retained much of the land at that time. Transfer of the land has stalled. Local government agencies have reconsidered their earlier proposals for development on the site. The former base includes an airport, now managed by the State Department of Transportation, the Coast Guard's Hawai'i airwing, the National Guard's Youth ChalleNGe program, housing for homeless veterans and families, and facilities retained by military agencies. Due in part to the cost of replacing infrastructure, redevelopment rather than simply reusing the existing facilities has been limited.

The 2000 Census data in this report reflects the closure. In 1990, the base had 2,200 residents and supported 1,600 civilian jobs. Since the closure, airport operations have been transferred to the State of Hawai'i, and the Hawai'i Community Development Authority (HCDA) has been charged with redevelopment. The Navy transferred some housing parcels to a private developer, and on-base housing is now available for civilian rentals. Transfer of much of the land area is stalled. Redevelopment will demand extensive work on infrastructure. HCDA has long-term plans for a mixed-use community on site.

2.4.3 Mobility

Two distinct sorts of mobility deserve note: movement of new households into the region and daily movement to and from work or school. Over the economic slowdown of the 1990s, residents of many communities in 'Ewa established themselves. However, jobs have not moved west as quickly as households, so long-distance commuting is common.

As of 2000, more than half the population in most 'Ewa communities had lived in the same house for five years or more. This figure is about the same as for the island as a whole (the exceptions are the two military areas, where most residents moved in the preceding year or two). However, the share of residents who had lived in the same house for a decade or more was well below the island average, except in 'Ewa Beach.

The CDP communities do not include some of the major development sites, and new residential development in 'Ewa has climbed since 2000.

Table 7: Geographic Mobility, 2000

	City and County of Honolulu	Ewa CDPs						Central Oahu CDPs (selected)		
		Ewa Villages	*Ewa Gentry*	*Ewa Beach*	*Iroquois Point*	*Barbers Point*	*Makakilo*	*Waipahu*	*Village Park*	*Waipio*
Geographic Mobility										
Where lived in 1995 --										
Population age 5 and over										
Same house in 1995	56.3%	56.7%	51.9%	64.5%	6.9%	4.3%	55.4%	58.6%	63.4%	60.3%
Different house, same county	26.1%	37.4%	32.1%	27.7%	4.5%	27.1%	32.9%	31.3%	26.5%	26.1%
Different county, same state	1.2%	0.0%	0.2%	1.2%	0.5%	0.0%	0.8%	1.1%	0.8%	1.2%
Different state	11.7%	0.8%	10.7%	4.0%	80.6%	52.9%	7.8%	2.3%	6.4%	8.7%
Elsewhere	4.7%	5.1%	5.1%	2.5%	7.5%	15.7%	3.1%	6.7%	2.9%	3.7%
When moved into unit --										
Householders										
1999 to March 2000	20.1%	20.9%	27.6%	15.3%	49.9%	82.4%	19.5%	17.0%	21.4%	22.6%
1995 to 1998	26.5%	32.4%	23.9%	18.0%	47.6%	17.6%	30.0%	22.6%	20.7%	23.2%
1990 to 1994	14.4%	0.4%	35.5%	14.0%	2.6%	0.0%	20.2%	12.7%	23.7%	17.5%
1980 to 1989	15.2%	19.5%	7.3%	18.5%	0.0%	0.0%	14.1%	14.9%	33.2%	28.4%
before 1980	23.8%	17.9%	1.6%	34.0%	0.0%	0.0%	16.1%	32.8%	1.1%	8.3%

SOURCE: US Census (www.census.gov).

Census data show the majority of 'Ewa workers as commuting to work in 2000. Use of public transportation was higher than the island average among workers from 'Ewa Villages, 'Ewa Beach, and Iroquois Point. Again, most workers with jobs in the leeward region commuted in their own cars.

Planning for the Second City envisaged residents as working near home, so that long-distance commuting could be minimized. A recent study suggests that no more than 29% of 'Ewa and Wai'anae Coast workers have jobs in their own home region. More residents work in Pearl City and Central O'ahu than in their home area.