Kapolei West Expansion Area
Final Environmental Impact Statement

APPENDICES



VOLUME 2 OF 2

June 2005

prepared for
Aina Nui Corporation and
The Estate of James Campbell

prepared by
Helber Hastert and Fee, Planners

for submittal to
State of Hawaii Land Use Commission
in support of a District Boundary Amendment

APPENDIX A
State of Hawaii Land Use Commission Dockets

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAII

In the Matter of the Petition of WEST BEACH ESTATES, a Hawaii general partnership To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 372.6 Acres, at Honouliuli, Ewa, Oahu, Hawaii, Tax Map Key: 9-1-15: 18 and portion of 4, and 9-1-56: portion of 11 and portion of 12	DOCKET NO. A90-655 WEST BEACH ESTATES, a Hawaii general partnership

This is to certify that this is a true and correct copy of the Decision and Order on file in the office of the State Land Use Commission, Honolulu Hawaii.

FEB 14 1991 by _____
Date Executive Officer

FINDINGS OF FACT,
CONCLUSIONS OF LAW, AND DECISION AND ORDER

FEB 14 7 55 AM '91

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FINDINGS OF FACT,
CONCLUSIONS OF LAW, AND DECISION AND ORDER

WEST BEACH ESTATES, a Hawaii general partnership (hereinafter sometimes referred to as "Petitioner"), filed a Petition for Land Use District Boundary Amendment, a First Amendment to Petition for Land Use District Boundary Amendment, and a Second Amendment to Petition for Land Use District Boundary Amendment (hereinafter collectively referred to as the "Petition"), pursuant to Chapter 205, Hawaii Revised Statutes, as amended, and the Hawaii Land Use Commission Rules, Title 15, Subtitle 3, Chapter 15, Hawaii Administrative Rules ("Commission Rules"), as amended, to amend the Land Use District Boundary to reclassify approximately 372.6 acres of land situate at Honouliuli, Ewa, Oahu, State of Hawaii, identified as Oahu Tax Map Key Nos.: 9-1-15: 18 and portion of 4, and 9-1-56: portion of 11 and 9-1-56: portion of 12

(hereinafter referred to as the "Property"), from the Agricultural District to the Urban District. Petitioner proposes to develop the Property as Phase II of the Ko Olina Resort project (hereinafter referred to as "Phase II").

The Land Use Commission of the State of Hawaii (hereinafter the "Commission"), having heard and examined the testimony, evidence and argument of the parties and/or counsel for the parties presented during the hearings, and the parties' proposed findings of fact, conclusions of law and decision and order, hereby makes the following findings of fact and conclusions of law:

FINDINGS OF FACT

PROCEDURAL MATTERS

1. On June 22, 1990, Petitioner filed a Petition for Land Use District Boundary Amendment.

2. On August 21, 1990, a request for intervention was filed by Elizabeth Ann Stone. On October 25, 1990, a request to extend the Commission hearings to allow time for further testimony, an Environmental Impact Statement opposing the petition, and a request to excuse her absence at the Commission hearings due to transportation expenses was received from Elizabeth Ann Stone. Upon consideration of the request and upon motion adopted by the Commission on October 29, 1990, the request for intervention was denied. The Order denying intervention was filed on November 30, 1990.

3. On September 5, 1990, Petitioner filed a First Amendment to Petition for Land Use District Boundary Amendment.

4. On October 5, 1990, the Department of the Navy filed a Petition To Intervene, (hereinafter "Intervenor") and a Motion For Fee Waiver, which were subsequently granted by the Commission by motion adopted on October 29, 1990, and by Order filed on November 30, 1990.

5. On October 25, 1990, Petitioner filed a Second Amendment to Petition for Land Use District Boundary Amendment which proposed to allow the existing 5.8-acre Kamokila Park to remain in its present location; the deletion of the previously proposed new park site on the west end of the Property; a reconfiguration of the 18-hole championship golf course; and a reconfiguration of the low-density apartment parcel to accommodate the existing Kamokila Park.

6. The Commission held hearings on the Petition on October 29 and 30, 1990, pursuant to notice published on September 20, 1990, in the Honolulu Star-Bulletin, a newspaper of general circulation.

7. On October 29, 1990, the Commission accepted into evidence the written testimony of Calvin Kawamoto in favor of the Phase II Petition. The Commission also received into evidence written testimony in favor of the Petition from Charles Dick Beamer, Sterling Ing, Agnes K. Cope, George Kaeo, Kamaki Kanahele and M. Kauila Clark and allowed them to testify

as public witnesses. Also testifying as public witnesses in favor of Phase II were Jane Ross, Francisco Lumbago and Francis Kalama.

DESCRIPTION OF THE PROPERTY

8. The Property is located within the Ewa District, island of Oahu, approximately 20 miles west of Honolulu. The Ewa District encompasses the entire Ewa Plain from Kunia Road on the east to Kahe Point on the west. Located within this area are a planned destination resort, residential communities, a major industrial park, a deep draft harbor, a major military installation, and a portion of Oahu's largest sugar plantation.

9. The Ewa Plain has been designated for development by the City and County of Honolulu ("City") as a secondary urban center and is expected to accommodate most of the anticipated increase in population on Oahu through the year 2005.

10. The Property is bound to the north by the H-1 Freeway, Farrington Highway, Honokai Hale and Nanakai Gardens Subdivision; to the east by the western boundary of the proposed Kapolei Town Center near Kalaeloa Boulevard; to the west by Ko Olina Resort; and to the south by Ko Olina Resort and the abandoned Oahu Railroad and Land Company railroad right-of-way.

11. The site is approximately one mile inland from the shoreline. Access to the property is provided by the H-1

Freeway via the Palailai Interchange and by Farrington Highway and Kalaeloa Boulevard.

12. Ko Olina Phase I which was approved by the Land Use Commission on July 9, 1985, is adjacent to the property on its western and southern boundary. The proposed Kapolei Town Center which was incrementally approved by the Commission is situated east of the Property. The proposed Kapolei Business-Industrial Park is southeast of the Property.

13. Most of the Property is presently used for sugar cane cultivation by the Oahu Sugar Company. An estimated 298 acres or 80% of the Phase II Property is currently under cultivation. The remaining 68.8 acres are vacant lands. Existing uses on the Property also include the 5.8-acre Kamokila Park located adjacent to the eastern end of the Honokai Hale/Nanakai Gardens subdivision. Facilities at the park include a multi-purpose room, a basketball and volleyball court, a small slide for children, and a softball field.

14. Most of the lands within the Phase II Property are owned by the Estate of James Campbell. Approximately 359.8 acres of the Property are under a lease from Campbell Estate to the Oahu Sugar Company for sugarcane cultivation. A neighborhood park consisting of 5.8 acres adjacent to the eastern end of Honokai Hale Subdivision is currently under a lease from Campbell Estate to the City and County of Honolulu, Department of Parks and Recreation.

15. The Property also includes some acreage which is owned by West Beach Estates. Those include a 5.2-acre portion of the proposed golf course and a 1.8-acre portion of a proposed public school site.

16. Through an unrecorded Amended and Restated Ko Olina Resort Development Agreement ("Development Agreement") executed with Campbell Estate, West Beach Estates intends to purchase and develop the entire Phase II site. A short form of the Development Agreement was recorded on December 2, 1986, and was submitted as Exhibit 3.

17. The Property is located at the foot of the Waianae Range, with slopes generally ranging from 1% to 3%. In certain small portions on the western end of the Property, the slope ranges from 20-30%. The ground elevation of the Property ranges from approximately 65 feet near the abandoned railroad right-of-way to 100 feet near the highway. The Ewa Plain receives high insolation year-round and modest amounts of rainfall, with average annual precipitation of about 20 inches. Much of the total annual rainfall accumulates from several storms during the winter rainy season from October to April.

18. The Land Study Bureau Detailed Land Classification for Oahu identifies the overall productivity rating of soils of the Property as follows: approximately 2% as Class A, 86% as Class B, 2% as Class C, and 8% as Class E.

Agricultural suitability ratings range from A - very good to E - very poor.

19. If irrigated, the Land Study Bureau classifies 6 acres as "A", 328 acres as "B", 8 acres as "C" and 31 acres as "D" and "E" lands.

20. The Agricultural Lands of Importance to the State of Hawaii (ALISH) system designates approximately 359 acres of the Property as "Prime" and the remaining 14 acres are classified as "Other" and "Unclassified" lands.

21. The Property lies outside of the tsunami hazard zone and is identified as an "area of undetermined, but possible flood hazard" (Zone D) on the Federal Insurance Administration maps.

PROPOSAL FOR RECLASSIFICATION

22. The proposed Ko Olina Phase II is intended to provide for the future expansion and the necessary amenities to support the first phase of the Ko Olina Resort now well underway. The Phase II master plan proposes the development of an 18-hole championship golf course amidst low and medium density apartments, commercial retail and office development on the east end, and the existing neighborhood park.

23. The following table represents the proposed land uses and approximate acreages for the Property.

Land Use	Acres
Low Density Apartment	102.1
Medium Density Apartment	50.7
Portion of Park (Phase I)	5.2
Portion of Public School Site (Phase I)	1.8
Circulation	14.3
Open Space	4.7
Existing Kamokila Park	5.8
Commercial	32.9
Public Facility	0.5
Golf Course	154.6
Total	372.6

24. The golf course development will consist of an 18-hole championship golf course and will include a clubhouse, parking lot, maintenance facility and driving range. The golf course will help serve the visitor demand for resort golf play, Ko Olina residents, possible memberships, as well as providing tee times for Hawaii residents at reduced rates.

25. Low and medium-density apartments are planned in four clusters within the Property. A total of approximately 1,500 low density units and 2,000 medium density apartments are planned.

26. The commercial parcel on the east end is planned to accommodate a shopping center with retail-commercial development and a low-rise garden office complex.

27. The existing Kamokila Park will be kept at its present location, adjacent to the Honokai Hale subdivision, with access and planning being coordinated with the City Department of Parks and Recreation.

28. A half-acre parcel at the southeast end of the Property is to be part of a future transit station site.

29. The addition of 1.8 acres in Phase II to the contiguous proposed school site in Phase I will allow for a 6-acre site. An agreement was negotiated between West Beach Estates and the State Department of Education during the Phase I process regarding this site.

30. The Petitioner intends to comply with a sixty percent (60%) affordable housing condition through various alternatives, including, but not limited to, the provision of affordable housing on-site or off-site, the provision of an appropriate in-lieu contribution, or a combination of these alternatives to the satisfaction of HFDC.

31. The preliminary estimate for the construction of the golf course, clubhouse, and on-site and off-site infrastructure improvements is approximately $53.55 million in 1990 dollars.

32. Assuming timely approval of all necessary permits, construction of the golf course and on-site and off-site infrastructure are expected to start by late 1991 or early 1992, with completion scheduled sometime in 1993. The on-site residential construction is expected to commence in 1993 or 1994 with availability of units beginning in 1995 and ending in 2006. Development of a retail center and office complex is expected to occur in increments beginning from 1993, for a total of 275,000 square feet.

PETITIONER'S FINANCIAL CAPABILITY

TO UNDERTAKE THE PROPOSED DEVELOPMENT

33. Petitioner presented testimony and evidence, including Petitioner's Balance Sheet dated March 31, 1990 and Financial Statement and Report of Independent Certified Accountants, dated December 31, 1989, showing that the proposed Phase II development is economically feasible and that Petitioner has the experience and financial capability to undertake the proposed development.

STATE AND COUNTY PLANS AND PROGRAMS

34. The 372.6-acre Property is located entirely within the State Agricultural District. Reclassification of the site into the Urban District is being sought to enable the proposed uses and developments of Ko Olina Phase II. It should be noted that the Phase II boundary along the lower western edge does not coincide with the State Land Use boundaries separating the Urban from the Agricultural Districts.

35. Ko Olina Phase II is part of the secondary urban center which is an adopted policy of the City and County of Honolulu as expressed in the General Plan. Implementation of the policy at the development plan level was obtained in May of 1986 with the adoption of Ordinance 86-75.

36. The City and County of Honolulu Development Plan Land Use Map presently provides for Commercial, Low and Medium Density Apartment, Park, and Public Facility uses similar to that proposed in the Petition. Petitioner is pursuing a

Development Plan amendment to adjust the land use boundaries and shift acreages within the Property to provide a more compatible arrangement of land uses. An amendment to the Ewa Development Plan Public Facilities Map is also being pursued to include development of Aliinui Drive (the main collector road) and a system of privately-developed potable and non-potable water transmission mains and a non-potable well.

37. The City and County of Honolulu Land Use Ordinance designates the Phase II site as AG-1 Restricted Agricultural District, and P-2 General Preservation District (for Kamokila Park).

38. The Property is not located within the Special Management Area boundaries established pursuant to the State Coastal Zone Management Law.

NEED FOR THE PROPOSED DEVELOPMENT

39. Golf course demand is tied to population growth and tourism. Resort development is also a primary factor in projecting the demand for golf in Hawaii because the availability of championship golf courses at premier resorts has become a highly desirable amenity to the economic success of a resort. On Oahu, there is a high demand for golf. Although Oahu has 80% of the State's population and approximately 50% to 60% of the State's total visitors, less than 50% of the State's golf courses and only 15% of the State's resort golf courses are located on the island. Presently, Oahu's municipal courses are some of the busiest in

the world, the four private country clubs have waiting lists, and the military courses and public daily fee courses are at capacity. Petitioner expects resort golf to continue to grow due to: growth in volume of visitors, higher golf participation rates, an upscaling of the resort industry, an increase in the number of resort destination areas, and an increase in eastbound visitors. The existing 19 non-military courses play 1.5M rounds/year. Play by residents at non-military courses accounts for 79% of the rounds while play by visitors accounts for 21%. Based on these assumptions (but not accounting for the existing shortfall estimated by Petitioner's consultant), and the anticipated increase in population and visitors to Oahu, Petitioner estimates that there would be demand for up to 18 additional courses on Oahu. Petitioner believes that additional courses are needed to service peak demand and keep resort demand from spilling over to courses primarily servicing local demand. Petitioner maintains that there is currently an existing shortage on Oahu, as evidenced by: existing courses operating at capacity, escalating golf fees, and institution of telephone lottery systems. Actual demand was determined by Petitioner's consultants on the basis of 1 round/day: per 10 units for resort, per 15 units for resort/condo, per 75 units for residential. Consultants estimate that Ko Olina will in and of itself require four courses. Consultants estimate that by

1993, with completion of the first 2,000 hotel rooms, development of the second golf course will be necessary.

40. The supply of housing units on Oahu has not kept pace with demand, with estimates of the shortfall ranging from 20,000 to 50,000 units. Petitioner estimates that Phase II would satisfy 2.8% of overall housing demand through 2010 and 5.2% of housing demand on an average basis over its 12-year life. Petitioner envisions three target markets: primary home, retirees and second home. Residential development of a mix of housing types at Ko Olina Phase II is attractive for a number of reasons. Its location in the Ewa area is preferred by both the State and City for future population growth. Proximity to major job centers will be afforded, including Ko Olina Resort, James Campbell Industrial Park, proposed Kapolei Business-Industrial Park, and the future Kapolei Town. The residential units at Ko Olina will enjoy attractive surroundings, notably golf course frontage and location within a planned community and within a destination resort area. Petitioner is committed to fulfilling a 60% affordable housing condition as agreed with HFDC. However, they would like to maintain their flexibility in being able to satisfy this condition in a number of ways - including on-site, off-site development, in-lieu or a combination of alternatives.

41. Ewa has been designated by the City and County of Honolulu as its "Second City". If development takes place as envisioned, there will be demand for office space to support

urban activities taking place there. Additional office development proposed by Campbell Estate at nearby Kapolei Town Center is also expected to have favorable synergistic impact on demand. Based on the Department of Business and Economic Development's population growth estimates and absorption rates for office space over the past ten years, Oahu will need 290,000-400,000 square feet/year by the year 2000. Commercial use of the property is planned to provide for shopping center demand which is estimated to be generated by the resort and residential development, as well as to provide for an office complex to meet a portion of the island-wide demand for office space over the next decade. Demand for the retail center consisting of approximately 300,000 square feet will also be generated from projected resort and residential developments at Ko Olina Resort Phase I. The office complex of 275,000 square feet is expected by the Petitioner to supply approximately 10% of the island-wide demand for new office space over a 7-year period.

ECONOMIC IMPACTS

42. According to Petitioner's marketing consultant, John Zapotocky, direct employment is estimated to result in 2,525 new direct jobs and 394 indirect jobs as compared to an estimated 12 direct jobs generated by current sugar operations.

43. Upon project completion, County net revenues are projected to be $3.7 million per year (in 1990 dollars). Total revenues accruing to the State during the construction phase

are expected to be $54.5 million. Upon completion of the project, State net revenues derived from Phase II are projected to be $1.4 million per year.

SOCIAL IMPACTS

44. The proposed multi-family residential units, golf course, and commercial developments of Ko Olina Phase II will help establish the Secondary Urban Center by providing a balance of adequate housing, employment, and recreational opportunities to meet the needs of the projected population increase within the area.

45. The development of Ko Olina Phase II will result in a variety of employment opportunities as the development's long-term employment is expected to generate approximately 2,500 direct jobs, primarily stemming from the commercial retail and office development.

46. The development of Ko Olina Phase II would provide a total of approximately 3,500 multi-family units, which will consist of 1,500 low density and 2,000 medium density apartments.

IMPACTS UPON RESOURCES OF THE AREA

Agricultural Resources

47. Frank S. Scott, Jr. conducted a study addressing the land capabilities for crop production on the Property and the probable effects on Oahu Sugar Company (hereinafter "Oahu Sugar") and agriculture on Oahu in general if the Property were withdrawn from crop production for other uses.

48. An April 25, 1990, letter from Oahu Sugar to West Beach Estates, confirmed that Ko Olina Phase II is "outside Oahu Sugar's critical core lands." Oahu Sugar also specified that cultivation of these lands may become infeasible within a few years regardless of the development of Ko Olina Phase II due to the planned "Second City" and other developments, which would cut these fields off from mill facilities and make cultivation impractical for the long run.

49. The acreage of the Property that is used for sugarcane production represents only 2.2 percent of the 13,561 acres of sugarcane reported for Oahu Sugar in 1988. Oahu Sugar's net returns might be expected to be somewhat less than the indicated 2.2 percent based on proportion of land area considering (1) somewhat lower quality soils than for the average of the plantation, (2) higher irrigation requirements than for mauka lands, (3) greater distance from the mill than for most parcels and (4) possible conflicts in burning and transporting sugarcane associated with the surrounding urban infringement.

50. Withdrawal of this acreage should not in itself have a major impact on sugar production and should have a relatively minor effect on the economic viability of Oahu Sugar.

51. Mr. Scott indicated that there are no foreseeable alternative agricultural uses for most of the land on the Property. Extensive research by the Hawaiian Sugar Planters

Association, the University of Hawaii and the sugar plantations has failed to identify major alternatives to sugar crops on Oahu.

52. As of 1988, 141,886 acres were zoned as agricultural on Oahu by the State Land Use Commission, of which only 42,500 acres were in cultivated crop production, and 99,386 acres of agricultural lands were uncultivated.

Flora

53. Based on a Botanical Survey of the Property conducted by Kenneth Nagata, five vegetation types were identified: sugarcane, koa-haole, Guinea grass, scrub grassland dominated by buffelgrass, roadway vegetation of grasses and other herbaceous species, and some cultivated ornamentals around the pumphouse. No endemic or rare and endangered species were found despite a careful search. No native ecosystems will be affected by the proposed project.

Fauna

54. The Property includes introduced mammals, amphibian species and land reptiles. Of the eighteen species of introduced birds observed within the vicinity, none are classified as an endangered species. No endemic or endangered mammals, amphibians, reptiles or birds were found on the Property. The proposed project would have no adverse effect on the terrestrial vertebrate animals observed within the area of the Property.

Historical/Archaeological Resources

55. A reconnaissance survey and subsurface archaeological testing of the Property was conducted by Paul H. Rosendahl, Ph.D. Inc. The survey revealed that the entire Property has been extensively modified in recent times, primarily by sugarcane cultivation and that no significant archaeological sites were encountered within the Property during the Reconnaissance Survey and Subsurface Testing.

56. Petitioner states that if any potentially significant subsurface cultural remains are encountered during construction of the proposed development, work will cease, archaeological consultation will be sought and the appropriate governmental agencies will be notified immediately.

57. The Oahu Railroad and Land Company Right-of-Way railroad bed extends approximately 3,200 feet along a portion of the southern boundary of the Property, and is listed on the National Register of Historic Places (Site 50-80-12-9714). The project will not have any adverse effect on the railroad bed.

Recreational and Scenic Resources

58. The Property is planned to include the 5.8-acre Kamokila Park. Phase II will also include a 156-acre, 18-hole championship golf course with a clubhouse facility and driving range.

59. The Petitioner, in its Phase I plans, provides an 11-acre park adjacent to a proposed school site and just below the western end of the Phase II Property. Phase I also

includes an 18-acre beach park located near the resort's primary entrance and a 9.3-acre beach park located adjacent to the marina.

60. A number of private developments in the vicinity of the Property have proposed or will develop recreational facilities as part of their master plans.

61. Four community parks currently exist within the Ewa District, including the 5.8 acre Kamokila Park located within the Property and three neighborhood parks.

62. The proposed development of the golf course and park will help preserve the makai view from the highway which is elevated above the Property. The low density apartments are not expected to affect any views from the highway and mauka areas. Medium density apartments are confined to two areas near the commercial development. The commercial developments will be low-rise in character with height limits established such that views will not be materially affected.

ENVIRONMENTAL QUALITY

Noise

63. A Noise Study was prepared by Y. Ebisu and Associates in December 1989. According to the Noise Study, the latest Air Installations Compatible Use Zones (AICUZ) study for Naval Air Station Barbers Point indicates that aircraft noise levels do not presently exceed 60 Ldn at any of the residential areas planned, even when combined with aircraft operations from Honolulu International Airport. The 60 Ldn contour crosses the

edge of the transit station site as drawn utilizing 1987 data. The 60 Ldn contour would also include a corner of the Commercial site as forecasted for 2005. The 55 Ldn Contours for 1987 and 2005 cross over the Medium and Low Density Apartment areas of the project.

64. None of the Barbers Point Naval Air Station's ("BPNAS") flight tracks come across the Phase II development.

65. Hawaii Revised Statutes § 467-31 requires that real estate brokers and salesmen provide a disclosure regarding properties which lie within an AICUZ area to prospective buyers, lessees, and tenants, prior to any sale, leasing or other transactions.

66. The Property is closer to the BPNAS than the Honolulu International Airport, however, the Navy did not request any avigation easement. Hawaii Revised Statutes § 467-31 and OSP's proposed condition regarding deed disclosures should satisfy any aircraft-related concern that the Navy might have regarding the Phase II Property.

67. The Phase II development, as presently proposed, is compatible with the BPNAS aircraft operations, noise and accident environment and is consistent with agreements reached between the Navy and Campbell Estate.

68. Traffic noise levels would not be incompatible with development of the golf course and commercial area. A portion of the low density apartment units on the northeast portion of the Property within 250 feet from the highway

centerline would be impacted by highway noise. Noise mitigation such as air-conditioning these units will be undertaken to prevent adverse noise impacts on future residents.

Air Quality

69. An Air Quality Study was conducted by Root and Neal Air Pollution Consulting in January 1990 on fugitive dust and exhaust emissions related to construction equipment and commuting construction workers. To mitigate the short-term fugitive dust, the Petitioner will comply with the State of Hawaii Air Pollution Control Regulations. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Vehicular emissions may be limited by moving construction equipment and workers to and from the project site during off-peak traffic hours.

70. All long-term air quality impacts associated with the proposed project are indirect. The primary indirect impact will be increased levels of carbon monoxide from vehicle traffic along roadways leading to and from the proposed development, especially near the new intersection of Kalaeloa Boulevard and Ko Olina Parkway.

Water Quality

71. According to the petitioner's pesticide safety expert, Dr. Brennan, the change from sugarcane cultivation to a well-managed golf course is consistent with the State's goal of preserving and protecting groundwater. The total amount of

nitrogen used in the fertilizer for sugarcane production is similar to that which would be used on the proposed golf course. The presence of caprock between the surface of the property and the Pearl Harbor aquifer should serve as an effective barrier between the brackish and potable groundwater sources and will not cause significant degradation of potable groundwater quality from the land use conversion from sugarcane cultivation to golf course.

Fertilizers and Pesticides

72. Development of the proposed golf course and the use of chemical fertilizers and pesticides if properly managed should not pose adverse environmental risks. The combination of soil properties, gently sloping topography, and a net evapotranspiration deficit suggest no recharge of the brackish groundwater from rainfall. The amount of nitrogen used would be similar to that used in sugarcane production.

73. The pesticides to be used on the golf course degrade relatively quickly. Airborne drift would be controlled by using low-pressure nozzles, lowering application booms, using drift control agents, selecting proper formulations, observing local weather conditions, and making applications by properly trained personnel.

ADEQUACY OF PUBLIC SERVICES AND FACILITIES

Highway and Roadway Facilities

74. Primary roadway access to the Property is via the H-1 Freeway and Farrington Highway, with west and eastbound

access via the Palailai Interchange and Kalaeloa Boulevard and the newly constructed Ko Olina Interchange. From the access points, circulation through the Property will be provided by Aliinui Drive (a four-lane collector road) which will be extended from the Phase I area to and along the southern boundary of the Phase II site to Kalaeloa Boulevard.

75. A Traffic Study prepared by Wilbur Smith Associates in February 1990, concluded that the proposed project would generate approximately 1,262 vehicle trips per day in 1992 upon completion of the golf course and 41,900 vehicle trips to or from the project areas on an average weekday upon full development of the 3,500 residential units and the commercial area in 2005.

76. To improve the level of service of traffic, which would be LOS F (Level of Service) with or without the project to LOS D, a large intersection at Aliinui Drive and Kalaeloa Boulevard, with sufficient through lanes and separate left and right turn lanes on both roadways, will be required. Petitioner's consultant stated that the intersection should be signalized.

77. Petitioner's consultant stated that the intersection of Aliinui Drive and Koio Drive which would operate at LOS F with or without the project could be improved by constructing four lanes on Aliinui Drive from the Koio Drive to the Kalaeloa intersection. The eastbound approach will require double left turn lanes and a single through lane. Koio

Drive should have two lanes approaching and departing. Petitioner's consultant stated the intersection should be signalized.

78. The anticipated traffic is expected to be dispersed throughout the interior access roadway intersections. Left and right turn lanes into the various project areas would be provided with appropriate stop-control or signalization to allow continuous free-flowing traffic on Aliinui Drive.

79. Petitioner is participating in the implementation of the Ewa Transportation Master Plan which is in the process of determining the funding and construction of regional transportation improvements in the Ewa area and the impacts generated by the Phase II project.

Water Service

80. The proposed development will be serviced by a dual water system supplying potable water for human consumptive uses and brackish water for irrigation. Potable water source improvements proposed in the Ewa Water Master Plan have been jointly implemented by the Ewa Plain Water Development Corporation (EPWDC), of which West Beach Estates is a member.

81. Mauka of the Property and Farrington Highway, water transmission mains, reservoirs, and non-potable wells have been either constructed or bonded for Ko Olina Phases I and II. New potable water wells have been identified for

development as part of the Ewa Water Master Plan at the 440-foot elevation of upper Honouliuli, mauka of H-1 Freeway, and west of Kunia Road.

82. Total water demand is estimated at 1.09 million gallons per day of potable water and 1.16 million gallons per day of non-potable water. The Ewa Water Master Plan, approved by the Board of Water Supply in October 1987, includes the development plan for Ko Olina Phase II.

Wastewater

83. On the mauka side of the railroad right-of-way, 33-inch and 36-inch trunk sewers connect to the municipal Makakilo Interceptor Sewer which conveys and discharges wastewater to the Honouliuli Wastewater Treatment Plant. The existing lines are adequate to accommodate the estimated 1,164,000 gallons per average day of wastewater generated by the proposed development.

84. Appropriate permits and approvals will be requested from the State Department of Health and the City Department of Public Works for the proposed wastewater system. Since the Phase II development will be constructed over a period of years, each individual building or project will obtain approval of its wastewater allocation from the City Department of Public Works as part of the building permit process.

85. The City has plans to expand the capacity of the Honouliuli Wastewater Treatment Plant. The expansion is

scheduled for completion in 1993 or 1995. After completion of the expansion, there will be adequate capacity to treat and dispose of the wastewater generated by Ko Olina Resort Phase II. Petitioner must seek approval from the City and County of Honolulu to connect to the Honouliuli Wastewater Treatment Plant. Should the capacity at the plant not be sufficient for the proposed development, the Petitioner may utilize other alternatives acceptable to the State Department of Health.

Drainage System

86. The Property lies within three natural drainage basins. Existing off-site downstream drainage facilities are adequate for the proposed development. An unlined channel south and east of the Property and recently completed drainage improvements in Ko Olina Phase I were designed and built to accommodate storm runoff from the Property and sub-tributary mauka areas.

87. Proposed on-site improvements include construction of underground pipe drain systems within Aliinui Drive and grassed swales, ditches and channels in the proposed golf course. A drainage master plan will be prepared and submitted for City review at the appropriate stage of the development process.

Solid Waste Disposal

88. Solid waste expected to be generated by the proposed development is approximately 50 tons of refuse per

day. Solid waste will be collected by the City and private refuse companies and transported to the H-POWER facility or to a public landfill site.

Schools

89. The Ko Olina Resort plan provides a site for an elementary school which would be developed when the Ko Olina community has generated a sufficient demand for a new facility. The State Department of Education estimates that the Ko Olina Phase II residential development would increase the enrollment of Makakilo Elementary and Kapolei Elementary (grades K-6) by 340-360 students, Ilima Intermediate (grades 7-8) by 130-140 students, and Campbell High (grades 9-12) by 200-220 students.

Police and Fire Protection

90. Police service to the Ewa area is provided by the Pearl City station, which jurisdiction includes three districts: the Waianae Coast, Waipahu/Ewa Beach, and Aiea/Pearl City.

91. Fire service to the proposed development site is presently provided from the Makakilo station, which houses an engine company and five firefighters. Additional City Fire Department units are available from the Waipahu and Nanakuli stations.

92. Ko Olina Resort Phase I plans also provide for a 2-acre site for police/fire/day care center facilities.

Emergency/Civil Defense

93. The State Department of Defense, Office of the Director of Civil Defense requests the installation of infrastructure support for siren warning equipment. Civil Defense explains that emergency warning systems must be planned for the safety of communities and that inclusion of the systems at the permitting process results in considerable savings. Planning and installation would be done in consultation with Civil Defense and the systems would subsequently be donated to Civil Defense.

94. It is estimated that three siren locations would be needed to serve the project. Preliminary locations are identified at the southwest corner of the park alongside the drainage canal, in the parking lot of the golf course closest to Ali'inui Drive, and in the public facility next to Ali'inui Drive.

95. The Oahu Civil Defense Agency also states "the need for the developer and those organizations involved in designing and constructing commercial, school, and recreation facilities, to assure every effort is made to create usable shelter for the new population."

Electricity and Telephone Services

96. Major electrical transmission facilities within the Property include Hawaiian Electric Company's 138 KV overhead line that traverses along the western edge of the

proposed commercial parcel and existing 46 KV lines parallelingthe railroad right-of-way. Projected peak demand for the proposed project is estimated at approximately 18 MVA. Based on the projected loading, Hawaiian Electric Company does not anticipate that a new substation will be required to serve the project.

97. The telephone system will be an underground facility except for cross-connect pedestals provided by Hawaiian Telephone Company at various locations throughout the Property to permit access and telephone service to the project facilities.

Health Care Services

98. Existing health and medical care facilities are located in Waianae, Ewa Beach, and Waipahu. These facilities consist of medical clinics and physician offices. Hospital facilities include the 116-bed facility at Pearl Ridge (the Pali Momi Medical Center) and a 136-bed facility in Waipahu (St. Francis Medical Center West and St. Francis Medical Plaza West).

CONFORMANCE TO THE URBAN DISTRICT STANDARDS

99. The Property meets the standards applicable for determining the boundaries for the Urban District as set forth in Section 15-15-18 of the Commission's Rules as follows:

100. The Property includes lands characterized by "city-like" concentrations of people, structures, streets,

urban level of services and other related land uses. It is adjacent to the 290-unit Honokai Hale/Nanakai Gardens Subdivision and the first phase of the Ko Olina Resort development on its western end. To the east lies the proposed Kapolei Town Center development which is intended to be the focal point of the Second City development.

101. The Property is in proximity to centers of trading and employment and would also generate new centers of trading and employment. The Property lies between and in close proximity to the Ko Olina Resort and the proposed Kapolei Town Center development. Phase II will also be a significant generator of trading and employment as approximately 2,500 direct jobs would be created by the golf course and commercial developments.

102. The Petitioner has substantiated the economic feasibility of the Phase II Project. The Market Study indicates a substantial demand exists for an additional golf course facility to support the resort development. The Market Study further emphasizes a long-term demand for residential housing on Oahu. The proposed residential development of Ko Olina Phase II would contribute to this demonstrated need for additional residential units. There is also the demand for additional commercial space which will be allocated to retail and office facilities on the east end of the Property.

103. The Property is in proximity to basic services such as sewers, transportation systems, water, sanitation,

schools, parks, and police and fire protection. The sewer system when expanded, will be adequate to accommodate the wastewater generated by the planned residential, golf course clubhouse, and commercial developments. Electrical and communications services will be provided from existing utility systems. Planned roadways and mitigative measures are proposed to alleviate impacts and maintain traffic volumes within roadway capacities.

104. There are sufficient reserve areas for urban growth in appropriate locations based on a ten-year projection. The Property is a logical continuum of urbanization and growth in the Ewa area as it lies between the Ko Olina Resort Phase I and the proposed Kapolei Town Center. In its Ewa Development Plan, the City has also planned for urban-type uses within the Property.

105. The Property includes lands with satisfactory topography and drainage and are reasonably free from the danger of floods, tsunami, and unstable soil conditions, although the predominant soils have high shrink-swell potential and crack widely upon drying. The Property has slopes generally ranging from 1 to 3% and is not situated within a flood hazard area. General on-site improvements are proposed to improve drainage and storm runoff conditions. Upon development, the golf course will function as a retention/flood basin to lessen storm flows to lower-lying areas and will help to mitigate any flood hazard. No adverse environmental impacts are anticipated.

106. The Property is contiguous with existing Urban areas on the west, including the Honokai Hale/Nanakai Gardens Subdivision and the Ko Olina Resort Phase I. To the east, the Property is contiguous with the "Subsequent Increments" area of the proposed Kapolei Town Center which recently obtained incremental redistricting to the Urban District. The Property is also planned for future urban uses on the City's Development Plan for Ewa, including low and medium density apartment uses, commercial, park, and public facility uses.

107. The Property supports and is consistent with the designation of Kapolei as the Secondary Urban Center for growth and development on Oahu. The proposed golf course, multi-family residential units, park, and commercial area will provide the necessary support facilities to accommodate the future growth and development of the Ko Olina Resort.

108. The Property is a logical extension of urbanization in the Ewa District and will not contribute to scattered spot urban development. Petitioner will provide all required on-site and off-site improvements to minimize the burden on public systems which are affected by the development. Thus, urbanization of the Property will not necessitate unreasonable investment in public infrastructure or support services.

109. The Property does not include lands with a general slope of twenty percent or more which do not provide open space amenities or scenic values.

CONFORMANCE WITH THE GOALS, OBJECTIVES AND POLICIES OF THE HAWAII STATE PLAN AND RELATIONSHIP WITH APPLICABLE PRIORITY GUIDELINES AND FUNCTIONAL PLAN

The urban designation of the Property is in conformance with the Hawaii State Plan, the overall theme, goals, objectives and priority guidelines for the future long-range development of the State. The Petition supports and is consistent with the following State Plan objectives and policies:

110. In conformance with Section 226-5(b)(7), Hawaii Revised Statutes, the development of Phase II will support the designation of Ewa as the Secondary Urban Center. A variety of employment opportunities will result, particularly for residence of the leeward area.

111. In conformance with Section 226-6(a)(1), (b)(6), (b)(10), and (b)(15), Hawaii Revised Statutes, Phase II activities will help sustain the level of construction activity in the State, and benefit the Ewa area and nearby communities by the additional employment opportunities. After construction, the new facilities are expected to provide full-time employment for approximately 2,500 persons. The new jobs created by the proposed project will help to diversify economic opportunities for the Ewa area and will reduce the number of residents that will have to commute to Honolulu for employment. Petitioner has formed the West Oahu Employment Corporation (WOEC) in conjunction with the community and area providers of employment training. WOEC's purpose is to

facilitate employment of the residents of West Oahu into jobs created in the Ko Olina, Ewa, Makakilo, and Waianae areas.

112. In conformance with Section 226-7(b)(6), Hawaii Revised Statutes, the withdrawal of the Property, in itself, would not significantly impact the availability of agriculturally suitable lands as the effect is expected to be less adverse than withdrawal of other similar-sized parcels elsewhere on the plantation. Factors which lessen the site's desirability include somewhat lower quality of soils than for the average plantation and higher irrigation requirements than for mauka lands. In addition, the remaining acreages of agricultural lands on Oahu are sufficient for crop production.

113. In conformance with Section 226-8(b)(3), (b)(4), (b)(5), and (b)(6), Hawaii Revised Statutes, the construction of the golf course and commercial development, and the retention of the existing Kamokila Park will support the promotion of Hawaii's visitor industry and improve the quality of the Ko Olina Resort destination area. The new facilities will provide a variety of activities to meet the diverse needs of both visitors and residents. The new Phase II project will also provide a variety of permanent job opportunities and facilities for the residents in the neighboring communities. Petitioner has established WOEC to take the role of both catalyst and facilitator in developing partnership activities with community organizations, training groups, and West Oahu area businesses.

114. In conformance with Section 226-10(b)(3) and (b)(8), Hawaii Revised Statutes, Petitioner has established the Pacific Foundation. Its primary objective is to promote the improvement of social and living conditions in West Oahu communities and to support other religious, educational, and charitable activities that contribute to the betterment of the people of Hawaii.

115. In conformance with Section 226-13(b)(7), Hawaii Revised Statutes, the proposed Phase II project will provide housing and employment, as well as commercial and recreational opportunities which are in close proximity to a variety of existing and future developments. The Property is adjacent to the Farrington Highway, the Ko Olina Resort Phase I complex, Barbers Point Harbor, and the Honokai Hale and Nanakai Gardens subdivisions. Future developments within the vicinity of the proposed Phase II project also include the Kapolei Town Center, Makakilo expansion, Kapolei Village, Kapolei Business-Industrial Park, and Campbell Industrial Park expansion.

116. In conformance with Section 226-14(b)(3), Hawaii Revised Statutes; and Section 226-16(b)(1), Hawaii Revised Statutes, an assessment of groundwater resources has been undertaken in conjunction with the Ewa Water Master Plan to ensure that the required facility system can be supported within the existing resource capacities. To preserve potable water supply, non-potable water sources will be developed for irrigation of the Phase II golf course.

117. In conformance with Section 226-19(a)(2), and (b)(5), Hawaii Revised Statutes, the 3,500 multi-family residential units planned in connection with Ko Olina Phase II will provide housing opportunities to accommodate the demands of the market sector desiring residence in a resort community and will complement and support the employment and recreational opportunities afforded by the Ko Olina Resort. The Phase II residential development will also be readily accessible to public facilities and services. Petitioner will provide affordable housing through various alternatives, including, but not limited to, the provision of affordable housing on-site or off-site, the provision of an in-lieu contribution, or a combination of these alternatives under such terms as may be mutually agreeable between Petitioner and the Housing Finance and Development Corporation of the State of Hawaii.

118. In conformance with Section 226-21(b)(5), Hawaii Revised Statutes, the West Oahu Employment Corporation, which is partially funded by the Petitioner, provides job training and placement.

119. In conformance with Section 226-22(b)(1), Hawaii Revised Statutes, Petitioner has established and will continue to contribute to the Pacific Foundation, a non-profit philanthropic organization whose primary objective is to promote the establishment and maintenance of social, educational, religious, and cultural activities to foster the traditional culture, environment, and economic prosperity of

the people of Hawaii and the West Oahu area. The Pacific Foundation is working with and has provided grants to schools and human service agencies to assist in their efforts to identify needs, encourage and help cultivate more youth development programs, and to help the homeless in the West Oahu area.

120. In conformance with Section 226-23(b)(2) and (b)(5), Hawaii Revised Statutes, the Phase II golf course and neighborhood park expansion will help to fulfill the recreational needs of the resort and surrounding community. They will provide a range of activities to accommodate both current user groups as well as the demand that will be generated by future development and growth in the Ko Olina Resort area.

121. The proposed Phase II development supports or conforms to the following Hawaii State Plan Priority Guidelines:

122. The Petitioner conforms with Section 226-103(a)(10)(B), Hawaii Revised Statutes, by its organization of WOEC, its establishment of scholarships and tutorial programs for students, and the expansion of business and entrepreneurial training through Leeward Community College. WOEC's formation of a one-stop-service center for community residents provides services including career counseling, entrepreneurial training, job placement and referral, and job training partnerships.

123. In conformance with Section 226-103(b)(7), Hawaii Revised Statutes, the Phase II golf course, residential and commercial development are intended to provide for a more favorable resort investment climate. Development will help to improve the overall functional relationship within the Ko Olina resort community. The proposed development will also provide new commercial and office facilities to support the Ko Olina Resort and the Second City communities.

124. In conformance with Section 226-103(e)(2), Hawaii Revised Statutes, present plans call for the use of non-potable water sources for the Phase II landscaping and the irrigation of the golf course.

125. In conformance with Section 226-103(e)(4), Hawaii Revised Statutes, Ko Olina Resort and other Ewa projects are constructing dual water systems; a potable system for human consumptive uses and brackish systems for irrigation and other non-potable uses.

126. In conformance with Section 226-104(a)(3) and (b)(6), Hawaii Revised Statutes, adequate support services and facilities already exist or will be provided to accommodate the proposed Phase II development. The proposed Phase II development will also provide a variety of jobs and support facilities to help accommodate the resort needs and the projected growth within the Second City and the Ewa district. The general public will benefit from the construction of the Phase II infrastructure, including the access road, community

park, school site, transit station, golf course, and commercial area. These infrastructure costs will be borne by the Petitioner. Development of the golf course and community park will also help to preserve open space between the neighboring residential developments and within the project area.

127. In conformance with Section 226-104(b)(2), Hawaii Revised Statutes, withdrawal of this site from sugar cultivation is expected to have a less adverse effect than withdrawal of most similar sized parcels elsewhere on the plantation due to higher irrigation requirements and greater distance from the mill.

128. The proposed Phase II project complies with and supports the following policies of the State Tourism Functional Plan:

129. Phase II complies with Section 226-104(b)(2), (b)(3), and (b)(4), Hawaii Revised Statutes, because it is part of the overall Ko Olina Resort community, which includes a golf course, park, residential, and commercial areas, which will provide a variety of jobs and facilities for the anticipated population growth in Ewa and will enhance the quality of the Ko Olina Resort development; Phase II has been carefully planned, is sensitive to existing neighborhood communities; and the golf course and community park will help to preserve open space and views for the existing neighboring communities. Phase II will also provide additional infrastructure, facilities, and

recreational and commercial opportunities that may be utilized by existing neighboring communities.

CONFORMANCE WITH COASTAL ZONE MANAGEMENT OBJECTIVES AND POLICIES

130. The Property does not abut the shoreline and is not in a tsunami or stormwave inundation area. Drainage facilities included on the Property, including the drainage swale across the golf course, will ensure that the Property will be in compliance with the requirements of the National Flood Insurance Program.

131. The proposed reclassification of the Property for the development of the proposed project conforms to the policies and objectives of the Coastal Zone Management Program Chapter 205A, Hawaii Revised Statutes, as amended.

INCREMENTAL DISTRICTING

132. Petitioner states that full development of the Property cannot be substantially completed within five (5) years after the date of final county zoning approval. Assuming other timely government approvals, Petitioner expects to complete the golf course and begin construction of residential and commercial properties within five (5) years from the date of final county zoning approval. Petitioner also expects that it's incremental development plan can be substantially completed. Petitioner's position is that its request to reclassify the entire Property to the Urban District is appropriate at this time as major commitments regarding

financing and construction of infrastructure for the entire development will be required during the initial five (5) year period.

RULING ON PROPOSED FINDINGS OF FACT

Any of the proposed findings of fact submitted by the Petitioner and the other parties not already ruled upon by the Commission by adoption herein, or rejected by clearly contrary findings of fact herein, are hereby denied and rejected.

Any conclusion of law herein improperly designated as a finding of fact should be deemed or construed as a conclusion of law; any finding of fact herein improperly designated as a conclusion of law should be deemed or construed as a finding of fact.

CONCLUSION OF LAW

Pursuant to Chapter 205 of the Hawaii Revised Statutes, as amended, and the Hawaii Land Use Commission Rules, the Commission finds upon a preponderance of the evidence that the reclassification of the Property consisting of approximately 372.6 acres from the Agricultural Land Use District into the Urban Land Use District at Honouliuli, Ewa, Oahu, City and County of Honolulu, subject to the conditions stated in the Order, conforms to the standards for establishing the Urban Boundaries, is reasonable, non-violative of Section 205-2, Hawaii Revised Statutes, and is consistent with the Hawaii State Plan as set forth in Chapter 226, Hawaii Revised Statutes, as amended.

ORDER

IT IS HEREBY ORDERED that the Property, being the subject of this Docket No. A90-655 by Petitioner WEST BEACH ESTATES, a Hawaii general partnership, consisting of approximately 372.6 acres, situated at Honouliuli, District of Ewa, Island of Oahu, State of Hawaii, and identified as Oahu Tax Map Key Nos.: 9-1-15: 18 portion of 4 and 9-1-56: portion of 11 and 9-1-56: portion of 12, and approximately identified on Exhibit "A" attached hereto and incorporated by reference herein, for reclassification from the Agricultural District to the Urban District, shall be reclassified from the Agricultural District into the Urban District and the State Land Use District Boundaries are amended accordingly, subject to the following conditions:

1. Petitioner shall provide affordable housing opportunities for residents of the State of Hawaii by offering for sale or lease a number of units equal to at least thirty percent (30%) of the residential units in the Property at prices which families with an income range of up to one hundred twenty percent (120%) of the City and County of Honolulu's median income can afford, and a number of units equal to at least thirty percent (30%) of the residential units in the Property at prices which families with an income range of one hundred twenty to one hundred forty percent (120%-140%) of the City and County of Honolulu's median income can afford.

a. This condition may be fulfilled through various alternatives, including, but not limited to, the provision of affordable housing on-site or off-site, the provision of an in-lieu contribution, or a combination of these alternatives under such terms as may be mutually agreeable between Petitioner and the Housing Finance and Development Corporation of the State of Hawaii ("HFDC").

b. This condition may also be fulfilled, with the approval of the HFDC through construction of rental units to be made available at rents which families in the specified income ranges can afford.

c. In addition, Petitioner may obtain special credit, as determined by HFDC, for the provision of housing affordable to persons with low and/or very low incomes and for the provision of housing for special needs groups, as determined by the HFDC.

d. Insofar as possible, the Petitioner shall implement this affordable housing requirement concurrently with the completion of market priced units for the residential project.

e. The determination of median income, as the term is used in this condition, shall be based on median income published by the United States Department of Housing and Urban Development at the time that construction of such housing units commences.

2. Petitioner shall participate in the implementation of the Ewa Transportation Master Plan ("ETMP"). In the alternative, should the ETMP not be completed on a schedule compatible with Petitioner's development schedule, Petitioner shall undertake the following on a fair proportionate share basis as determined by the State Department of Transportation ("DOT"):

a. Petitioner shall participate in the funding and construction of transportation improvements at project access points as identified and deemed necessary by DOT.

b. Petitioner shall also participate in the funding and construction of other on-site and off-site transportation improvements necessitated by the proposed development of the Property and in designs and schedules accepted by and coordinated with DOT.

c. With respect to the foregoing requirements, the extent of the Petitioner's participation shall not exceed its fair proportionate share of the increased community impacts in the region.

d. In the event that the City and County of Honolulu ("C&C") adopts an impact fee for transportation improvements, the foregoing requirements shall be satisfied to the extent that the cost of any specific traffic improvement is also included in the C&C's impact fee computation.

e. Petitioner shall appoint a transportation manager whose function is the formulation, use, and

continuation of alternative transportation opportunities that would optimize the use of existing and proposed transportation systems. In the alternative, Petitioner may participate in a regional program for transportation management with other developers and/or landowners. This program shall address the formulation, use, and continuation of alternative transportation opportunities that would optimize the use of existing and proposed transportation systems. Participation in the Leeward Oahu Transportation Management Association would satisfy this condition.

3. Petitioner will provide other community benefits to mitigate impacts, which may include adequate golf tee times at affordable rates for public play by Hawaii residents based on prevailing rates for public play at privately owned daily fee golf courses to the satisfaction of the Office of State Planning and the City and County of Honolulu.

4. Petitioner shall provide drainage improvements for the Property and shall, to the extent necessary as determined by the City and County of Honolulu, coordinate off-site improvements with the Estate of James Campbell, the Barbers Point Naval Air Station, adjoining landowners and developers, and/or other Federal, State or City and County of Honolulu agencies.

5. Petitioner shall participate in an air quality monitoring program as specified by the State Department of Health.

6. The Petitioner shall connect the wastewater system for the proposed development in the Property to the Honouliuli Wastewater Treatment Plant (HWTP). Construction of any structure(s) within the Property shall not commence until Petitioner has obtained assurances from the City and County of Honolulu that the capacity at HWTP has been reserved for such structure(s); provided that if the capacity at the HWTP is not sufficient for the proposed structure(s) within the Property, the Petitioner may utilize other alternatives acceptable to the State Department of Health.

7. Petitioner shall implement soil erosion and dust control measures during all phases of the development in compliance with the applicable rules and regulations of the City and County of Honolulu and the State Department of Health.

8. Petitioner, by itself or together with other members of the Ewa Plain Water Development Corporation, shall develop the necessary water source, storage, and transmission facilities to provide an adequate supply of potable and non-potable water to the Property in conjunction with the development of Ko Olina Phase II. Non-potable water shall be used for irrigation.

9. Petitioner shall be responsible for implementing sound attenuation measures to bring noise levels from vehicular traffic in the Property down to levels in compliance with the applicable State Department of Health standards and in cooperation with the State Department of Transportation.

10. Petitioner shall disclose in its deeds to all initial purchasers of residential units in the Property: (a) the possible odor, air, noise, and dust pollution resulting from Farrington Highway, Barbers Point Naval Air Station, Honolulu International Airport, neighboring developments, and any adjacent agricultural operations, and (b) the Hawaii Right-to-Farm Act, Chapter 165, Hawaii Revised Statutes, which limits the circumstances under which pre-existing farm activities may be deemed a nuisance.

11. Petitioner will provide covenants in the deed to initial purchases releasing the State of Hawaii and the United States Government or any subdivision thereof from all liability, and provide that such initial purchasers will not file suit against the State of Hawaii and the United States Government or any subdivision thereof on account of, or resulting from, any inconvenience, disturbance and/or injury due to noise under 65 Ldn in the area affecting such occupants or their property. Such covenants shall run with the land.

12. Petitioner shall immediately stop work on the impacted area and contact the Historic Preservation Division, State Department of Land and Natural Resources should any significant archaeological resources such as artifacts, shell, bones or charcoal deposits, human burial, or rock or coral alignments, paving or walls of historic or prehistoric significance be encountered during the development of the Property.

13. Petitioner shall comply with "The Eight (8) Conditions Applicable to This Golf Course Development", prepared by the State Department of Health dated April, 1990 (Version 3), introduced as the Office of State Planning's Exhibit Number 2.

14. Petitioner shall engage the services of a qualified golf course manager to oversee the irrigation of the golf course and application of fertilizers and pesticides to the golf course within the Property and who shall be qualified in the application of fertilizers and pesticides on those areas.

15. Petitioner shall provide its fair proportionate share for school facilities as may be required by and to the satisfaction of the State Department of Education and the Office of State Planning.

16. Petitioner shall provide its fair proportionate share for police, fire, park and solid waste disposal as may be required by and to the satisfaction of the City and County of Honolulu.

17. Petitioner shall participate with City and State civil defense agencies, with U.S. Department of the Navy, and with adjoining landowners and developers in formulating and implementing an emergency preparedness and evacuation plan for the Property. Petitioner shall fund and install the necessary number of emergency siren units (including infrastructure) within the development area to the specifications and satisfaction of the State Office of Civil Defense.

18. Petitioner shall complete the development on the Property in substantial compliance with the representations made before the Land Use Commission. Failure to so develop may result in the Land Use Commission taking any action authorized under, and pursuant to Act 261.

19. Petitioner shall give notice to the Land Use Commission of any intent to sell, lease, assign, place in trust, or otherwise voluntarily alter the ownership interest in the Property covered by the approved Petition prior to visible commencement of construction on the Property; provided, however, that Petitioner may transfer ownership in the Property to an affiliate or joint venture of which Petitioner is a member or in a manner consistent with prior representations to the Land Use Commission, and may mortgage the Property at any time without notice to the Land Use Commission. A mortgagee under such mortgage may foreclose the mortgage, by judicial foreclosure or under a power of sale contained in such mortgage (provided notice of the date of such foreclosure sale is given to the Land Use Commission), or may, with notice to the Land Use Commission, acquire title to such Property in lieu of foreclosure and the mortgagee or the person acquiring title at such foreclosure or in lieu of foreclosure may also transfer title to the Property with notice to the Land Use Commission.

20. The Commission may fully or partially release these conditions as to all or any portion of the Property upon

timely motion and upon the provision of adequate assurance of satisfaction of these conditions by the Petitioner.

Adequate assurance of satisfaction may be evidenced by execution of a certificate of satisfaction in recordable form stating that such condition has been satisfied, in whole or in part. The Office of State Planning will certify for itself and all state departments and agencies. Petitioner will obtain any applicable certifications from the appropriate county departments and agencies. Any other party to the boundary amendment proceeding may be asked to indicate whether they concur in the certification of satisfaction.

21. Petitioner shall provide annual reports to the Land Use Commission, the Office of State Planning, and the City and County of Honolulu, Department of General Planning in connection with the status of the subject project and the Petitioner's progress in complying with the conditions imposed.

Done at Honolulu, Hawaii, this 14th day of February 1991, per motion on February 7, 1991.

LAND USE COMMISSION
STATE OF HAWAII

By _____
RENTON L. K. NIP
Chairman and Commissioner

By _____
ALLEN K. HOE
Vice Chairman and Commissioner

By (conflict)
ALLEN Y. KAJIOKA
Vice Chairman and Commissioner

By _____
KAREN S. AHN
Commissioner

By (absent)
EUSEBIO LAPENIA, JR.
Commissioner

By _____
JOANN N. MATTSON
Commissioner

Filed and effective on
February 14, 1991

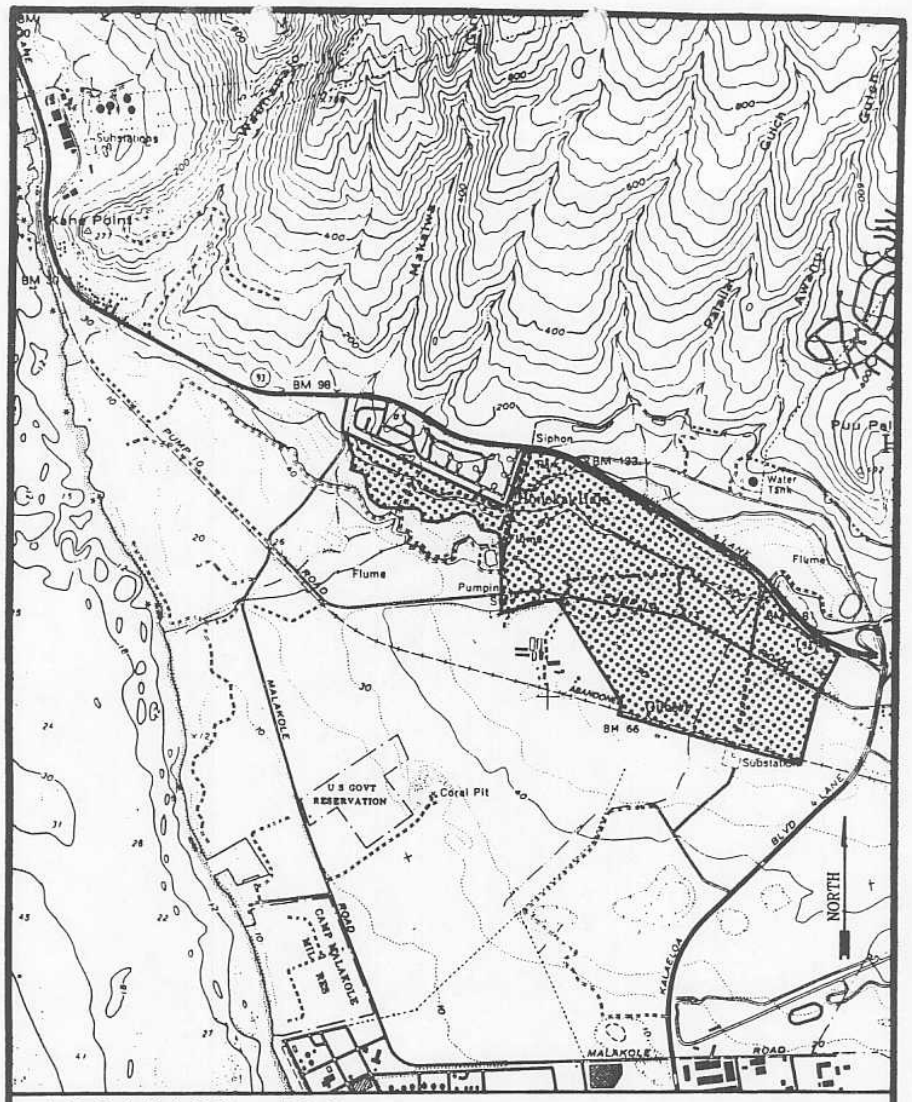
Certified by:

_____
Executive Officer

By (absent)
JAMES M. SHINNO
Commissioner

By _____
ELTON WADA
Commissioner

By _____
DELMOND J. H. WON
Commissioner



LOCATION MAP

EXHIBIT A

DOCKET NO.: A90-655/WEST BEACH ESTATES

TAX MAP KEY: 9-1-15: por. 4, 18;
9-1-56: por. 11 & por. 12

HONOULIULI, EWA, OAHU

SCALE: 1" = 2,000 ft.±

APPROVED AREA

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI'I

In the Matter of the Petition of WEST BEACH ESTATES, a Hawai'i general partnership To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 372.6 Acres at Honouliuli, 'Ewa, O'ahu, Hawai'i, TMK 9-1-15: 18 and portion of 4 and 9-1-56: portion of 11 and portion of 12	DOCKET NO. A90-655 ORDER GRANTING MOTION TO AMEND FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER

This is to certify that this is a true and correct copy of the document on file in the office of the State Land Use Commission, Honolulu, Hawaii.

MAR 06 1997 by
Date Executive Officer

ORDER GRANTING MOTION TO AMEND FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER

LAND USE COMMISSION
STATE OF HAWAII
MAR 6 9 56 AM '97

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI'I

In the Matter of the Petition of WEST BEACH ESTATES, a Hawai'i general partnership To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 372.6 Acres at Honouliuli, 'Ewa, O'ahu, Hawai'i, TMK 9-1-15: 18 and portion of 4 and 9-1-56: portion of 11 and portion of 12	DOCKET NO. A90-655 ORDER GRANTING MOTION TO AMEND FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER

ORDER GRANTING MOTION TO AMEND FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER

On November 20, 1996, West Beach Estates, a Hawai'i general partnership ("Petitioner"), filed a Motion to Amend Findings of Fact, Conclusions of Law, and Decision and Order ("Motion"), pursuant to sections 15-15-70 and 15-15-94, Hawai'i Administrative Rules. The Motion requested the Land Use Commission ("Commission") to revise Condition No. 1 of the Findings of Fact, Conclusions of Law, and Decision and Order ("Decision and Order") filed on February 14, 1991, in its entirety and to replace it with the following:

1) Petitioner shall provide affordable housing opportunities for low to moderate income residents of the State of Hawaii to the satisfaction of the City and County of Honolulu. The location and distribution of the affordable housing or other provisions for affordable housing shall be under such terms as are mutually agreeable between the Petitioner and the City and County of Honolulu.

Attached in support of the Motion was an Affidavit of Jan Naoe Sullivan, Esq., Petitioner's counsel ("Affidavit"),

which stated that the current affordable housing requirement for the project in the subject docket, as set forth by the Department of Housing and Community Development ("DHCD") (Exhibit "A") requested that 30 percent of the housing units that are developed be sold or rented to households whose incomes do not exceed 120 percent of O'ahu's median income, and that at least 10 percent of the total units be sold or rented to households earning 80 percent or less of O'ahu's median income, or that Petitioner provide an in-kind substitute that is acceptable to the City and County of Honolulu ("City & County").

The Affidavit also stated that the current affordable housing requirement of the City & County for the project was inconsistent with the affordable housing requirement that was contained in Condition No. 1, and that the State's affordable housing policies have changed over time such that the State's current policy was to assign responsibility to the counties to establish and enforce affordable housing requirements in land use reclassifications. Also attached in support of the Motion was a letter from Roy S. Oshiro, Executive Director, Housing and Finance Development Corporation ("HFDC") (Exhibit "B"), which stated that HFDC had no objections to Petitioner's Motion

The Motion came on for hearing before this Commission on December 12, 1996, in Honolulu, Hawai'i, with the parties listed in the minutes being present. At the hearing, the Commission heard public testimony from Henry Curtis, Executive Director, Life of the Land. The Office of Planning and the City

& County Planning Department ("Planning Department") had no objections to Petitioner's Motion.

Following a discussion on Petitioner's Motion, this Commission requested the Planning Department to provide further information to clarify its comments contained in Petitioner's Exhibit "A" regarding an in-kind substitute as it applied to the City & County's affordable housing requirement for the subject docket. This Commission deferred action on the Motion to its meeting on January 31, 1997, without objection

On January 2, 1997, this Commission received a letter dated December 30, 1996, from Cheryl D. Soon, Chief Planning Officer, Planning Department, which provided additional information regarding the City & County's policy on affordable housing and on the use of the term, in-kind substitute, as used by DHCD.

On January 31, 1997, this Commission deferred action on the Motion, without objection.

On February 28, 1997, this Commission held a continued action meeting on the Motion

This Commission, having duly considered Petitioner's Motion, Affidavit, Exhibits "A" and "B," the additional information provided by the City & County, and the arguments provided by the parties present in this proceeding, and good cause existing therefrom

IT IS HEREBY ORDERED that Condition Number 1 be amended as follows:

1. Petitioner shall provide affordable housing opportunities for low to moderate income residents of the State of Hawaii to the satisfaction of the City and County of Honolulu. The location and distribution of the affordable housing or other provisions for affordable housing shall be under such terms as are mutually agreeable between the Petitioner and the City and County of Honolulu.

All other conditions to the Decision and Order filed on February 14, 1991, are hereby reaffirmed and shall continue in effect.

Done at Honolulu, Hawai'i, this 6th day of March 1997, per motion on February 28, 1997.

LAND USE COMMISSION
STATE OF HAWAI'I

TRUDY K. SENDA
Chairperson and Commissioner

RUPERT K. CHUN
Vice Chairperson and Commissioner

By
LAWRENCE N.C. ING
Commissioner

(opposed)
M. CASEY JARMAN
Commissioner

By
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Commissioner

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Commissioner

Filed and effective on
March 6, 1997

Certified by:

Executive Officer

By (absent)
EUSEBIO LAPENIA, JR
Commissioner

By (absent)

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI`I

In The Matter Of The Petition Of	)	DOCKET NO. A04-753
	)	
AINA NUI CORPORATION,	)	ORDER DETERMINING (1)
a Hawai`i Corporation	)	THAT THE LAND USE
	)	COMMISSION AGREES TO BE
To Amend The Agricultural Land Use District	)	THE ACCEPTING AUTHORITY
Boundary Into The Urban Land Use District	)	PURSUANT TO CHAPTER 343,
For Approximately 174.209 Acres Of Land At	)	HAWAI`I REVISED STATUTES;
`Ewa, O`ahu, Hawai`i, Tax Map Keys: 9-1-14:	)	AND (2) THAT THE PROPOSED
Por. 33 And 9-1-15: Por. 4 And Por. 20	)	ACTION MAY HAVE A
	)	SIGNIFICANT EFFECT UPON
		THE ENVIRONMENT TO
		WARRANT THE
		PREPARATION OF AN
		ENVIRONMENTAL IMPACT
		STATEMENT

ORDER DETERMINING (1) THAT THE LAND USE COMMISSION AGREES TO BE THE ACCEPTING AUTHORITY PURSUANT TO CHAPTER 343, HAWAI`I REVISED STATUTES; AND (2) THAT THE PROPOSED ACTION MAY HAVE A SIGNIFICANT EFFECT UPON THE ENVIRONMENT TO WARRANT THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT

This is to certify that this is a true and correct copy of the document on file in the office of the State Land Use Commission, Honolulu, Hawaii.
DEC 14 2004 by Executive Officer
Date

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI`I

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		STATEMENT

ORDER DETERMINING (1) THAT THE LAND USE COMMISSION AGREES TO BE THE ACCEPTING AUTHORITY PURSUANT TO CHAPTER 343, HAWAI`I REVISED STATUTES; AND (2) THAT THE PROPOSED ACTION MAY HAVE A SIGNIFICANT EFFECT UPON THE ENVIRONMENT TO WARRANT THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT

On September 29, 2004, Aina Nui Corporation, a Hawai`i corporation ("Petitioner"), filed a Petition For Land Use District Boundary Amendment ("Petition") to reclassify approximately 174.209 acres of land at `Ewa, O`ahu, Hawai`i, identified as Tax Map Keys: 9-1-14: por. 33 and 9-1-15: por. 4 and por. 20, from the State Land Use Agricultural District to the State Land Use Urban District for residential, golf course,

and park uses ("Project"). An Environmental Impact Statement Preparation Notice ("EISPN") was included with the Petition.[1]

The Project is subject to the environmental review process as it will involve the use of a historic site located on State lands[2], pursuant to sections 343-5(a)(1) and 343-5(a)(4), Hawai`i Revised Statutes ("HRS"), and sections 11-200-6(b)(1)(A) and 11-200-6(b)(1)(D), Hawai`i Administrative Rules ("HAR"). In the Petition and EISPN, Petitioner asserted that the Land Use Commission ("Commission") was the appropriate accepting authority for the EIS as it was the initial agency receiving and processing Petitioner's request for a land use approval, pursuant to chapter 343, HRS, and title 11, chapter 200, HAR.

On October 7, 2004, this Commission held a meeting in Hilo, Hawai`i, to determine (i) whether the Commission should be the accepting authority pursuant to chapter 343, HRS; and (ii) if so, whether the Project warranted the preparation of an EIS. Benjamin A. Kudo, Esq., and Naomi U. Kuwaye, Esq., appeared on behalf of Petitioner. John W. K. Chang, Esq., and Abe Mitsuda appeared on behalf of the Office of Planning ("OP"). By an e-mail correspondence dated October 6, 2004, the City and County of Honolulu Department of Planning and Permitting informed the Commission that (i) it would not be present at the meeting; (ii) it agreed this Commission was the appropriate

[1] By preparing the EISPN, Petitioner has already acknowledged that the Project may have a significant effect upon the environment, and therefore will require the preparation of an Environmental Impact Statement ("EIS").
[2] The Project's roadways are proposed to cross the O`ahu Railroad and Land Company right-of-way, which is owned by the State of Hawai`i and listed on the National Register of Historic Places.

accepting authority; and (iii) it concurred with Petitioner's determination to prepare an EIS.

At the meeting, Petitioner reiterated that the Project involved the use of a historic site located on State lands and may generate significant effects upon the environment to warrant the preparation of an EIS. Petitioner further noted that this Commission was the appropriate accepting authority for the EIS as it was the agency initially receiving and processing the Petition pursuant to section 343-5(c), HRS. The OP stated that based upon the ruling by the circuit court in the First Circuit, this Commission should be the accepting authority, and that they had no objection to the preparation of an EIS.

Following discussion, a motion was made and seconded to have this Commission agree to be the accepting authority pursuant to chapter 343, HRS, and further that the Commission find that the Project may have a significant effect upon the environment sufficient to warrant the preparation of an EIS. There being a vote tally of 7 ayes, 0 nays, and 2 absent, the motion carried.

ORDER

This Commission, having duly considered Petitioner's EISPN, the arguments by the parties in this proceeding, and a motion having been made at its meeting on October 7, 2004, in Hilo, Hawai`i, and the motion having received the affirmative votes required by section 15-15-13, HAR, and there being good cause for the motion,

HEREBY ORDERS that it agrees to be the accepting authority pursuant to chapter 343, HRS, and that the Project may have a significant effect upon the environment to warrant the preparation of an EIS.

IT IS FURTHER ORDERED that Petitioner shall make available the EISPN for a 30-day public review and comment period pursuant to sections 11-200-15(b), HAR, and 343-5(c), HRS.

Dated: Honolulu, Hawai`i, December 14, 2004.

ADOPTION OF ORDER

The undersigned Commissioners, being familiar with the record and proceedings, hereby adopt and approve the foregoing ORDER this 14th day of December, 2004. This ORDER and its ADOPTION shall take effect upon the date this ORDER is certified and filed by this Commission.

Done at Honolulu, Hawai`i, this 14th day of December, 2004, per motion on October 7, 2004.

APPROVED AS TO FORM

Diane Erickson
Deputy Attorney General

LAND USE COMMISSION
STATE OF HAWAI`I

By _____
P. ROY CATALANI
Chairperson and Commissioner

By (absent)
RANDALL SAKUMOTO
Vice-Chairperson and Commissioner

By Steven Lee Montgomery
STEVEN LEE MONTGOMERY
Vice Chairperson and Commissioner

By _____
PRAVIN DESAI
Commissioner

By _____
KYONG SU IM
Commissioner

By _____
ISAAC FIESTA, JR.
Commissioner

By _____
LISA M. JUDGE
Commissioner

By _____
MICHAEL D. FORMBY
Commissioner

By (absent)
PETER YUKIMURA
Commissioner

Filed and effective on
DEC 14 2004

Certified by:

ANTHONY J. H. CHING

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI`I

In The Matter Of The Petition Of	)	DOCKET NO. A04-753
	)	
AINA NUI CORPORATION, a Hawai`i Corporation	)	CERTIFICATE OF SERVICE
	)	
To Amend The Agricultural Land Use District Boundary Into The Urban Land Use District For Approximately 174.209 Acres Of Land At `Ewa, O`ahu, Hawai`i, Tax Map Keys: 9-1-14: Por. 33 And 9-1-15: Por. 4 And Por. 20	)	

CERTIFICATE OF SERVICE

I hereby certify that a copy of the Order Determining (1) That The Land Use Commission agrees To Be The Accepting Authority Pursuant To Chapter 343, Hawai`i Revised Statutes; And (2) That The Proposed Action May Have A Significant Effect Upon The Environment To Warrant The Preparation Of An Environmental Impact Statement, was served upon the following by either hand delivery or depositing the same in the U. S. Postal Service by regular or certified mail as noted:

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Dated: Honolulu, Hawaii, DEC 14 2004.

ANTHONY J. H. CHING
Executive Officer



APPENDIX B
Agricultural Impact Assessment (Decision Analysts Hawaii, Inc.)

KAPOLEI WEST:
IMPACT ON AGRICULTURE

Decision Analysts Hawai'i, Inc.

KAPOLEI WEST:
IMPACT ON AGRICULTURE

PREPARED FOR:

Aina Nui Corporation

PREPARED BY:

Decision Analysts Hawai'i, Inc.

March 2005

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CONTENTS

EXECUTIVE SUMMARY iv

1. INTRODUCTION 1
2. PROJECT AND PETITION AREA LOCATIONS 1
3. PROJECT DESCRIPTION 2
4. AGRICULTURAL CONDITIONS 3
   a. Soil Types 3
   b. Soil Ratings 5
   c. Soil Characteristics 6
   d. Elevation 7
   e. Slopes 7
   f. Climatic Conditions 7
   g. Irrigation Water 8
   h. Road Access 8
   i. Summary 8
5. COMPATIBILITY WITH SURROUNDING LAND USES 8
6. LOCATIONAL ADVANTAGES AND DISADVANTAGES 9
7. PAST AND CURRENT AGRICULTURAL LAND USES 9
   a. Historic Agricultural Uses 9
   b. Current Agricultural Uses 9
8. POTENTIAL CROPS 10
9. ACREAGE REQUIREMENTS FOR DIVERSIFIED CROPS 10
   a. Crops to Replace Imports 10
   b. Export Crops 11
   c. Recent Trends 11
10. LAND AVAILABLE FOR DIVERSIFIED CROPS 11

11. IMPACT ON EXISTING AGRICULTURAL OPERATIONS 12
12. IMPACT ON THE GROWTH OF DIVERSIFIED CROPS 12
13. OFFSETTING BENEFITS 13
14. CONSISTENCY WITH STATE AND COUNTY PLANS 13
   a. Availability of Lands for Agriculture 13
   b. Conservation of Agricultural Lands 14
   c. 'Ewa Development Plan, City & County of Honolulu 14
15. REFERENCES 15

TABLES

1. Kapolei West: Summary of Land-Use Plan 3
2. Kapolei West Petition Area: Soil Types and NRCS Ratings 4

FIGURES

1. Kapolei West: Project Location F-1
2. Kapolei West: Project Master Plan F-2
3. Kapolei West: Soil Conservation Service Soil Types F-3
4. Kapolei West: Land Study Bureau Soil Classifications F-4
5. Kapolei West: Agricultural Lands of Importance to the State of Hawai'i F-5
6. Hawai'i Agriculture, Acreage in Crop: 1960 to 2002 ..... F-6

APPENDICES

A. Hawai'i's Agricultural Land Market A-1
B. Selected State and City Goals, Objectives, Policies and Guidelines Related to Agricultural Lands B-1

EXECUTIVE SUMMARY

1. PROPOSED DEVELOPMENT

The Aina Nui Corporation, an affiliate of The Estate of James Campbell, proposes to develop Kapolei West ("the Project") on a 546.8-acre site ("the Project Area") in 'Ewa. Although most of the Project Area is within the State Urban District, a 174.2-acre portion of it is in the Agricultural District. This portion is the subject of a State Land Use District Boundary Amendment Petition for Reclassification from the Agricultural District to the Urban District ("the Petition Area"). The development proposed for the Petition Area is referred to as "the Petition Area Development."

2. AGRICULTURAL CONDITIONS

About 15 acres (±5 acres) of the Petition Area are good for growing low-elevation crops, and another 33 acres (±12 acres) are suitable for these crops. This evaluation is based on the favorable soil conditions and soil ratings over much of the site, the gently-sloping terrain, the mild sunny climate, and good access.

The remaining 126 acres (±17 acres) of the land are poorly suited for farming, largely because most of the land is coral outcrop.

3. COMPATIBILITY WITH SURROUNDING LAND USES

All of the current and planned land uses surrounding the Petition Area are urban, with no adjacent or nearby agricultural activities. If the better agricultural land within the Petition Area were to be farmed, nuisance issues could arise with residents of nearby homes and operators of nearby stores complaining about farming activities that create dust, noise, chemical drift, etc.

4. LOCATIONAL ADVANTAGES AND DISADVANTAGES

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.

5. POTENTIAL ACREAGE REQUIREMENTS FOR DIVERSIFIED CROPS

a. Crops to Replace Imports

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 is estimated at 12,700 acres and 8,600 acres, respectively. 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.

b. 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 competitive in overseas markets is difficult. 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 18,000 acres in 2002); one additional crop that requires more than 5,000 acres (coffee at 7,200 acres); and only five additional crops or crop categories that required more than 1,000 acres.

c. Recent Trends

For all diversified crops—i.e., all crops other than sugarcane and pineapple, including both crops to replace imports and crops for export—land requirements have grown by an average of less than 200 acres per year since the mid-1980s, or less than 2,000 acres per decade.

6. LAND AVAILABLE FOR DIVERSIFIED CROPS

Statewide, a vast amount of land has been released from plantation agriculture (about 239,300 acres since 1968), and this release of land has far outpaced the demand for land for diversified crops (an increase of about 25,100 acres over this same period). The net decrease in crop land amounted to 214,200 acres. While some of the released land has been converted or is scheduled to be converted to non-agricultural uses, most of it remains available for diversified crops.

The above indicates that ample land is available in Hawai'i to accommodate the growth of diversified crops, whether demand is based on potential or recent trends. In other words, the limiting factor to the growth of diversified crops is *not* the *land supply*, but rather the *size of the market* for crops that can be grown *profitably* in Hawai'i.

These findings also apply to O'ahu. Since 1968, the contractions and eventual closures of three sugar plantations plus the contractions of two pineapple plantations released about 47,500 acres. Furthermore, most of the 28,300 acres released since 1990 remains available. Fields in Kunia and 'Ewa are regarded as among the best farm land in Hawai'i. These lands have been leased for farming, but markets for crops grown on the land are still being developed. On O'ahu's North Shore, various crops are being explored, but most of the former sugarcane and pineapple land remains fallow.

7. IMPACT ON EXISTING AGRICULTURAL OPERATIONS

The Petition Area Development will have no impact on existing agricultural operations because none exist within or near the Petition Area.

8. IMPACT ON THE GROWTH OF DIVERSIFIED CROPS

The Petition Area Development will commit about 15 acres (±5 acres) of good agricultural land to a non-agricultural use. This amount of land could support about two farm jobs, based on about 12.5 jobs per 100 acres.

More realistically, the development of this agricultural land—combined with other developments in Hawai'i—involves the loss of too little good agricultural land to affect (1) the availability of land to farmers in Hawai'i, (2) agricultural land rents, (3) the growth of diversified agriculture, or (4) potential agricultural employment.

This conclusion is based on the finding that ample land is available for diversified agriculture, with the available supply far exceeding likely or potential demand. Furthermore, in practice, the good agricultural land within the Petition Area has already been removed from the inventory of farm land due to its small acreage, its isolation from other farming areas, and the existing and planned urban uses that surround the Petition Area.

9. OFFSETTING BENEFITS

The loss of 15 acres (±5 acres) of good agricultural land will be offset by the following benefits of the Petition Area Development:

- 1,154 new homes;
- 17.1 acres of new parks;
- 59.9 acres of a new golf course;
- jobs supported by development activity, including (1) direct construction and other jobs involved with development, and (2) indirect jobs supported by the purchase of goods and services by construction companies and their employees;
- jobs supported by the purchase of goods and services by those living in Petition Area homes; and
- tax revenues (excise taxes, personal income taxes, corporate income taxes, property taxes, etc.) paid by (1) companies and employees directly and indirectly supported by development activities, (2) residents living in Petition Area homes, and (3) companies and employees directly and indirectly supported by the purchase of goods and services by those living in Petition Area homes.

10. CONSISTENCY WITH STATE AND CITY PLANS

The Petition Area Development does not conflict with the thrust of the major State and City policies for agriculture, which is to preserve the economic viability of plantation agriculture and to provide an adequate supply of suitable lands to accommodate the growth of diversified agriculture. The Petition Area Development will not adversely affect plantation agriculture since none exists on the property. Also, the Petition Area Development will not limit the growth of diversified agriculture. This is due to the enormous supply of agricultural land that is now available due to the contraction of plantation agriculture.

However, the Petition Area Development conflicts with State policies that call for conserving and protecting agricultural lands. Nevertheless, the Petition Area Development is justified based on (1) the major change in economic conditions since the State policies were adopted (i.e., the enormous contraction in plantation agriculture, resulting in the supply of agricultural land far exceeding demand); and (2) the overriding community benefits (homes, parks, a portion of a golf course, jobs, and tax revenues).

The proposed urban development of the Petition Area is consistent with the 'Ewa Development Plan in that the Petition Area is within the designated Urban Growth Boundary.

However, portions of the development are inconsistent with planned phasing of urban expansion. Specifically, most of the western portion of the Petition Area north of the O'ahu Railway & Land Company Right-of-Way (OR&L ROW) is scheduled for urban expansion between 2006 and 2015, while most of the eastern portion north of the OR&L ROW is scheduled for urban expansion after 2016. The remaining portion of the Petition Area and all of the surrounding lands are scheduled for urban expansion by 2005.

KAPOLEI WEST:
IMPACT ON AGRICULTURE

1. INTRODUCTION

The Aina Nui Corporation, an affiliate of The Estate of James Campbell, proposes to develop Kapolei West ("the Project") on a 546.8-acre site ("the Project Area") in 'Ewa (see Figure 1).[1] Although most of the Project Area is within the State Urban District, a 174.2-acre portion of it is in the Agricultural District. This portion is the subject of a State Land Use District Boundary Amendment Petition for Reclassification from the Agricultural District to the Urban District ("the Petition Area," shown in gray in Figure 2). The development proposed for the Petition Area is referred to as "the Petition Area Development."

This report addresses the impacts on agriculture of developing the Petition Area. The material below covers the Project and Petition Area locations; a description of the Project; agricultural conditions; compatibility with surrounding land uses; locational advantages and disadvantages; past and current agricultural land uses; potential crops; acreage requirements for diversified agriculture crops; land available for diversified crops; the impact of the Petition Area Development on existing agricultural operations; the impact on the growth of diversified crops; benefits of the Petition Area Development that would offset adverse agricultural impacts; and consistency of the Petition Area Development with State and City agricultural policies.

At the end of the report are six figures. The first two figures are maps that show the location of the Project and the Petition Area, and the general layout of the Project. The next three figures map the soils in the Petition Area by three soil classification systems that are commonly used to rate Hawai'i soils. The sixth figure gives a graph of acreage in crop in Hawai'i from 1960 through 2002. Finally, two Appendices provide information on (1) Hawai'i's agricultural land market; and (2) State and City goals, objectives, policies, and guidelines related to agricultural lands.

2. PROJECT AND PETITION AREA LOCATIONS[1]

As shown in Figure 1, Kapolei West is located in the southwest corner of O'ahu between the Ko Olina Resort to the west and the City of Kapolei to the

east, and between the H-1 Freeway to the north and the Kapolei Business Park and Kalaeloa Barbers Point Harbor facilities to the south. The O'ahu Railway and Land Company (OR&L) railroad right-of way (ROW) bisects the southern section of the Project.

As shown in Figure 2, the Petition Area straddles but does not include the OR&L ROW, and consists of a roughly triangular-shaped parcel north of the ROW as well as land south of the ROW. The Petition Area includes portions of three Tax Map Key (TMK) parcels: TMK 9-1-14: por. 27; TMK 9-1-15: por 4; and TMK 9-1-15: por. 20.

3. PROJECT DESCRIPTION[1]

At full development, Kapolei West will include an estimated 2,370 low- and medium-density residential units, a mixed use/residential area, neighborhood and regional commercial areas, an 18-hole championship golf course and clubhouse, a middle school, parks, circulation, and open spaces (see Table 1). The Petition Area will include an estimated 1,154 homes, portions of the golf course, circulation, park and other open spaces.

The residential units will include higher-value homes with many amenities for (1) working residents, (2) retirees, and (3) part-time residents who use their units as vacation homes or second homes.

The commercial space in the Project Area will accommodate retail stores, restaurants, offices, and other businesses. The neighborhood commercial space will support the proposed Kapolei West community as well as the nearby communities of Honokai Hale, Nanakai Gardens and Ko Olina Fairways. The regional commercial space will complement commercial activities in the nearby City of Kapolei.

The golf course is intended to accommodate guests visiting the neighboring Ko Olina Resort, residents living in Kapolei West and nearby neighborhoods, and others in the general public.

Urbanization of the Petition Area would allow development of the entire Kapolei West Project as summarized above and in Table 1. If the Petition Area is not approved for urban development and remains in the State Agricultural District (i.e., no action), the portion of the 373-acre Project Area that is already classified as Urban will still be developed, while the Petition Area will remain in its current, unimproved state.

Table 1. Kapolei West: Summary of Land-Use Plan

	Petition Area		Existing Urban Area		Total Project Area	
Land Use	**Acres (appx.)**	**Units**	**Acres (appx.)**	**Units**	**Acres (appx.)**	**Units**
Residential						
Low Density	9.3	11	107.9	858	117.2	869
Medium Density	77.2	1,143	20.9	208	98.1	1,351
Mixed Use/Residential			10.0	150	10.0	150
Commercial						
Neighborhood			2.0		2.0	
Regional			23.2		23.2	
Golf Course and Clubhouse	59.9		152.8		212.7	
Middle School			6.0		6.0	
Transit			5.8		5.8	
Parks	17.1		7.7		24.8	
Circulation and Other Open Spaces	10.7		36.3		47.0	
TOTAL	**174.2**	**1,154**	**372.6**	**1,216**	**546.8**	**2,370**

4. AGRICULTURAL CONDITIONS

a. Soil Types[2]

As shown in Figure 3, the Petition Area contains four soil types which reflect the fact that the 'Ewa Plain is an emerged coral-algae calcareous reef covered by alluvium deposits. These soils and their acreages are categorized in Table 2 by their quality as rated by the Natural Resources Conservation Service (NRCS) (formerly known as the Soil Conservation Service).

Table 2. Kapolei West Petition Area: Soil Types and NRCS Ratings

Soil Types	Acres		NRCS Ratings
Higher-Quality Soils			
EmA	10.8	6%	IIs
EmB	3.0	2%	IIe
Moderate-Quality Soil			
MnC	23.7	14%	IIIs
Low-Quality Outcrop			
CR	136.6	78%	VIIIs
Total	174.2	100%	

For each of these four soil types, the complete name, range of slopes, and soil descriptions are:

— EmA: Ewa silty clay loam, 0 to 2% slopes

The 'Ewa series consists of well-drained soils in basins and on alluvial fans. The surface layer is dark reddish-brown silty clay loam about 18 inches thick. The subsoil, about 20 to 50 inches thick, is dark reddish-brown and dark-red silty clay loam that has a subangular blocky structure. The substructure is coral limestone, sand, or gravelly alluvium. The soil is neutral in the surface layer and subsoil. Runoff is very slow, and the erosion hazard is no more than slight.

— EmB: Ewa silty clay loam, 2 to 6% slopes

This soil is identical to EmA above, except that the slope is somewhat steeper.

— MnC: Mamala stony silty clay loam, 0 to 12% slopes

This series consists of shallow, well-drained soils and is found along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand. Coral rock fragments are common in the surface layer, and the soil is neutral to mildly alkaline. Permeability is moderate, runoff is very slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 2.2 inches per foot in the surface layer and 1.9 inches per foot in the subsoil. Roots are affected by the coral limestone; consolidated sand and the stones hinder, but do not prevent, cultivation.

— CR: Coral Outcrop

Coral outcrop consists of coral or cemented calcareous sand. Between 80 and 90% of this soil type is comprised of coral outcrop, and the remainder consists of a thin layer of friable, red soil material similar to that of the Mamala series found within the cracks, crevices, and depressions of the coral outcrop. This soil type is unsuitable for cultivating crops.

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)[2]

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 level, VIII.

As shown in Table 2, nearly 11 acres (6%) and about 3 acres (2%) of the Petition Area have soils that are rated IIs and IIe, respectively. Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices. The subclassification "s" indicates that the limitation is due to stoniness, unfavorable texture, shallowness, or low water-holding capacity. The subclassification "e" indicates that the limitation is due to erosion.

Nearly 24 acres (14%) have soils rated IIIs. Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Most of the soils (nearly 137 acres or 78%) in the Petition Area are rated VIIIs. Class VIII soils have severe limitations that preclude their use for commercial plant production.

Overall Productivity Rating (LSB Rating)[3]

In 1972, the University of Hawai'i (UH) 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. Figure 4 shows the LSB soil classifications. In the Petition Area, about 20 acres (11%) are rated B; 45 acres (26%) are C, 92 acres (53%) are E, and 17 acres (10%) are unrated.

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

ALISH ratings were developed in 1977 by the NRCS, 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.

As indicated in Figure 5, the majority of the soils in the Petition Area (142 acres or 82%) are unrated, while about 10 acres (or about 6%) are rated Prime, and 22 acres (or about 12%) are rated Other. None of the soils are rated Unique.

Summary Evaluation of Soil Quality

The above three soil-rating systems indicate that about 15 acres (±5 acres) of the Petition Area are good for cultivating crops (II or better under the SCS rating, B or better under the LSB rating, and Prime under the ALISH rating). Another 33 acres (±12 acres) are suitable for farming (III rating under the SCS rating, C under the LSB rating, and Other under the ALISH rating).

c. Soil Characteristics[2,3]

Consistent with the above soil ratings, the small amount of land in the Petition Area that could be used for farming exhibits a number of favorable characteristics: the soil depth exceeds 30 inches, the texture is fine although stony, the soils have moderate tillability, soils are well drained, the slopes are gentle (see below), the erosion hazard is slight, and the soil pH is neutral.[2,3]

d. Elevation[1]

The ground elevation of the Petition Area ranges from sea level at its southernmost tip to 65 feet along its northern boundary.

e. Slopes[1]

The Petition Area is relatively flat to gently sloping, with slopes generally ranging from 1 to 5 percent. However, a modest ridgeline with 25% slopes forms part of the northernmost boundary of the Petition Area.

f. Climatic Conditions

Like other areas in Hawai'i, the 'Ewa plain has a mild *semi*tropical climate that 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[5]

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

Rainfall[6]

Average annual rainfall in the Petition Area is approximately 21 inches. Most of this rainfall occurs during the winter rainy season (October through April), while the summer months (May through September) are hot and dry.

Temperatures[6]

Average low temperatures range from about 61° Fahrenheit in the winter to about 70° in the summer. Average high temperatures range from about 80° in the winter to 88° in the summer.

Winds and Storms[6]

The prevailing surface winds are tradewinds that blow from a northeasterly direction, with occasional southerly winds. Low-velocity surface winds of less than 10 miles per hour occur frequently. The tradewinds tend to break down during the fall, giving way to lighter, more variable wind conditions through the winter and into the early spring. Storms are infrequent, occurring mostly from the south in the winter months.

g. Irrigation Water[7]

Historically, the sugarcane fields within the Petition Area were irrigated with groundwater.

h. Road Access

Fields in the Petition Area are reached via Pump 10 Road which connects to Kalaeloa Boulevard. In turn, Kalaeloa Boulevard connects to the H-1 Freeway.

i. Summary

About 15 acres (±5 acres) of the Petition Area are good for growing low-elevation crops, and another 33 acres (±12 acres) are suitable for these crops. The remaining 126 acres (±17 acres) are poorly suited for farming, largely because most of the land is coral outcrop.

5. COMPATIBILITY WITH SURROUNDING LAND USES

Land uses surrounding the Petition Area are shown in Figures 1 and 2, and include: (1) to the west, the Ko Olina Golf Course and Ko Olina Marina; (2) to the north, the vacant lands of the larger Kapolei West Project Area; (3) to the east, the City of Kapolei adjacent to Kalaeloa Boulevard; and (4) to the south, the Grace Pacific Quarry (not shown), Kalaeloa Barbers Point Harbor and its related industrial activities, and Kapolei Business Park.

As indicated, all of the current and planned land uses surrounding the Petition Area are urban, with no adjacent or nearby agricultural activities. If the better agricultural land within the Petition Area were to be farmed, nuisance issues could arise, with residents of nearby homes and operators of nearby stores complaining about farming activities that create dust, noise, chemical drift, etc.

6. LOCATIONAL ADVANTAGES AND DISADVANTAGES

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, however, 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. PAST AND CURRENT AGRICULTURAL LAND USES

a. Historic Agricultural Uses[1,3,7,8-10]

Following the Mahele of 1848, the Project 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 Project Area) for cattle ranching—an activity that lasted until 1899.

Campbell then leased the property to Benjamin Dillingham in 1889 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 (OSCo) took over operations. Sugarcane cultivation was continued until 1995 when OSCo closed.

Until about 1970, about 65 acres (37%) of the Petition Area were used for growing sugarcane. The remaining acreage was unsuitable for cultivation. In the early 1970s, this acreage was reduced to about 28 acres (16%) of the Petition Area due to shallow stony soils, low yields and the long trucking distance from the fields to the mill.

In recent years some livestock operations took place within the Petition Area. Specifically, in the late 1960s, some of the land unsuitable for crop farming was used for a piggery. And after OSCo closed in 1995, some of the former sugarcane land was used to graze a few horses.

b. Current Agricultural Uses[1]

Currently, none of the land in the Petition Area is used for agriculture. In fact, most of it lies vacant and unused—except for the ROW used by the Hawai-

ian Railway Society for the OR&L, and quarrying and stockpiling activities inside and adjacent to the southern boundary of the Petition Area. In addition, a Coast Guard Range Light used by navigators to enter Kalaeloa Barbers Point Harbor is located at the southernmost tip of the Petition Area.

8. POTENTIAL CROPS[11]

Based on the above agronomic conditions, the Petition Area is suitable for low-elevation crops commercially grown in Hawai'i, including but not limited to: asparagus, beans (green, bush, and snap), bell peppers, bittermelon, cantaloupe, Chinese peas, cucumbers, daikon, dry onions, eggplant, flowers/nursery products, ginger root, green onions, green peppers, head and semi-head lettuces, herbs, honeydew melons, limes, lotus root, lychee, Manoa lettuce, mango, mustard cabbage, Oriental squash, parsley, pumpkins, seed crops, sweet corn, sweet potatoes, tangerines, and watermelons.

9. ACREAGE REQUIREMENTS FOR DIVERSIFIED CROPS

a. Crops to Replace Imports[12]

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 is estimated at 12,700 acres and 8,600 acres, respectively, plus some additional acreage for fallowing land between crops. 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.

Allowing for competition from imports, these estimates drop to about half. 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) overproduction 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.

b. Export Crops[12]

The potential market for export crops is far larger than the Hawai'i market: a population of 290.8 million in 2003 for the U.S. compared to a resident-plus-visitor population of only 1.4 million for Hawai'i.[13,14] 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 successful and may grow into a major export crop.

However, the history of agricultural efforts in Hawai'i reveals that developing major new export crops competitive in overseas markets is difficult. 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 18,000 acres in 2002); one additional crop that requires more than 5,000 acres (coffee at 7,200 acres); and only five additional crops or crop categories that required more than 1,000 acres (papaya at 2,320 acres, bananas at 1,440 acres, tropical specialty fruits at 1,170 acres, flowers/nursery products at 3,420 acres, and seed crops at 3,500 acres).[11] Tropical specialty fruit include longan, lychee, mango, rambutan, star-fruit, etc.

c. Recent Trends[11]

For all diversified crops—i.e., all crops other than sugarcane and pineapple, including both crops to replace imports and crops for export—land requirements have grown by an average of less than 200 acres per year since the mid-1980s, or less than 2,000 acres per decade (see Figure 6 and Appendix A).

During the 5-year period from 1998 to 2002, acreage increased for just three of the major export crop categories: tropical specialty fruits up 370 acres, flowers/nursery products up 745 acres, and seed crops up 430 acres. During this same period, acreage declined for four of the major export crops: macadamia nuts down 2,200 acres, coffee down 200 acres for coffee, papaya down 1,230 acres, and bananas down 160 acres. The net change was a decrease of 2,245 acres.

10. LAND AVAILABLE FOR DIVERSIFIED CROPS[15]

Statewide, a vast amount of land has been released from plantation agriculture (about 239,300 acres since 1968), and this release of land has far outpaced the demand for land for diversified crops (an increase of about 25,100 acres over

this same period)—see Figure 6 and Appendix A. The net decrease in crop land amounted to 214,200 acres. While some of the released land has been converted or is scheduled to be converted to non-agricultural uses, most of it remains available for diversified crops.

The above indicates that ample land is available in Hawai'i to accommodate the growth of diversified crops, whether demand is based on potential or recent trends. In other words, the limiting factor to the growth of diversified crops is *not* the *land supply*, but rather the *size of the market* for crops that can be grown *profitably* in Hawai'i.

These findings also apply to O'ahu. Since 1968, the contractions and eventual closures of three sugar plantations plus the contractions of two pineapple plantations released about 47,500 acres. Furthermore, most of the 28,300 acres released since 1990 remains available. Fields in Kunia and 'Ewa are regarded as among the best farm land in Hawai'i. These lands have been leased for farming, but markets for crops grown on the land are still being developed. On O'ahu's North Shore, various crops are being explored, but most of the former sugarcane and pineapple land remains fallow.

11. IMPACT ON EXISTING AGRICULTURAL OPERATIONS

The Project will have no impact on existing agricultural operations because none exist within or near the Petition Area.

12. IMPACT ON THE GROWTH OF DIVERSIFIED CROPS

The Petition Area Development will commit about 15 acres (±5 acres) of good agricultural land to a non-agricultural use. This amount of land could support about about two farm jobs, based on about 12.5 jobs per 100 acres.

More realistically, the development of this agricultural land—combined with other developments in Hawai'i—involves the loss of too little good agricultural land to affect (1) the availability of land to farmers in Hawai'i, (2) agricultural land rents, (3) the growth of diversified agriculture, or (4) potential agricultural employment.

This conclusion is based on the above finding from Sections 9 and 10, and from Appendix A, that ample land is available for diversified agriculture, with the available supply far exceeding likely or potential demand. Furthermore, in practice, the good agricultural land within the Petition Area has already been removed from the inventory of farm land due to its small acreage, its isolation

from other farming areas, and the existing and planned urban uses that surround the Petition Area.

13. OFFSETTING BENEFITS

The loss of 15 acres (±5 acres) of good agricultural land will be offset by the following benefits of the Petition Area Development:

- 1,154 new homes;
- 17.1 acres of new parks;
- 59.9 acres of a new golf course;
- jobs supported by development activity, including (1) direct construction and other jobs involved with development, and (2) indirect jobs supported by purchases of goods and services by construction companies and their employees;
- jobs supported by purchases of goods and services by those living in Petition Area homes; and
- tax revenues (excise taxes, personal income taxes, corporate income taxes, property taxes, etc.) paid by (1) companies and employees directly and indirectly supported by development activities, (2) residents living in Petition Area homes, and (3) companies and employees directly and indirectly supported by purchases of goods and services by those living in Petition Area homes.

14. CONSISTENCY WITH STATE AND COUNTY PLANS[16]

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 agriculture. 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 the plantation closed in 1995 for reasons unrelated to the proposed Project.

With regard to diversified agriculture, development of the Petition Area will not limit the growth of diversified agriculture since ample agricultural land is available on O'ahu and on other islands. This is due to the enormous supply of

agricultural land that is now available due to the contraction of plantation agriculture.

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 will be available to utilize these 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 utilized for diversified agriculture (see Sections 9 and 10 above, Figure 6, and Appendix A).

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."[17] The enormous contraction in plantation agriculture, resulting in the supply of agricultural land far exceeding demand, constitutes a major change in economic conditions. Moreover, development in the Petition Area will provide community benefits (homes, parks, a portion of a golf course, jobs, and tax revenues) that far exceed that which could be provided by diversified agriculture (about two jobs). In practice, however, development of the Petition Area will not result in a loss of existing or potential agricultural employment.

c. 'Ewa Development Plan, City & County of Honolulu

The proposed urban development of the Petition Area is consistent with the 'Ewa Development Plan in that the Petition Area is within the designated Urban Growth Boundary.

However, portions of the development are inconsistent with planned phasing of urban expansion. Specifically, most of the western portion of the Petition Area north of the OR&L ROW is scheduled for urban expansion between 2006 and 2015, while most of the eastern portion north of the OR&L ROW is scheduled for urban expansion after 2016. The remaining portion of the Petition Area and all of the surrounding lands are scheduled for urban expansion by 2005.

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[15] Appendix A.

[16] Appendix B.

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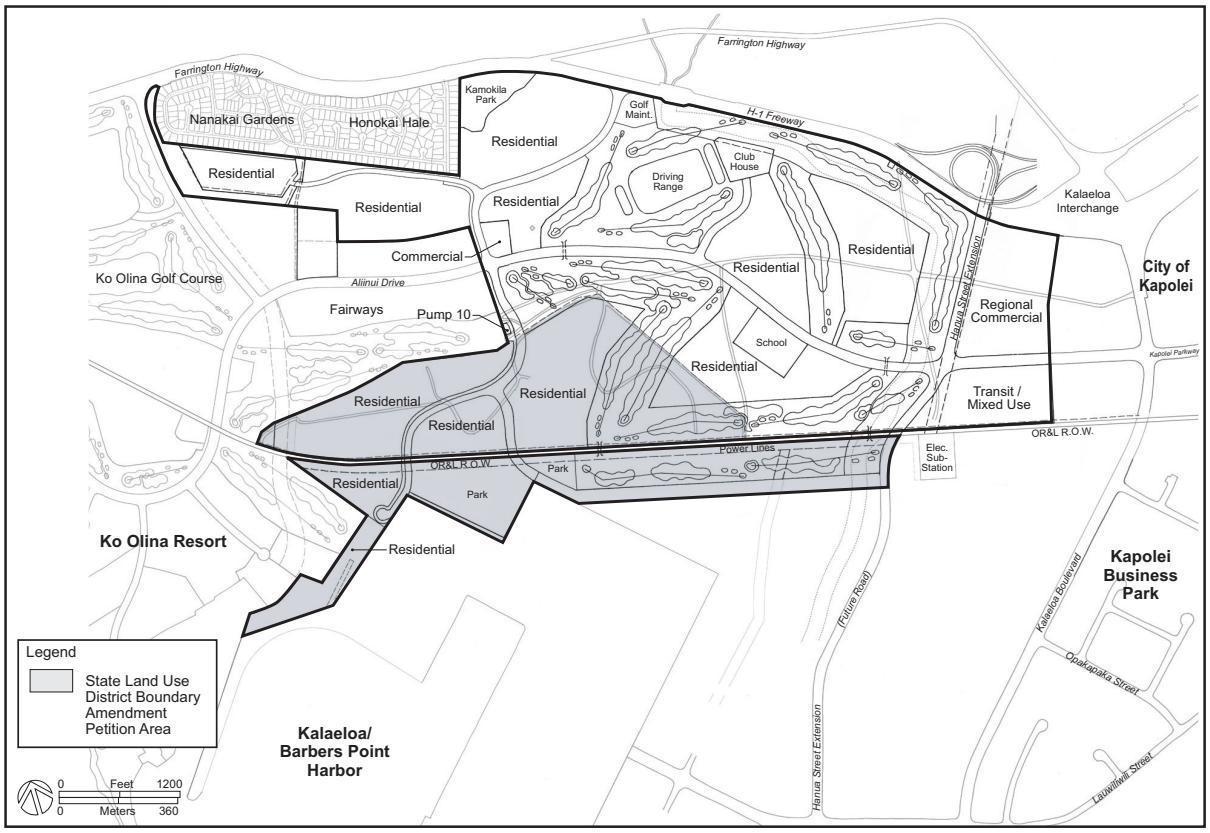
FIGURES



Project Location **Figure 1**

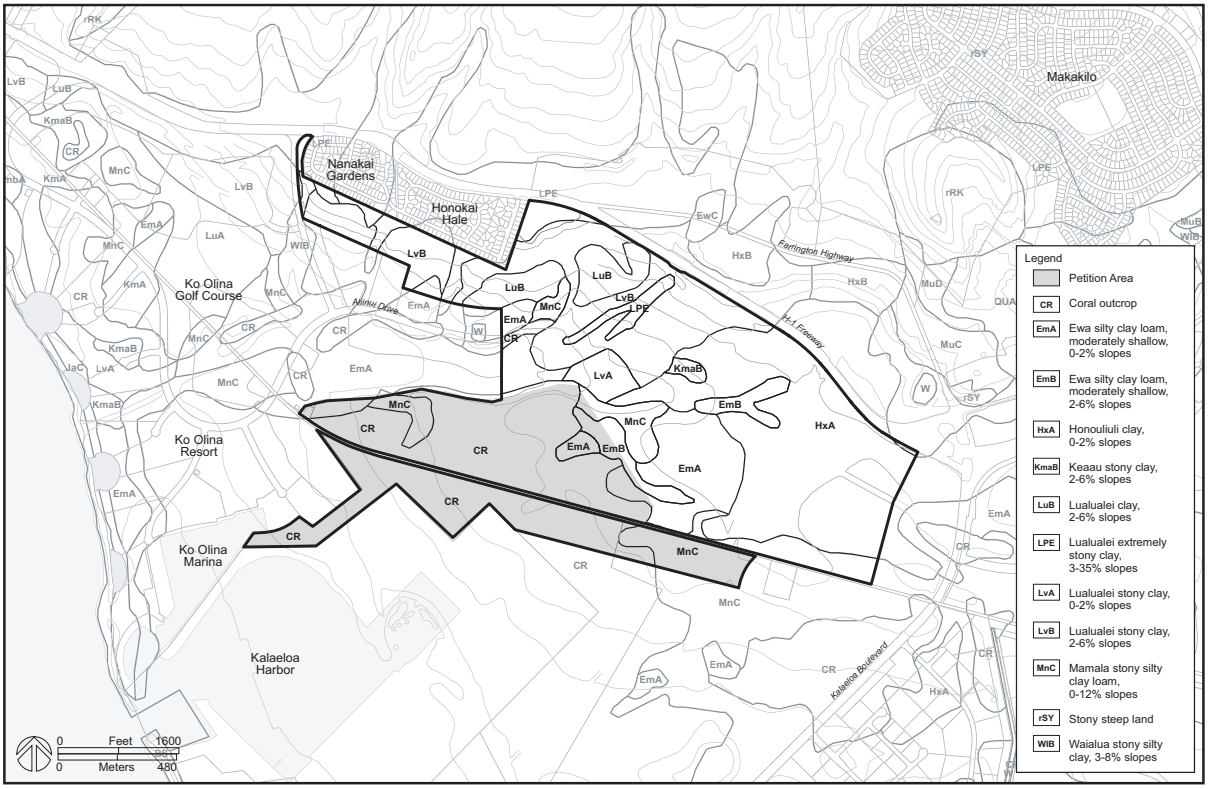
Kapolei West
O`ahu, Hawai`i



F-2

Project Master Plan **Figure 2**

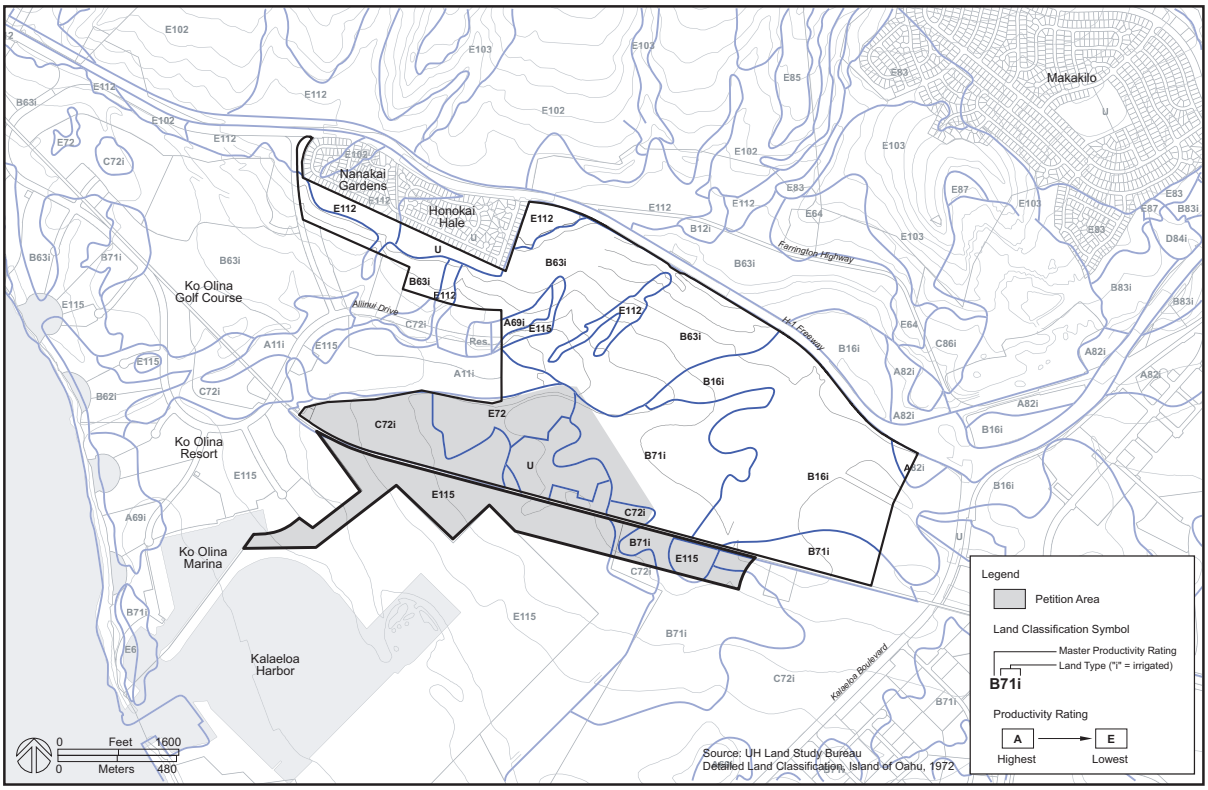
Kapolei West
O`ahu, Hawai`i



F-3

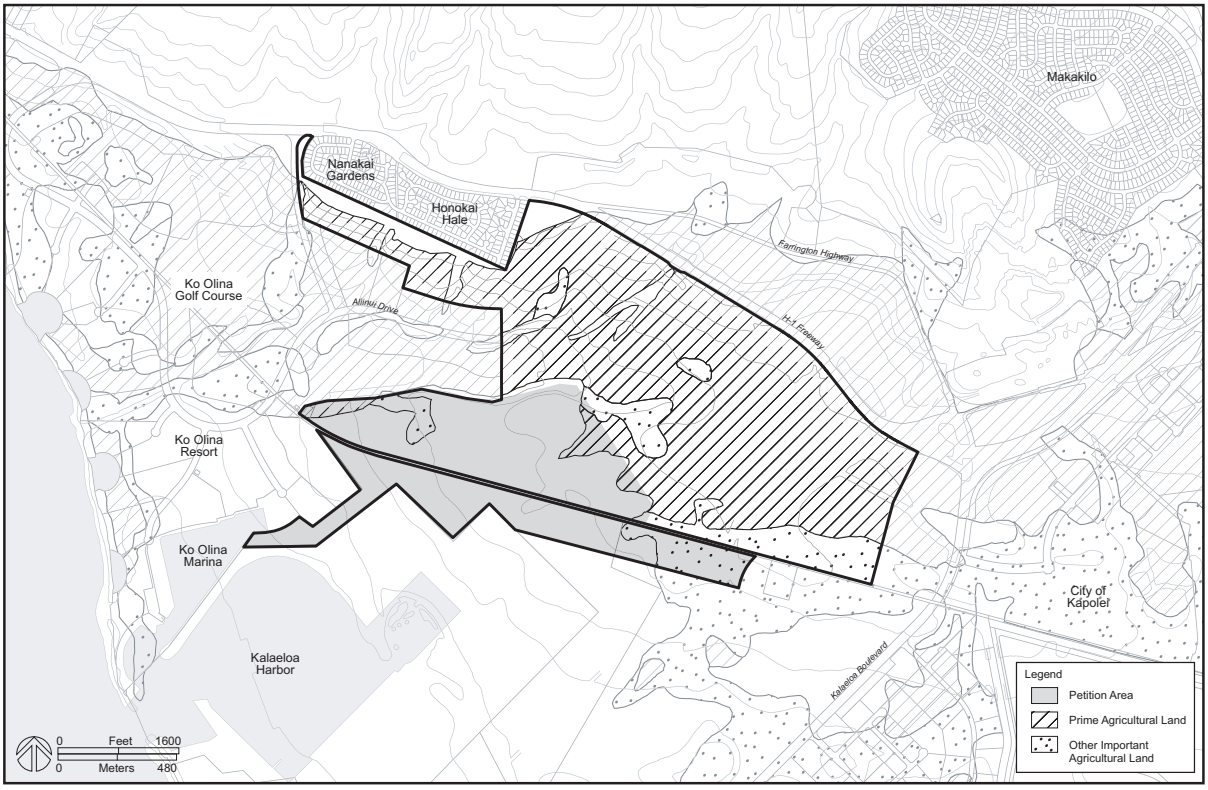
Soil Conservation Service Soil Types **Figure 3**

Kapolei West
O`ahu, Hawai`i



Land Study Bureau Soil Classifications **Figure 4**

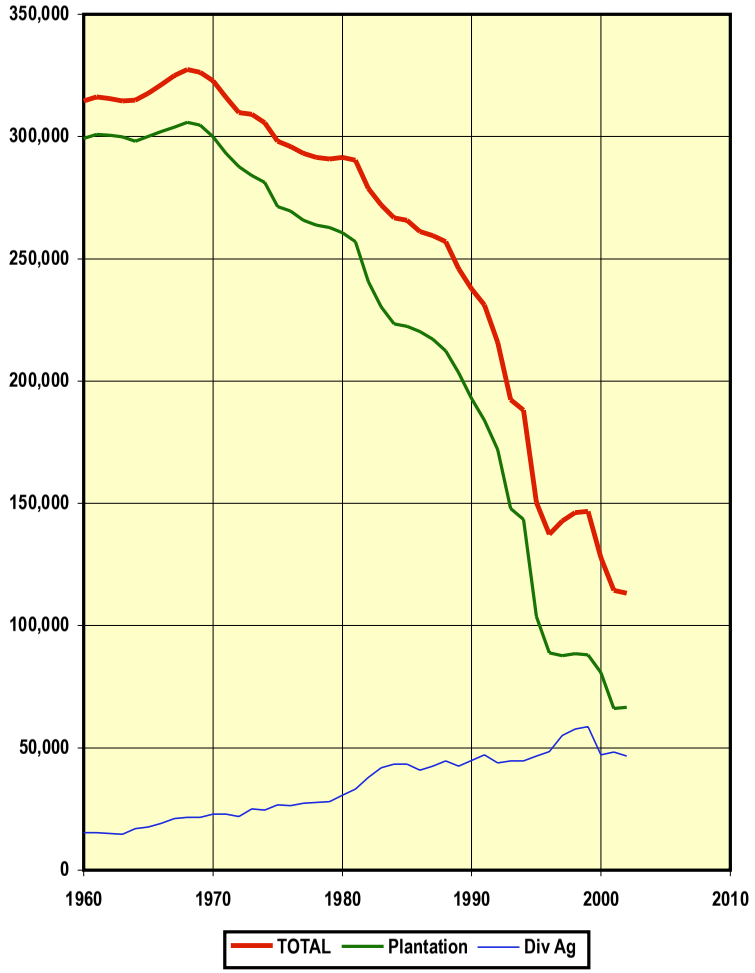
Kapolei West
O`ahu, Hawai`i



Agricultural Lands of Importance to the State of Hawai`i **Figure 5**

Kapolei West
O`ahu, Hawai`i

Figure 6. Hawai'i Agriculture, Acreage in Crop: 1960 to 2002



APPENDIX A:
HAWAI'I'S AGRICULTURAL LAND MARKET

1. INTRODUCTION

Presented below is an overview of the agricultural land market in Hawai'i. The discussion includes the release of land from plantation agriculture (i.e., sugarcane and pineapple); the growth in land required for diversified crops (i.e., all crops other than sugarcane and pineapple); the net change of acreage in crop; the current availability of land for diversified crops; recent changes in agricultural rents; and the limiting factors to the growth of diversified agriculture.

2. RELEASE OF LAND FROM PLANTATION AGRICULTURE

As shown in Figure 6, an enormous amount of land has been released from plantation agriculture over the past three decades: declining from about 305,900 acres in 1968 for the entire State to about 66,600 acres in 2002, for a 34-year decrease of about 239,300 acres (an average decrease of over 7,000 acres per year).[1,2]

A similar release of land occurred on O'ahu. Since 1968, the contractions and eventual closures of three sugar plantations plus the contractions of two pineapple plantations released about 47,500 acres.[3] Since 1990, the release totaled about 28,300 acres.

3. GROWTH IN LAND REQUIRED FOR DIVERSIFIED CROPS

While plantation agriculture was contracting, Statewide land requirements for diversified crops grew from about 21,600 acres in 1968 to about 46,700 acres in 2002, for a 34-year increase of about 25,100 acres (an average increase of about 740 acres per year)—see Figure 6.[1,2]

The fastest growth of diversified agriculture acreage occurred between the mid-1960s and the mid-1980s when land was first released from plantation agriculture. Since the mid-1980s, the growth in diversified agriculture has slowed to an average of less than 200 acres per year.[1]

4. NET CHANGE OF ACREAGE IN CROP

As indicated above and shown in Figure 6, the release of land from plantation agriculture far outpaced the demand for land for diversified crops. As a result, the amount of land in crop has declined from about 327,500 acres in 1968 to about 113,300 acres in 2002, for a net release of about 214,200 acres (an average decrease of about 6,300 acres per year).[1,2]

5. CURRENT AVAILABILITY OF LAND FOR DIVERSIFIED CROPS

Some of the 214,200 acres released from crop production have been converted or are scheduled to be converted to urban, forestry or other uses. But, the majority of the acreage remains available for diversified crops. Much of this land is fallow, is used for grazing, or is in some other low-value land-holding operation. A major issue Statewide is how to use productively the vast amount of high-quality agricultural land that has come available.

On O'ahu, most of the 28,300 acres released from sugar and pineapple production since 1990 remains available. Fields in Kunia and 'Ewa are regarded as 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 and, for export markets, to the Honolulu International Airport and Honolulu Harbor.[4] These lands have been leased for farming, but markets for crops grown on the land are still being developed.[5] On the North Shore, various crops are being explored, but most of the former sugarcane and pineapple land remains fallow.[5,6]

Similarly, agricultural lands remain available on Kaua'i, Moloka'i, Maui, Lana'i and the Big Island.

6. AGRICULTURAL RENTS

Because of the increased availability of agricultural land, a number of landowners report a decrease in per-acre land rents on O'ahu and the Neighbor Islands compared to rents that were charged before the major contraction in plantation agriculture.[7]

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1. In Figure 6, the temporary bump in diversified crop acreage that occurred in the late 1990s reflects former sugarcane fields that were newly planted with grasses for cattle feed. In 2000, much of this acreage was reassigned from crop land to grazing land.

7. LIMITING FACTORS TO THE GROWTH OF DIVERSIFIED AGRICULTURE

Although a great many crops can be grown in Hawai'i's year-round subtropical climate, the modest growth in land requirements for diversified crops reflects the fact that few of them can be grown profitably on a large scale. The primary reasons for this are given below.[8,9]

- 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.
- High overseas transportation costs increase the cost of importing agricultural supplies and equipment and, for export crops, shipping produce to market.
- 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).
- Trends towards crops that are certified as safe and towards 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.

8. SUMMARY

In summary, ample land is available in Hawai'i and on O'ahu to accommodate the growth of diversified agriculture due to the enormous release of land from sugar and pineapple over the past three decades. As a result, the limiting factor to the growth of diversified agriculture is *not* the *land supply*, but rather the *size of the market* for crops that can be grown *profitably* in Hawai'i.

9. REFERENCES

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APPENDIX B:
SELECTED STATE AND CITY 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 C
Water Resources Study
(Mink and Yuen, Inc.)

Mink & Yuen, Inc.

1670 Kalakaua Avenue • Suite 605 • Honolulu, Hawaii 96826 • Telephone: (808) 943-1822 • Fax: (808) 943-1821



May 26, 2005

Helber, Hastert and Fee: Planners
Attention Corlyn Orr
733 Bishop St. Suite 2590
Honolulu HI 96813

Dear Sirs:

Listed below are amendments provided by Mink and Yuen, Inc., to the Kapolei West Draft Environmental Impact Statement in response to comments made by reviewers regarding water issues.

CWRM

Sec. 4.5.1, pg. 4-11: correct typographical error by changing 15.547 mgd to 15.457 mgd. The unallocated share remains the same.

Pg. 4-12: change the Waipahu-Waiawa System allocation from 81.95 mgd to 82.95 mgd, and the unallocated share from 22 to 21 mgd.

pg. 4-12: change the potable water demand from 1.02 to 1.24 mgd, and the non-potable demand from 1.11 to 1.00 mgd, to give a total of 2.24 instead of 2.13 mgd. The correct values are from Sec. 6.2.2, which were calculated to be consistent with the engineering report.

Sec. 6.2.1, pg 6.26, 2nd paragraph under Potable Water: Rephrase as follows, "Groundwater in the Waianae Aquifer in the vicinity of the project site does not meet potability standards .... ".

University of Hawaii

Sec. 6.4.2: to respond to the concern that impervious surfaces will alter flow to coastal waters, add the following: "Impervious surfaces may affect the hydrology in two ways, 1) by reducing infiltration into the underlying aquifer, and 2) by increasing overland flow to the coast. Denying natural drainage into the limestone caprock by replacing the natural surface with impervious surfaces may have an effect on coastal waters because seepage of groundwater at the coast may decrease. However, the effects are likely to be too small to be measurable. Increasing overland runoff will add fresh water and potential contaminants that may diminish the quality of the coastal waters. However, runoff from the impervious surfaces is expected to be relatively minor. The petition area has an average annual rainfall of about 20 inches. Of the 174.2 acres, a golf course will account for 60 acres and another 28 acres will be devoted to parks and open spaces, leaving about 86 acres for the residential area. The annual average rainfall of 20 inches on 86 acres amounts to 47 million gallons per year (128,000 gallons per day), but of this amount only a fraction would reach the coast as runoff.

Ko Olina

Item 8: In the Petition area the caprock water is non-potable and mostly too saline for efficient irrigation. Because non-potable water will be provided by the Board of Water Supply, infiltration from irrigation will have a positive effect on the sustainable yield of the caprock aquifer.

Sincerely,

John F. Mink
Vice President
Mink and Yuen, Inc.

KAPOLEI WEST
Geology, Hydrology and Water Resources Study

Prepared by:
Mink and Yuen, Inc.
1670 Kalakaua Avenue, Suite 605
Honolulu, Hawaii 96826

Prepared for:
Helber Hastert & Fee, Planners

March 2005

Location and Topography

The Kapolei West development project lies between the foothills of the southern portion of the Waianae Mountains and the Ewa Coastal Plain, and comprises elements of both of these geomorphic provinces. The H-1 Freeway, Farrington Highway, Honokai Hale and Nanakai Gardens form its northern boundary; the southern boundary is just below the old OR&L right of way; the eastern boundary reaches almost to Kalaeloa Boulevard; and the irregular western boundary abuts Koio Road, part of a golf course and developed areas already in place (see accompanying map). The surface of the northern part of the area consists of alluvium derived from erosion of the Waianae Mountains. The smaller remainder to the south consists of coralline limestone that constitutes the Ewa Plain.

Along the southern boundary the land surface lies between 30 and 70 feet elevation (mean sea level datum) while along the north it is as high as 120 feet. Within the boundaries most of the surface falls between 40 and 80 feet elevation. The higher elevations are on the alluvial deposits; the coastal plain limestone lies below about 70 feet elevation. The map on page 9 is the U.S.G.S. quadrangle

map, scale 1:24,000. Note that the map does not show developments that have taken place since its publication in 1984.

Geology

Three geological formations dominate the surface and subsurface of the project area. The oldest is the Waianae Basalt, which is the basement rock of the Waianae Mountains. This formation occurs sparingly along the northern border of the area. Approximately 50 to 75 feet of alluvium overlie the basalt throughout much of the area. Where the limestone constitutes the surface it also lies on the Waianae Basalt and its weathered products. Within the area the limestone has a thickness of less than 100 feet. It was formed from coral reefs that grew during higher sea levels. The most recent significant high sea level is called the Waimanalo Stand of the Sea, which was about 25 feet higher than present sea level about 125,000 years ago. However, the high sea level responsible for creation of the bulk of the Ewa Plain ascended to approximately 100 feet above present sea level 400,000 to 500,000 years ago and is called the Kaena Stand of the Sea. Limestones in the project area were formed during this period.

The alluvium is composed of non-calcareous clay to highly weathered boulders cemented into a poorly permeable wedge overlying the basement rock. About 80 percent of the area is covered by alluvium. The remaining 20 percent is made up

of the limestone derived from marine lagoonal sediments. The limestone is highly permeable.

Surface Drainage

Three shallow gulches draining the foothills of the southern Waianae Mountains merge to flow onto the central portion of the project area (see map, page 9). The largest stream is Awanui, the most easterly; the second largest is Palailai, the middle drainage; and the smallest and most westerly is unnamed. Total drainage area of the streams above where they converge and enter the project area is about two square miles. Average annual rainfall in the drainage basin is approximately 25 inches, most of which falls in the winter months, November through April. An unusual winter storm may bring as much as 10 to 15 inches of rain in a single day. Such intense rainfalls can result in flooding on the coastal plain.

Stream flow into the area takes place only when rainfall in the drainage basin is substantial, which is infrequently. Normal flow passes over the alluvial sector and dissipates there and in the limestone by infiltration.

Water Resources Occurrence and Development

Nowhere within the project limits is there a potable water resource. Stream flow is trivial and not worth capturing, and groundwater, the principal source of supply on Oahu, is too brackish for domestic usage. Groundwater beneath the

area, however, can be used for irrigation in some types of agriculture, for golf courses and landscaping.

Within the project area groundwater occurs in two separate aquifers, the Waianae Basalt aquifer and the caprock limestone aquifer. The Waianae aquifer is included in the Ewa-Kunia Aquifer System of the Pearl Harbor Aquifer Sector. Average total pumpage in the System over the last five years has been 11.6 mgd (million gallons per day), but the State Commission on Water Resources Management (CWRM) allows for a total draft of 16 mgd, equal to the sustainable yield. Of this amount, 15.547 mgd has been allocated by CWRM, including 0.957 mgd for the Aina Nui Corporation. The unallocated share is 0.543 mgd. Based on average pumpage over the last five years, of the allocation, 4.0 mgd is unused. The Board of Water Supply share of the total allocation is 9.72 mgd, of which it has pumped an average over the last five years of 7.85 mgd, leaving an unused balance of 1.87 mgd. If the available allocation (0.543 mgd) is added to the presumptive Board of Water Supply surplus (1.87 mgd), a total of 2.41 mgd is hypothetically available from the Ewa-Kunia Aquifer System.

In the project area groundwater in the Waianae aquifer does not meet potability standards, although its salinity is less than 1,000 mg/l chlorides. Groundwater in the limestone aquifer is likely to exceed 1,000 mg/l, which is at the margin of utility for irrigation of grasses.

Although potable groundwater is not developable in the project area, groundwater of a quality suitable for golf course and landscape irrigation is available by means of relatively shallow wells. A former Ewa Plantation-Oahu Sugar Company primary pumping station lies within the property at its indented western margin adjacent to the proposed golf course. The State number of the station is 2006-01 to 12. In plantation nomenclature it is listed as Pump 10. The station consists of a battery of wells drilled into the Waianae Basalt aquifer. Ground surface is at elevation 40 feet , and the wells had to penetrate 60 feet of alluvium before encountering the basalt aquifer. During its period of maximum production (1975-1983) it yielded an average of 15 mgd of water having a chloride content of 500 to 750 mg/l (milligrams per liter).

The CWRM allocation for Pump 10 via Aina Nui Corporation is 957,000 gpd (gallons per day), about sufficient for a 100 to 200 acre golf course. Acceptable caprock water for irrigation may also be developable. In addition, reclaimed wastewater is an option.

Within or very near the property boundaries is an active well used by West Beach Estates for golf course irrigation. The well, State no. 2006-13, exploits the basalt aquifer. It has averaged 744,000 gpd of 450 mg/l chloride water over the last five years.

Sources of Municipal Water Supply

Municipal water supply for Kapolei and the Ewa Plain is derived from both the Koolau and Waianae Basalt aquifers. The Board of Water Supply Kunia I and Hoaeae well fields in the Waipahu Aquifer System provide averages of 4.8 and 6.6 mgd, respectively, from the Koolau aquifer for Ewa and Waianae. From the Waianae basalt aquifer in the Ewa-Kunia Aquifer System the Board of Water Supply pumps from two Honouliuli well fields and a we`ll at Makakilo. Over the last five years the average output from Honouliuli 1 and 2 was 1.17 mgd; from Honouliuli 3 and 4, 5.81 mgd; and from Makakilo, 0.865 mgd. Total average withdrawals by the Board from Ewa-Kunia was 7.85 mgd, while its CWRM allocation is 9.72 mgd, resulting in an unused balance of 1.87 mgd.

The total of all uses in the Ewa-Kunia Aquifer System has been 11.6 mgd whereas the permitted allocation is 16 mgd, leaving 4.4 mgd for future withdrawals. From the Koolau aquifer of the combined Waipahu and Waiawa Aquifer Systems, CWRM permits have been granted for 81.952 mgd out of a total allocable quantity of 104 mgd, leaving about 22 mgd unallocated.

Sources of Non-Potable Water Supply

Potable water in the Pearl Harbor region is obtained from aquifers in the Koolau Basalt formation and the Waianae Basalt formation, which are the aquifers of

primary concern to the State Commission o n Water Resources Development. The allocations refer to these aquifers. A third aquifer composed of limestone and other marine sediments occurs on and forms the Ewa coastal plain. In this aquifer the groundwater is non-potable because of salinity, but depending on location the salinity may be low enough for use of the water in irrigation.

Non-potable groundwater also occurs in the Waianae Basalt underlying the property. However, extraction of this resource would require an allocation as if it were potable.

The most voluminous and readily available supply of non-potable water will be the R-1 treated water from the Honouliuli Wastewater Treatment Plant provided by the Board of Water supply.

Water Supply Demand

Total average demand in the project area for potable water will amount to 1.02 mgd, broken down as follows.

Petition area: 1,154 units @ 400 gpd/unit = 461,600 gpd.

Urban area: 1,216 units @ 400 gpd/unit = 486,400 gpd.

Urban area commercial: 25.2 acres @ 3,000 gpad (gallons per acre per day) = 75,600 gpd.

Total potable water: 1,023600 gpd.

The unused Board of Water Supply allocation in either the Waipahu-Waiawa or Ewa-Kunia Aquifer Systems is more than sufficient to supply the demand.

Non-potable demand for golf course and landscaping will average about 1.0 mgd, obtainable as follows.

Petition are golf course: 56.9 acres @1.0 inch/acre/week = 224,000

Urban area golf course: 153 acres @ 1.0 inch/acre/week = 603,000 gpd.

Total golf course irrigation: 827,000 gpd.

Petition area parks and open spaces: 27.8 acres @ 1.0 inch/acre/week = 110,000 gpd.

Urban area parks and open spaces: 44 acres @ 1.0 inch/acre/week = 173,000 gpd.

Total parks and open spaces: 283,000 gpd.

Total golf course, parks and open spaces: 1,110,000 gpd.

The source of non-potable water may be either treated wastewater supplied by the Board of Water Supply, or if agreeable by CWRM, the allocation (957,000 gpd) for Pump 10.

Conclusions

The largest portion of the project area is covered by alluvium and the smaller portion by limestone. The principal aquifer is in the Waianae Basalt on which both the alluvium and the limestone rest. The alluvium is 50 to 75 feet thick and the limestone less than 100 feet thick. Groundwater in the Waianae Basalt aquifer

is brackish with a chloride content greater than 500 mg/l. The limestone also embraces an aquifer, but its groundwater exceeds 1,000 mg/l chlorides. Nowhere in the project area will surface activity have an impact on a potable water supply.

A municipal water supply for the proposed residences is available from the Aquifer Systems that now serve the Ewa Plain. Draft from these Aquifers Systems is less than the allowed draft (sustainable yield) set by CWRM. For non-potable uses either brackish groundwater can be developed or reclaimed wastewater accessed.



APPENDIX D
Botanical Survey
(Char and Associates)

BOTANICAL SURVEY

KAPOLEI WEST - PARCELS A TO C

KAPOLEI, ʻEWA DISTRICT, OAHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawaiʻi

Prepared for **HELBER HASTERT & FEE**

April 2004

BOTANICAL SURVEY
KAPOLEI WEST - PARCELS A TO C
KAPOLEI, ʻEWA DISTRICT, OAHU

INTRODUCTION

The ±124-acre project site is comprised of tax map key parcels 9-1-14: por. 33 and 9-1-15: por. 20. The project site is bound by the OR&L right-of-way (ROW) to the north; overgrown, former sugar cane fields to the east; Barbers Point Harbor and Campbell Industrial Park to the south; and Ko Olina Golf Course to the west (see Figure 1: Project Location). The site is divided into three separate parcels: A, B, and C. Parcel A is a hook-shaped property that touches the Ko Olina Marina waterfront. Parcel B is a triangular-shaped parcel, and Parcel C is wedge-shaped parcel that is actively quarried

Field studies to assess the botanical resources on the project site were conducted on 03 February 2004. The primary objectives of the survey were to:

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

SURVEY METHODS

Prior to 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. A fairly recent aerial photo of the project site taken on June 11, 2000 (scale 1" = 200') was examined to determine vegetation cover types, terrain characteristics, access, boundaries and reference points. The project site is easily accessed from the Ko Olina Golf Course.

A walk-through survey method was used. Notes were made on plant associations and distribution, substrate types, disturbances, drainage, topography, exposure, etc. Plant identifications were made in the field.

The species recorded are indicative of the season ("rainy" vs. "dry") and the environmental conditions at the time of the survey. A survey taken at a different time of the year would no doubt yield slight variations in the species list, especially of the weedy, annual plants.



Figure 1: Project Location - Parcels A-C

DESCRIPTION OF THE VEGETATION

A description of the four vegetation types recognized on the parcels follows. An inventory of all the plant species observed on the project site is presented at the end of the report.

Quarry Vegetation

Portions of Parcel C are actively quarried. The lower portion of Parcel A has been quarried in the past and is now used for stockpiling coralline material. The southwest corner of Parcel B contains piles of coral rubble.

These highly disturbed areas are largely barren and support only scattered clumps of vegetation. Shrubs of Indian pluchea (Pluchea indica), sourbush (Pluchea carolinensis), and koa haole (Leucaena leucocephala), 3 to 5 ft. tall, cover piles of coral rubble which have not been disturbed for a few years. Level areas between the piles of coralline material support scattered patches of various grasses and weedy, mostly annual species which include swollen fingergrass (Chloris barbata), Natal redtop grass (Melinis repens), buffelgrass (Cenchrus ciliaris), saltbush (Atriplex suberecta), flaveria (Flaveria trinervia), wild spider flower (Cleome gynandra), and Bermuda grass (Cynodon dactylon). Two native species which prefer these more open areas with coralline substrate, the ‘akulikuli (Sesuvium portulacastrum) and kipukai (Heliotropium curassavicum), are locally abundant.

Buffelgrass/Koa Haole Scrub

This vegetation type occurs primarily on those areas formerly used for sugar cane cultivation and have well-drained, reddish-brown silty clay loam soils which overlay coral limestone (Foote et al. 1972). On the project site this is found on Parcel C. This vegetation type also occurs along the OR&L ROW corridor.

Buffelgrass forms dense mats, 1 to 3 ft. tall, and koa haole shrubs occur as scattered clumps, 3 to 6 ft. tall. Golden crown-beard (Verbesina encelioides) is locally abundant on the old cane fields, especially during the wetter months. The large, yellow, daisy-type flowers on plants 2 to 3 ft. tall are easily spotted among the clumps of buffelgrass. Other plants found occasionally within this vegetation type include Guinea grass (Panicum maximum), running pop (Passiflora foetida), cocklebur (Xanthium strumarium), tree tobacco (Nicotiana glauca), saltbush, ‘uhaloa (Waltheria indica), and Boerhavia coccinea.

A small drainage ditch is found on the eastern end of Parcel C. In this area, the koa haole shrubs are 10 to 15 ft. tall and form somewhat dense stands. Grass cover is a mixture of taller Guinea grass clumps and shorter mats of

buffelgrass. Shrubs of klu (Acacia farnesiana) and castor bean (Ricinus communis) are frequently encountered.

Kiawe Forest

Large, old kiawe trees (Prosopis pallida), 25 to 30 ft. tall, are found on the western end of Parcel C as well as Parcel B. One very large Chinese banyan tree (Ficus microcarpa) towers above the kiawe on Parcel B. In most places, the forest is closed, that is, the crowns of the trees interlock and canopy cover is greater than 60. percent. Under the kiawe trees there are koa haole shrubs, 12 to 25 ft. tall, however, most of the shrubs are dead. Guinea grass forms dense, robust clumps, 3 to 5 ft. tall, where there is a thin layer of soil over the limestone substrate. Where the pitted and weathered limestone (karst) is exposed, the Guinea grass cover is patchy. A few plants of common purslane (Portulaca oleracea), Achyranthes aspera, false mallow (Malvastrum coromadelianum), Euphorbia graminea, lantana (Lantana camara), and West Indian beggar's tick (Bidens cynapiifolia) occur on these exposed limestone areas. The native kupala vine (Sicyos pachycarpus), a member of the gourd or squash family, is locally abundant during the rainy season.

The endangered 'Ewa Plains 'akoko (Chamaesyce skottsbergii var. kalaeloana) has been recorded from the area around the deep draft harbor (Char and Balakrishnan 1979; U.S. Fish and Wildlife Service 1982). Plants were known from the kiawe forest on the project site. An intensive search was made of the kiawe forest area, but no 'akoko plants were found.

Koa Haole Scrub

Koa haole scrub occurs on the mauka portion of Parcel A and on the western half of Parcel B. Koa haole shrubs form somewhat dense thickets, 5 to 15 ft. tall, with a few kiawe trees, 7 to 20 ft. tall, scattered throughout the thickets. Ground cover consists of dense mats of buffelgrass and a few scattered pockets of green panicgrass (Panicum maximum var. trichoglume).

On the small piles of coral rubble and bulldozed roads, the grass cover is patchy. In these areas, 'uhaloa , a small native shrub with fuzzy leaves, is locally abundant. 'Ilima (Sida fallax), hoary abutilon (Abutilon incanum), and popolo (Solanum americanum), three other native species, are occasionally encountered. Other plants found here include swollen fingergrass (Chloris barbata), Australian saltbush (Atriplex semibaccata), hairy spurge (Chamaesyce hirta), stinkgrass (Eragrostis cilianensis), sowthistle (Sonchus oleraceus), and 'aheahea (Chenopodium murale). Low mats of Sida ciliaris and creeping indigo (Indigofera hendecaphylla) are common. Seedlings of several species were abundant due to the recent heavy rains; these include seedlings of hairy spurge, graceful spurge (Chamaesyce hypericifolia), tree tobacco, sourbush, 'uhaloa, and

cheese weed (Malva parviflora).

Almost all of the area covered by koa haole scrub vegetation has been disturbed in the past by bulldozing and/or human activity. Where this vegetation type borders the golf course, there are piles of branches, coconut fronds, and other green waste material. Closer to the bulldozed road which crosses the parcel, automobile debris and equipment are covered by dense mats of buffelgrass. Standing water provides a breeding ground for mosquitoes in the koa haole thickets and the adjacent kiawe forest.

DISCUSSION AND RECOMMENDATIONS

Except for the kiawe forest, the other three vegetation types have all been disturbed somewhat recently in the past by sugar cane cultivation, quarrying, bulldozing, and other human activity. The vegetation on the project site is dominated by introduced species such as buffelgrass, koa haole, kiawe, Guinea grass, etc. A very recent botanical survey (Char 2003) of the lands mauka of the project site recorded similar findings.

The few native species which occur on the site tend to be those that are widespread and do well in open, disturbed habitats. Eight native species were observed during the field studies. Six of them are indigenous, that is, they are native to the Hawaiian Islands and elsewhere; these are the 'akulikuli (Sesuvium portulacastrum), kipukai (Heliotropium curassavicum), hoary abutilon or ma'o (Abutilon incanum), 'ilima (Sida fallax), popolo (Solanum americanum), and 'uhaloa (Waltheria indica). Two species are endemic, that is, they are native only to the Hawaiian Islands. The kupala (Sicyos pachycarpus), a vine, is widespread in coastal and dry lowland plant communities including alien vegetation such as koa haole shrubland and kiawe forest. It occurs on the lower leeward slopes of all the main Hawaiian Islands and has been recorded from Laysan and Nihoa (Wagner et al. 1990). The kauna'oa (Cuscuta sandwicensis), also a vine, is found in coastal areas on all of the main islands except Kaho'olawe (Wagner and Herbst 1999).

The endangered 'Ewa Plains 'akoko (Chamaesyce skottsbergii var. kalaeloana) has been recorded from the area around the deep draft harbor. Before the construction of the harbor, the 'akoko plants were removed to various botanic gardens and arboreta or transplant sites within the industrial park. During this survey, an intensive search was made of the project site, especially in the area of the kiawe forest, for any remnant 'akoko plants. No 'akoko plants or any other threatened and endangered species or species of concern (U.S. Fish and Wildlife Service 1999a, 1999b; Wagner. et al. 1999) were found.

Given the findings above, the proposed development of the project site is not expected to have a significant negative impact on the botanical resources.

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PLANTS SPECIES LIST -- Kapolei West Parcels A to C

The following checklist is an inventory of all the plant species observed on the Kapolei West parcels. The plant names are arranged alphabetically by family and then by species into each of two groups of flowering plants: Dicots and Monocots. The taxonomy and nomenclature used follows Wagner et al. (1990) and Wagner and Herbst (1999). The few recent name changes are those recorded in the Hawaii Biological Survey series (Evenhuis and Eldredge, eds., 1999-2002).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - E = endemic = native only to the Hawaiian Islands.
   - I = indigenous = native to the Hawaiian Islands and elsewhere.
   - I? = questionably indigenous = data not clear if dispersal to the islands by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.
   - 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.
   - X? = questionably introduced = date of introduction unclear or very soon after Western contact; may possibly be indigenous or of Polynesian introduction.
4. Vegetation type. Presence (+) or absence (-) of a particular species within each of four vegetation types recognized on the project site (see text for discussion):
   - q = Quarry Vegetation
   - g = Buffelgrass/Koa Haole Scrub
   - f = Kiawe Forest
   - k = Koa Haole Scrub

Scientific name	Common name	Status	Vegetation type g	g	f	k
FLOWERING PLANTS						
DICOTS						
ACANTHACEAE (Acanthus family)						
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	X	-	-	+	+
AIZOACEAE (Fir-marigold family)						
Sesuvium portulacastrum (L.) L.	‘akulikuli	I	+	-	-	-
AMARANTHACEAE (Amaranth family)						
Achyranthes aspera L.		X	-	-	+	+
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X	-	-	-	+
Amaranthus vi ridis L.	slender amaranth, pakai	X	-	-	-	+
APOCYNACEAE (Dogbane family)						
Thevetia peruviana (Pers.) K. Schum.	be-still tree	X	-	-	-	+
ASTERACEAE (Daisy family)						
Ageratum conyzoides L.	maile hohono	X	-	-	+	-
Bidens cynapiifolia Kunth	West Indian beggar’s tick	X	-	-	+	-
Emilia fosbergii Nicolson	flora’s paintbrush, pualele	X	-	+	-	+
Flaveria trinervia (Spreng.) C. Mohr.	flaveria	X	+	-	-	-
Lactuca serriola L.	prickly lettuce	X	-	-	+	-
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	+	+	-	+
Pluchea indica (L.) Less.	Indian fleabane	X	+	-	-	+
Sonchus oleraceus L.	sowthistle, pualele	X	-	-	-	+
Tridax procumbens L.	coat buttons	X	-	+	-	-
Verbesina encelioides (Cave) Benth. & Hook.	golden crown-beard	X	+	+	+	+
Xanthium strumarium var. canadense (Mill.) Torr. & A. Gray	cocklebur, kikania	X	-	+	-	-
BORAGINACEAE (Borage family)						
Heliotropium curassavicum L.	kipukai, nena	I	+	-	-	-
Heliotropium procumbens var. depressum (Cham.) Fosb.		X	-	-	-	+

Scientific name	Common name	Status	Vegetation type g	g	f	k
CAPPARACEAE (Caper family)						
Cleome gynandra L.	wild spider flower, hohohina	X	+	-	-	-
CHENOPODIACEAE (Goosefoot family)						
Atriplex semibaccata R. Br.	Australian saltbush	X	-	+	-	+
Atriplex suberecta Verd.	saltbush	X	+	+	-	-
Chenopodium carinatum R. Br.		X	-	-	+	-
Chenopodium murale L.	‘aheahea	X	-	-	-	+
CONVOLVULACEAE (Morning glory family)						
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	-	+	-	+
Ipomoea triloba L.	little bell, pink bindweed	X	-	+	-	-
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	X?	+	-	-	+
CUCURBITACEAE (Gourd family)						
Coccinia grandis (L.) Voigt	ivy gourd, coccinia	X	-	+	-	+
Momordica charantia L.	wild bittermelon	X	-	-	+	-
Sicyos pachycarpus Hook. & Arn.	kupala	E	+	-	+	-
CUSCUTACEAE (Dodder family)						
Cuscuta sandwichiana Choisy	kauna‘oa	E	-	-	+	-
EUPHORBIACEAE (Spurge family)						
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	-	+	-	+
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	-	+	-	+
Chamaesyce prostrata (Aiton) Small	prostrate spurge	X	-	-	-	+
Euphorbia graminea Jacq.		X	-	-	+	-
Ricinus communis L.	castor bean, koli, pa‘aila, ka‘apeha	X	-	+	-	+
FABACEAE (Pea family)						
Acacia farnesiana (L.) Wind.	klu	X	-	+	-	+
Alysicarpus vaginalis (L.) DC	alysicarpus	X	-	-	-	+
Desmanthus pernambucanus (L.) Thellung	slender mimosa, virgate mimosa	X	-	+	-	+
Indigofera hendecaphylla Jacq.	creeping indigo	X	-	-	-	+
Indigofera suffruticosa Mill.	indigo, ‘iniko	X	+	+	-	+

Scientific name	Common name	Status	Vegetation type g	g	f	k
Leucaena leucocephala (Lam.) de Wit	koa haole	X	+	+	+	+
Pithecellobium dulce (Roxb.) Benth.	ʻopiuma	X	-	+	-	+
Prosopis pallida (Hump. & Bonpl. ex Willd.) Kunth	kiawe	X	+	+	+	+
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona, kalamona	X	-	+	-	+
LAMIACEAE (Mint family)						
Leonotis nepetifolia (L.) R. Br.	lion's ear	X	+	+	+	+
MALVACEAE (Mallow family)						
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, maʻo	X	-	+	+	-
Abutilon incanum (Link) Sweet	maʻo, hoary abutilon	I?	-	+	-	+
Malva parviflora L.	cheese weed	X	-	-	-	+
Malvastrum coromandelianum (L.) Garcke	false mallow, hauuoi	X	-	+	+	+
Sida ciliaris L.		X	-	-	-	+
Sida fallax Walp.	ʻilima	I	-	+	+	+
Sida rhombifolia L.		X	-	-	-	+
MORACEAE (Mulberry family)						
Ficus microcarpa L.f.	Chinese banyan	X	-	-	+	-
NYCTAGINACEAE (Four-o'clock family)						
Boerhavia coccinea Mill.		X	-	+	-	+
PASSIFLORACEAE (Passion flower family)						
Passiflora foetida L.	running pop, pohapoha	X	-	+	-	-
POLYGONACEAE (Buckwheat family)						
Antigonon leptopus Hook. & Arnott	Mexican creeper, chain-of-hearts	X	-	-	+	-
PORTULACACEAE (Purslane family)						
Portulaca oleracea L.	common purslane, pigweed, ʻihi	X	-	-	+	+

Scientific name	Common name	Status	Vegetation type g	g	f	k
SOLANACEAE (Nightshade family)						
Nicandra physalodes (L.) Gaertn.	apple of Peru	X	+	-	-	-
Nicotiana glauca R.C. Graham	tree tobacco	X	+	+	-	-
Solanum americanum Mill.	popolo, glossy nightshade	I?	+	-	+	+
Solanum lycopersicon var. cerasiforme (Dunal) Spooner, Anderson & Jansen	currant tomato, wild tomato	X	-	+	-	+
STERCULIACEAE (Cacao family)						
Waltheria indica L.	ʻuhaloa, hiʻaloa, kanakaloa	I?	+	+	-	+
VERBENACEAE (Verbena family)						
Lantana camara L.	lantana, lakana	X	-	-	+	-
MONOCOTS						
COMMELINACEAE (Spiderwort family)						
Commelina benghalensis L.	hairy honohono	X	-	-	-	+
POACEAE (Grass family)						
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	-	+	-	-
Cenchrus ciliaris L.	buffelgrass	X	+	+	+	+
Chloris barbata (L.) Sw.	swollen fingergrass, mauʻulei	X	+	+	-	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	+	+	-	-
Eragrostis ciliianensis (All.) Link	stinkgrass	X	-	+	-	+
Melinis repens (Wind.) Zizka	Natal redtop, Natal grass	X	+	+	-	-
Panicum maximum Jacq.	Guinea grass	X	+	+	+	+
Panicum maximum var. trichoglume Eyles ex Robyns	green panicgrass	X	-	-	+	+
Setaria verticillata (L.) P. Beauv.	bristly foxtail, mauʻu pilipili	X	+	-	-	-
Sporobolus sp.		X	+	-	-	-

BOTANICAL SURVEY
KAPOLEI REZONING
±96-ACRE PARCEL
KAPOLEI, ʻEWA DISTRICT, OʻAHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawaiʻi

Prepared for: **HELBER HASTERT & FEE**

November 2003

BOTANICAL SURVEY
KAPOLEI REZONING
±96-ACRE PARCEL
KAPOLEI, ʻEWA DISTRICT, OʻAHU

INTRODUCTION

The approximate 96-acre study site is part of the ±469-acre parcel located west of Kalaeloa Boulevard (TMK 9-145:4). This ±469-acre parcel has been referred to as Ko Olina Phase's II and III. Most of the parcel, about 373 acres, was designated "Urban" by the Land Use Commission. The ±96-acre parcel was not included in the land use petition or Environmental Impact Statement.

The roughly triangular-shaped ±96-acre parcel is bound along its makai base by an existing easement which follows along the old OR&L railroad track. Along its mauka sides, it borders the Ko Olina Golf Course and former sugar cane fields now overgrown with buffelgrass and koa haole scrub.

Field studies to assess the botanical resources on the ±96-acre parcel were conducted on 07 November 2003. 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;
3. search for threatened and endangered species as well as species of concern; and
4. identify areas of potential environmental problems or concerns and propose appropriate mitigation measures.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. Topographic maps and recent, colored aerial photographs were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

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

The species are indicative of the season ("rainy" vs. "dry") and the environmental conditions at the time of the field studies. A survey taken at a different time of the year would no doubt yield slight variations in the species list, especially of the weedy, annual species.

DESCRIPTION OF THE VEGETATION

Three vegetation types are recognized on the project site. About half of the parcel has been graded somewhat recently and supports a ruderal community. Kiawe forest also covers a large portion of the project site. Scrub-covered cane fields occupy a small area along the eastern boundary. A list of all the plant species inventoried within these three vegetation types is presented at the end of the report.

An intensive survey was made of the less disturbed kiawe forest as the 'Ewa plains 'akoko (Chamaesyce skottsbergii var. skottsbergii, formerly var. kalaeloana), an endangered species, was known from the nearby deep draft harbor area (Char and Balakrishnan 1979).

Ruderal Community

This plant community or vegetation type covers about 50 percent of the project site. It consists primarily of scattered mats of buffelgrass (Cenchrus ciliaris), 1 to 2 ft. tall. Other plants occasionally observed include 'ilima (Sida fallax), slender mimosa (Desmanthus pernambucanus), Australian saltbush (Atriplex semibaccata), saltbush (Atriplex suberecta), golden crown-beard (Verbesina encelioides), and scattered clumps of short-statured koa haole (Leucaena leucocephala) and sourbush (Pluchea carolinensis) shrubs, 1 to 4 ft. tall. In some places, swollen fingergrass (Chloris barbata), 'uhaloa (Waltheria indica), slender mimosa, and 'ilima form fairly large-sized patches.

Plant cover, however, tends to be patchy with many barren spots. Substrate is crushed coralline material with a thin layer of reddish-colored soil in some places. On the soil maps (Foote et al. 1972), most of the project site is mapped as "CR", coral outcrop.

Kiawe Forest

Large, old kiawe trees (Prosopis pallida), 25 to 35 ft. tall with trunks 1 to 2 ft. in diameter, also occur on the areas of coral outcrop. Under the kiawe trees, barren substrate is common. In places with thin soil, clumps of the more shade tolerant green panicgrass (Panicum maximum var. trichoglume) are found. Other plants found sparingly under the kiawe forest include lion's ear (Leonotis nepetifolia), Chinese violet (Asystasia gangetica), 'ilima, Achyranthes aspera, and slender mimosa.

Along the edge of the forest and alongside the unpaved roads which cut through the forest, the understory vegetation can become denser. Koa haole shrubs form small thickets, 12 to 20 ft. tall. Clumps of buffelgrass and Guinea grass (Panicum maximum)

are common. Scattered between the clumps of grass are small patches of slender mimosa, saltbush, garden spurge (Chamaesyce hirta), golden crown-beard, lion's ear, false mallow (Malvastrum coromandelianum), etc., and shrubs of lantana (Lantana camara), Christmas berry (Schinus terebinthifolius), sourbush, and hairy abutilon (Abutilon grandifolium).

The kiawe forest area was disturbed in the past. It may have been part of a military site and later a piggery or poultry operation. Until recently, the forested section as well as the rest of the property was used for grazing horses. Large concrete foundations are commonly encountered throughout the kiawe forest. A few trees of Chinese banyan (Ficus microcarpa), pink and red bougainvillea shrubs (Bougainvillea glabra), night-blooming cereus (Hylocereus undatus), and Mexican creeper (Antigonon leptopus) are found along the mauka edge of the forest. In places, the kiawe forest is more open with dense patches of buffelgrass between the trees. Piles of old lumber, rusted car/truck parts, sheet metal, tires, stacks of telephone poles, etc., are found here.

Buffelgrass/Koa Haole Scrub

This vegetation type occurs on soils of the 'Ewa series. These are well-drained, reddish-brown silty clay loam soils which overlay coral limestone (Foote et al. 1972), and were used for sugar cane cultivation in the past.

On the project site, the vegetation on these old cane fields consists of dense mats of buffelgrass, 1 to 3 ft. tall, and scattered clumps of koa haole shrubs, 3 to 6 ft. tall. Young kiawe trees, 12 to 15 ft. tall, occur as widely scattered individuals. In some places, dead stalks of sugar cane (Saccharum officinarum) can still be found.

Because of the dense mats of buffelgrass, most of the other species associated with this vegetation type occur in areas where the grass cover is thinner or has been disturbed such as along the roadsides, drainageways, and rock piles. Two native species. which are frequently found in these more open, disturbed sites are 'ilima and 'uhaloa. Other plants include Guinea grass, running pop (Passiflora foetida), klu (Acacia farnesiana), cocklebur (Xanthium strumarium), swollen fingergrass, tree tobacco (Nicotiana glauca), saltbush, golden crown-beard, and Boerhavia coccinea.

DISCUSSION AND RECOMMENDATIONS

The vegetation on the ±96-acre project site is dominated by introduced or alien plants such as buffelgrass, koa haole, and kiawe. A total of 60 plant species were inventoried on the project site. Of these, 56 (93%) are introduced species and four (7%) are native. These are the 'ilima (Sida fallax), 'uhaloa (Waltheria indica), hoary abutilon or ma'o (Abutilon incanum), and popolo (Solanum americanum). These all indigenous, that is, they are native to the Hawaiian Islands and elsewhere.

None of the plants which occur on the project site is a threatened and endangered

species or a species of concern (U.S. Fish and Wildlife Service 1999a, 1999b; Wagner et al. 1999). Nor are there any plant communities or vegetation types dominated by native species on the project site. This is not surprising as almost all of the site has been disturbed at some time in the past.

There is very little of botanical interest on the project site. The proposed rezoning of the ±96-acre parcel to the "Urban" designation and its development are not expected to have a significant negative impact on the botanical resources of the site or the general region.

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PLANT SPECIES LIST -- ±96-Acre Parcel, Kapolei Rezoning

The following checklist is an inventory of all the plants observed on the ±96 acre project site during the field studies. The flowering plants are arranged alphabetically by families and then by species within each of the two groups: Dicots and Monocots. The taxonomy and nomenclature of the flowering plants follow Wagner et al. (1990) and Wager and Herbst (1999). The few recent name changes are those reported in the Hawaii Biological Survey series (Evenhuis and Eldredge, editors, 1999-2002).

For each species, the following information is provided:

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

   I = indigenous = native to the Hawaiian Islands and elsewhere.
   I? = questionably indigenous = data not clear if dispersal to the Hawaiian Islands by natural or human-related mechanisms, but weight of evidence suggests probably natural.
   X = introduced by 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.

4. Presence (+) or absence (-) of a particular species within each of three vegetation types recognized on the project site (see text for description):

   r = Ruderal Community
   k = Kiawe Forest
   b = Buffelgrass/Koa Haole Scrub

Scientific name	Common name	Status	Vegetation type r	k	b
FLOWERING PLANTS					
DICOTS					
ACANTHACEAE (Acanthus family)					
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	X	-	+	-
AMARANTHACEAE (Amaranth family)					
Achyranthes aspera L.		X	-	+	-
ANACARDIACEAE (Mango family)					
Schinus terebinthifolius Raddi	Christmas berry	X	-	+	-
ASTERACEAE (Daisy family)					
Emilia fosbergii Nicolson	flora's paintbrush, pualele	X	+	-	+
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	+	+	+
Pluchea indica (L.) Less.	Indian pluchea	X	+	-	-
Tridax procumbens L.	coat buttons	X	+	+	+
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	X	+	+	+
Xanthium strumarium var. canadense (Mill.) Torr. & A. Gray	cocklebur, kikania	X	-	-	+
BORAGINACEAE (Borage family)					
Cordia dichotoma Forst. f.	Sebesten plum	X	-	-	+
Heliotropium procumbens var. depressum (Cham.) Fosb.		X	-	+	-

Scientific name	Common name	Status	Vegetation type r	k	b
CACTACEAE (Cactus family)					
Hylocereus undatus (Haw.) Britton & Rose	nigh-blooming cereus	X	-	+	-
CAPPARACEAE (Caper family)					
Cleome gynandra L.	wild spider flower, hohohina	X	-	+	-
CHENOPODIACEAE (Goosefoot family)					
Atriplex semibaccata R. Br.	Australian saltbush	X	+	+	+
Atriplex suberecta Verd.	saltbush	X	+	+	+
Chenopodium Murale L.	‘aheahea	X	-	+	-
CONVOLVULACEAE (Morning glory family)					
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	-	+	+
Ipomoea triloba L.	little bell, pink bindweed	X	-	-	+
CUCURBITACEAE (Gourd family)					
Coccinia grandis (L.) voigt	Ivy gourd, coccinia	X	-	+	+
EUPHORBIACEAE (Spurge family)					
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	+	+	+
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	+	+	+
Euphorbia graminea Jacq.		X	-	+	-
Ricinus communis L.	castor bean, koli, pa‘aila	X	-	-	+

Scientific name	Common name	Status	Vegetation type r	k	b
FABACEAE (Pea family)					
Acacia farnesiana (L.) Willd.	klu	X	-	-	+
Desmanthus pernambucanus (L.) Thellung	slender mimosa	X	+	+	+
Indigofera suffruticosa Mill.	indigo, ‘iniko	X	-	+	+
Leucaena leucocephala (Lam.) de Wit	koa haole	X	+	+	+
Pithecellobium dulce (Toxb.) Benth.	‘opiuma	X	-	-	+
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe	X	+	+	+
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona, kalamona	X	-	-	+
Lamiaceae (Mint family)					
Leonotis nepetifolia (L.) R. Br.	lion’s ear	X	+	+	+
Ocimum gratissimum L.	wild basil	X	-	+	-
MALVACEAE (Mallow family)					
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, ma‘o	X	+	+	+
Abutilon incanum (Link) Sweet	ma‘o, hoary abutilon	I?	+	-	+
Malva parviflora L.	cheese weed	X	-	+	-
Malvastrum coromandelianum (L.) Garcke	false mallow, hauuoi	X	-	+	+
Sida Ciliaris L.		X	-	+	-
Sida fallax Walp.	‘ilima	I	+	+	+
Sida rhombifolia L.		X	-	+	-
MORACEAE (Mulberry family)					
Ficus microcarpa L.f.	Chinese banyon	X	-	+	-

Scientific name	Common name	Status	Vegetation type r	k	b
NYCTAGINACEAE (Four-o'clock family)					
Boerhavia coccinea Mill.		X	-	-	+
Bougainvillea gilbra choisy	bougainvillea, pukanawila	X	-	+	-
PASSIFLORACEAE (Passion flower family)					
Passiflora foetida L.	running pop, pohapoha	X	+	-	+
POLYGONACEAE (Buckwheat family)					
Antigonon leptopus Hook. & Arnott	Mexican creeper, chain-of-hearts	X	-	+	-
PORTULACACEAE (Purslane family)					
Portulaca oleracea L.	pigweed, 'akulikuli kula	X	-	+	-
SOLANACEAE (Nightshade family)					
Nicotiana glauca R.C. Graham	tree tobacco	X	-	-	+
Solanum americanum Mill.	popolo, glossy nightshade	I?	-	+	-
Solanum lycopersicon var. cerasiforme (Dunal) Spooner, Anderson & Jansen	currant tomato, wild tomato	X	+	-	+
STERCULIACEAE (Cacao family)					
Waltheria indica L.	'uhaloa, hi'aloa, kanakaloa	I?	+	-	+
VERBENACEAE (Verbena family)					
Lantana camara L.	lantana, lakana	X	-	+	-

Scientific name	Common name	Status	Vegetation type r	k	b
MONOCOTS					
POACEAE (Grass family)					
Bothricochloa pertusa (L.) A. Camus	pitted beardgrass	X	-	-	+
Cenchrus ciliaris L.	buffelgrass	X	+	+	+
Chloris barbata (L.) Sw.	swollen fingergrass, mau'ulei	X	+	+	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	-	-	+
Digitaria insularis (L.) Mez ex Ekman	sourgrass	X	-	+	-
Eragrostis cilianensis (All.) Link	stinkgrass	X	+	-	+
Eragrostis sp.		X	+	+	-
Melinis repens (Willd.) Zizka	Natal redtop, natal grass	X	+	-	+
Panicum maximum Jacq.	Guinea grass	X	+	+	+
Panicum maximum var. trichoglume Eyles ex Robyns	green panicgrass	X	-	+	-

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14 November 2003

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SUBJECT Red 'Ilima (Abutilon menziesii) Reconnaissance Survey
Kapolei Rezoning, 'Ewa, O'ahu

Dear Mr. Fee:

On 06 and 07 November 2003, a reconnaissance-level survey was made for the endangered red 'ilima or ko'oloa'ula (Abutilon menziesii) on the Kapolei zoning parcels. These are the approximate 469-acre parcel located west of Kalaeloa Boulevard (TMK 9-1-15:4) and the approximate 250-acre parcel located east of Kalaeloa Boulevard (TMKs 9-1-16:1, 121-124). Two smaller parcels located just north of Kapolei City, a ±14-acre parcel (TMK 9-1-16:30) and a ±25-acre parcel (TMK 9-1-16:34), were also inspected.

Botanical surveys were conducted by Nagata (1987) for 373 acres of the ±469-acre west parcel. Char & Associates (2003) recently completed a botanical study of the remaining ±96 acres. A biological survey of the ±250-acre east parcel was prepared by Char & Associates in 1986. During the 1986 and 1987 studies, the lands were actively cultivated for sugar cane (Saccharum officinarum). No threatened and endangered species or rare plants were found during these studies.

In 1996, however, Nagata discovered a population of the endangered red 'ilima on abandoned sugar cane fields mauka of Varona Village and the City and County's golf course, near Kalo'i Gulch. The "Kapolei population" of red 'ilima is found

on the proposed North-South Road and adjacent State-owned lands (University of Hawaii West Oahu, Department of Hawaiian Home Lands, Department of Land and Natural Resources). The State Department of Transportation has sponsored a Habitat Conservation Plan for all of the Abutilon menziesii plants on the Kapolei property (PBR Hawaii 2003).

Because of the occurrence of the red 'ilima on former sugar cane lands on the nearby Kapolei site, it was decided that a reconnaissance-level survey be made for the parcels covered in the earlier 1986 and 1987 studies.

Survey methods: Before the reconnaissance study was conducted, topographic maps and recent, colored aerial photographs (1" = 400') were examined to determine areas most likely to provide habitat for the red 'ilima. The "Kapolei population" is associated with the Kalo'i Gulch drainage and occurs on deep, loose soils. It tends to occur in those areas where the native subshrubs hoary abutilon (Abutilon incanum), 'ilima (Sida fallax), and 'uhaloa (Waltheria indica) are abundant.

All of the parcels can be easily accessed from the roadsides; a network of unpaved, crushed coral-lined roads cross the cane fields. These roads are elevated and provide a good platform for surveying the vegetation with the aid of binoculars. The vegetation on the majority of the parcels is very open and consists of dense mats of buffelgrass (Cenchrus ciliaris), 1 to 3 ft. tall, with scattered clumps of koa haole shrubs (Leucaena leucocephala), 3 to 6 ft. tall. Young trees of kiawe (Prosopis pallida), 12 to 20 ft. tall, occur as widely scattered individuals. However, on the east parcel, adjacent to an old quarry and just outside of the former Barbers Point Naval Air Station main gate, the kiawe trees are older and denser; an open to closed canopy forest is found here.

Findings: No red 'ilima plants were observed on the ±250-acre east parcel and the two smaller parcels. Most of these parcels have been disturbed by bulldozing in the past or, more recently, by nearby construction projects. It is common

to find exposed coral limestone substrate and big piles of coralline boulders throughout the parcels. Soils are especially thin on the ±250-acre parcel.

No red 'ilima plants were observed on the approximate 469-acre parcel west of Kalaeloa Boulevard. Much of this site has deep, reddish-brown soils ('Ewa series). A few small drainages cross the site; these support koa haole thickets and dense clumps of Guinea grass (Panicum maximum). Transects were made through the buffelgrass/koa haole scrub-covered areas adjacent to the drainageways. On the western portion of this parcel, below Honokai Hale and on the recently surveyed ±96-acre site, the substrate is primarily coralline material with much of this quarried in the past or graded.

If you have any questions regarding this report, please do not hesitate to contact me.

Sincerely,

Winona P. Char

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APPENDIX E
Avifaunal and Feral Mammal Survey
(Phillip L. Bruner)

Helber Hastert & Fee
Planners, Inc.

June 1, 2005

Mr. Phil Bruner, Environmental Consultant
BYUH Box 1774
55-220 Kulanui Street
Laie, Hawaii 96762-1294

Dear Phil:

Kapolei West Expansion Area
Kapolei, ʻEwa District, Oʻahu, Hawaiʻi

Thank you for your May 16, 2005 letter to Ms. Orr. Based on our discussions, I wanted to clarify that you have not personally observed the Pueo within the project site, or for that matter, are not aware of any other personal accounts of observing the Pueo on the project site. References in your letter to having "seen Pueo foraging in this area on three occasions… my most recent siting was in October 2004." were in reference to other sites in the `Ewa plain, not the project area.

Your point that the Pueo "could forage" in the area is noted and has been added to the FEIS.

Sincerely,

HELBER HASTERT & FEE, Planners

Thomas A. Fee, AICP
President

Pacific Guardian Center • 733 Bishop Street, Suite 2590 • Honolulu, Hawaii 96813
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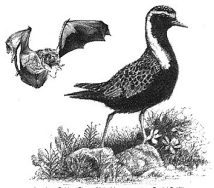

American Golden-Plover (Kolea) image courtesy Daniel S. Kilby
© Bat Conservation International, Inc.

Faunal Surveys

Bird & Mammal

16 May 2005

Corlyn Olson Orr
Helber Hastert & Fee
Pacific Guardian Center, Makai Tower
733 Bishop Street, Suite 2590
Honolulu, HI 96813

SUBJECT: Letter report for Kapolei West Expansion Area

At your request I carefully reviewed the previous faunal studies you provided. These investigations included Andrew Berger's Birds of West Beach, conducted in 1978/1979 and my survey of the avifauna and feral mammals at the proposed Campbell Commercial – Industrial Site, at Ewa, Oahu (1989). In addition, I reviewed the findings of other faunal surveys I have conducted in similar habitats in this region of Oahu (1988, 1989, 1990a, 1990b, 1991, 1993, 1994, 1995, 2000, 2002, 2003, 2005).

Berger's report contains much life history information and addresses conservation concerns. The common (vernacular) names of some of the birds in his report were changed in the 1980's. Likewise there have also been changes in the taxonomy of scientific names (e.g. *Pluvialis dominica fulva* to *Pluvialis fulva* and *Estrilda troglodytes* to *Estrilda astrild*). Despite the fact that this study is more than 25 years old it is still relevant. My 1989 faunal survey of a proposed commercial – industrial site at Ewa uses the common (vernacular) and scientific names employed in current publications. Relevant abundance estimates based on the protocol of eight minute circular plot counts were obtained in my 1989 study. These data are similar to that obtained in other studies I have conducted in similar habitat in west Oahu (see studies noted above). Both Berger and I mention that although the endangered Hawaiian Owl or Pueo (*Asio flammeus sandwichensis*) was not recorded on the surveys they could forage at this location. I have seen Pueo foraging in this area on three occasions in the past five years. My most recent sighting was in October 2004. This bird is listed as endangered on Oahu by the State of Hawaii. The statement in the draft EIS for the Kapolei West Expansion Area (4.8.1) paragraph two line 3,4) "no endemic, rare, or endangered species of wildlife and no suitable feeding or breeding of such species exist within the Petition Area" is likely to be incorrect. Pueo do forage (feed) in this area. They nest on the ground in tall grass habitats and may nest or have nested in this area. In addition, the migratory Pacific

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Phone: (808) 293-3820 • Fax: (808) 293-3825

Golden-Plover does forage in open fields in this region of Oahu. They are protected under the Migratory Bird Treaty Act.

In conclusion, the two studies you cite (Berger 1979 and Bruner 1989) provide a good overview of the fauna that occurred in this region during that period of time. A faunal survey today would likely record a similar array of alien species. I recommend that you revise your statements concerning endangered wildlife to account for the possibility of the endangered Pueo foraging and perhaps nesting in this area.

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APPENDIX D

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS AT THE PROPOSED CAMPBELL COMMERCIAL-INDUSTRIAL SITE, EWA, OAHU

Prepared for

William E. Wanket Inc.

by

Phillip L. Bruner
Assistant Professor of Biology
Director, Museum of Natural History
BYU-H
Laie, Hawaii 96762

28 August 1989

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS AT THE PROPOSED CAMPBELL COMMERCIAL-INDUSTRIAL SITE, EWA, OAHU

INTRODUCTION

The purpose of this report is to summarize the findings of a three day (27 July, 5, 18 August 1989) bird and mammal field survey at the proposed Campbell Commercial-Industrial Site, Ewa, Oahu (see Fig. 1). Also included are references to pertinent literature as well as unpublished reports.

The objectives of the field survey were to:

1- Document what bird and mammal species occur on the property or may likely occur given the range of habitats available.

2- Provide some baseline data on the relative abundance of each species.

3- Supplement these findings with published and/or unpublished data.

4- Evaluate the possible changes that might occur in the bird and mammal populations following the proposed development on the property.

GENERAL SITE DESCRIPTION

The proposed project property is located on the west shore of Oahu at Campbell Industrial Park (see Fig. 1). The site presently contains sugar cane fields, scrubby second growth patches of vegetation and some urban facilities ie. auto racing park, nursery and land fill dumping. The overall habitat could best be described as dry parkland and cultivated fields. Aside from sugar cane the dominant plants in the area are: Kiawe (Prosopis pallida) and Koa Haole (Leucaena leucocephala).

Weather during the field survey was generally clear mornings with occasional cloudy periods in the afternoons. Winds were NE trades.

STUDY METHODS

Field observations were made with the aid of binoculars and by listening for vocalizations. These observations were concentrated during the peak activity periods of early morning and late afternoon. Attention was also paid to the presence of tracks and scats as indicators of bird and mammal activity.

At various locations (see Fig.1) eight minute counts were made of all birds seen or heard. Between these count stations

walking tallys of birds seen or heard were also kept. These counts provide the basis for the population estimates given in this report. A special effort was made to census the specific area of the property designated as a "drainage ditch" (Fig.1). Data from this sector are reported separately in Table 1 of results.

Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative abundance and distribution.

Scientific names used herein follow those given in the most recent American Ornithologist's Union Checklist (A.O.U. 1983), Hawaii's Birds (Hawaii Audubon Society 1984), Field Guide to the Birds Hawaii and the Tropical Pacific (Pratt et al. 1987), Mammal species of the World (Honacki et al. 1982) and Hawaiian Coastal Plants (Merlin 1980).

RESULTS AND DISCUSSION

Resident Endemic (Native) Land Birds:

No endemic land birds were recorded during the course of the field survey. The only likely endemic species which might occasionally forage in the area are the Hawaiian Owl or Pueo (Asio flammeus sandwichensis) and the Hawaiian Stilt (Himantopus mexicanus knudseni). Pueo are diurnal and can be found in upland

forest as well as lowland grasslands and agricultural fields. Stilt are opportunistic and will forage in flooded fields where they search for invertebrate prey. This site apparently was inhabited by a variety of endemic birds in the past given the fossil evidence recovered from the "sink-holes" located on the makai protions of the property (pers. comm. A. Ziegler-zoologist formerly with the Bishop Museum, Honolulu.

Resident Indigenous (Native) Birds:

No resident indigenous land birds were recorded. The only potential species is the Black-crowned Night Heron (Nycticorax nycticorax). This species is opportunistic and may forage in flooded ditches and other temporary wet areas when such are available on the property.

Resident Indigenous (Native) Seabirds:

Seabirds typically nest on offshore islands which are free from disturbance by dogs, cats, mongooses and rats. However, there are areas on the main islands were predators lack access and nesting can be successful (Bruner 1988). Fossil evidence indicates seabirds have occurred on the property in the past (pers. comm. A. Ziegler). No seabirds were found during the survey and it is unlikely any would nest at this site due to an abundance of predators. Seabirds such as the Great Frigatebird (Fregata minor) may be seen overhead.

Migratory Indigenous (Native) Birds:

Only one species of migratory shorebird was found during the survey - Pacific Golden Plover (Pluvialis fulva). Plover are probably the most common migratory species in Hawaii. They prefer open areas such as mud flats, fields and lawns. Plover arrive in Hawaii in early August and depart to their arctic breeding grounds during the last week of April. Johnson et al. (1981) and Bruner (1983) have shown plover are extremely site-faithful on their wintering grounds and many establish foraging territories which they vigorously defend. Such behavior makes it possible to acquire a fairly good estimate of the abundance of plover in any one area. These populations likewise remain relatively stable over many years. A total of ten plover were recorded, all on the final day of the survey. Time did not permit a determination of how many of these plover were territorial residents and how many were passing through the area on their migration further south. The only other likely migratory species that may occur on the property is the Ruddy Turnstone (Arenaria interpres).

Exotic (Introduced) Birds:

A total of 17 species of exotic birds were found during this field survey. Table 1 shows the species recorded on this survey and their relative abundance. The most abundant species were Zebra Dove (Geopelia striata), Red-vented Bulbul (Pycnonotus

cafer), Japanese White-eye (Zosterops japonicus), Chestnut Mannikin (Lonchura malacca) and Nutmeg Mannikin (Lonchura punctulata). Exotic species not recorded on the actual survey but which potentially could occur at this locality include: Japanese Bush-warbler (Cettia diphone) and Ring-necked Pheasant (Phasianus colchicus). The habitat is probably too dry for White-rumped Shama (Copsychus malabaricus) and too open for Melodious Laughing-thrush (Garrulax canorus). The abundance and wide variety of finch and finch-like birds at this site is due to the dry brushy/grassy habitat which these species prefer.

Red-vented Bulbul have become one of Oahu's most abundant species in recent years. The adaptability of this species to a wide variety of habitats and its remarkable population increase have been well documentd (Williams 1983, Williams and Giddings 1984, and Williams and Evenson 1985).

Java Sparrow (Padda oryzivora) have also experienced a population increase and expansion in recent years (Pratt et al. 1987). Their occurrence at this site was not unexpected.

Feral Mammals:

The only feral mammals observed during the survey were cats and the Small Indian Mongoose (Herpestes auropunctatus). Without a trapping program it is difficult to conclude much about the relative abundance of rats, mice, cats and mongooses at this site, However, it is likely that their numbers are typical of what one would find elsewhere in similar habitat on Oahu.

Records of the endemic and endangered Hawaiian Hoary Bat (Lasiurus cinerus semotus) are sketchy but the species has been reported from Oahu (Tomich 1986). None were observed on this field survey. However, bats have been observed in urbanized habitat elsewhere in Hawaii (Bruner 1985).

CONCLUSION

A brief field survey can at best provide a limited perspective of the wildlife present in any given area. Not all species will necessarily be observed and information on their use of the site must be sketched together from brief observations and the available literature. The number of species and the relative abundance of each species may vary throughout the year due to available resources and reproductive success. Species which are migratory will quite obviously be a part of the ecological picture only at certain times during the year. Exotic species sometimes prosper for a time only to later disappear or become a less significant part of the ecosystem (Williams 1987). Thus only long term studies can provide the insights necessary to acquire a complete understanding of the bird and mammal populations in a particular area. However, when brief studies are coupled with data gathered from other similar studies the value of the conclusions drawn are significantly increased.

The following are some broad conclusions related to bird and mammal activity on this property:

1- The present environment provides a limited range of habitats which are utilized by the typical array of exotic birds one would expect at this elevation and in this type of environment on Oahu.

2- Doves and finches could decline in abundance as a result of habitat changes brought about by the proposed development. House Sparrows (Passer domesticus) and Common Myna (Acridotheres tristis) should increase in abundance following urbanization.

3- In order to obtain more data on mammals, a trapping program would be required. The brief observations of this survey did not reveal any unusual mammal activity.

4- The section of the site designated for a drainage canal was specifically censused throughout its entire length and did not contain any unusual or distinctive habitat nor did the fauna found in this area differ significantly from that recorded elsewhere on the property.

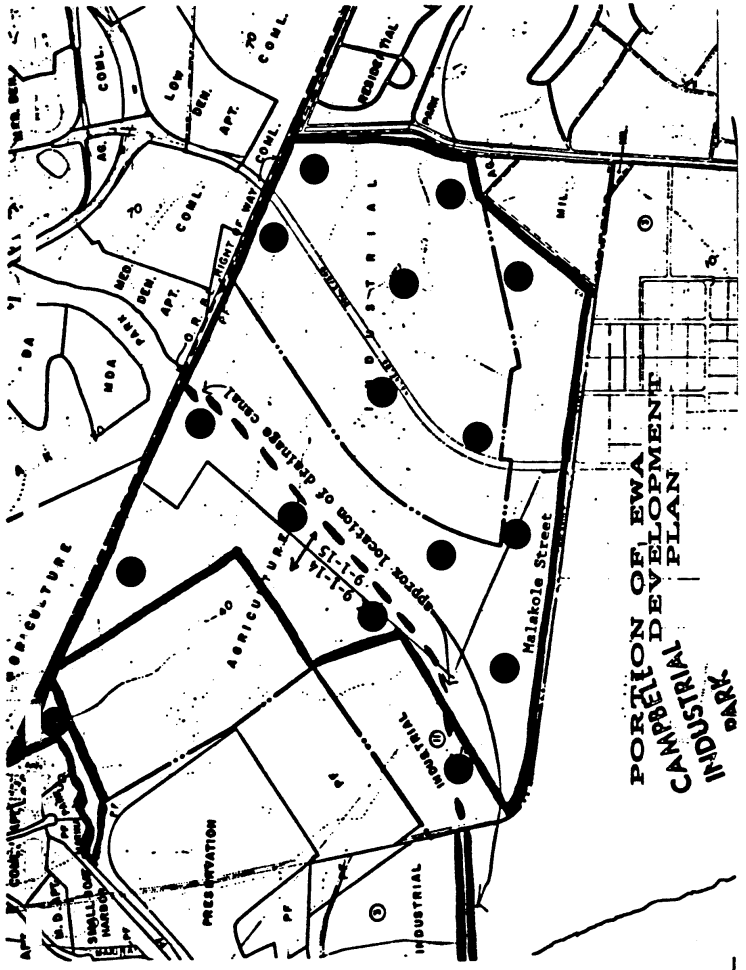

Fig. 1 Project site with eight minute census stations indicated by solid circles.

TABLE 1

Relative abundance of exotic birds at the Campbell Commercial-Industrial Site, Ewa, Oahu.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE*	
		Sector 1	2
Barn Owl	Tyto alba	R= 1	-
Cattle Egret	Bubulcus ibis	R= 1	-
Spotted Dove	Streptopelia chinensis	U= 4	U= 4
Zebra Dove	Geopelia striata	A= 16	A=12
Common Myna	Acridotheres tristis	U= 2	U= 3
Red-vented Bulbul	Pycnonotus cafer	A= 15	A=11
Northern Mockingbird	Mimus polyglottos	-	R= 1
Northern Cardinal	Cardinalis cardinalis	U= 2	U= 2
Red-crested Cardinal	Paroaria coronata	U= 3	U= 2
Japanese White-eye	Zosterops japonicus	A= 10	A=12
House Sparrow	Passer domesticus	U= 2	C= 6
House Finch	Carpodacus mexicanus	C= 7	C= 8
Java Sparrow	Padda oryzivora	R= 6	-
Red Avadavat	Amandava amandava	U= 4	U= 2
Common Waxbill	Estrilda astrild	C= 5	U= 4
Chestnut Mannikin	Lonchura malacca	A= 10	C= 6
Nutmeg Mannikin	Lonchura punctulata	A= 15	A=11

* (see page 12 for key to symbols)

KEY TO TABLE 1

Relative abundance = number of individuals observed during walking survey or frequency on eight minute counts in appropriate habitat.

A= abundant (10+) on 8 min. counts

C= common (5-10) on 8 min. counts

U= uncommon (less than 5) on 8 min. counts

R= recorded but not on 8 min. counts (number which follows is the total recorded over the course of the entire survey)

Sector= region of property

1= overall site minus the census data from the drainage ditch sector.

2= census data from proposed drainage ditch area only.

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May 12, 1984

Mr. F. J. Rodriguez, President
Environmental Communications, Inc.
P.O. Box 536
Honolulu, HI 96809

Dear Mr. Rodriguez:

Following is a summary of my studies of the birds of West Beach, Oahu.

I studied (12 field days) all habitats in the West Beach area during the fall of 1973 (October 27 to November 18, 1973); I repeated my study during April and May 1979; and on October 3, 1979, I visited the area with Ms. Jenny Peterson in order to identify sinkholes in the limestone formation there.

During this field work, I identified 14 species of exotic or introduced birds. None of these is an endangered species, and several have proven to be serious pests on agricultural crops in the Hawaiian Islands. Moreover, most of these species adapt well to both urban and rural areas. The proposed construction at the West Beach site will have no adverse effects on any of these introduced birds.

I found only two species of migratory shorebirds: the Golden Plover (Pluvialis dominica fulva) and the Wandering Tattler (Heteroscelus incanum). Neither are endangered species and both are common winter residents in the islands. The plover is an abundant winter resident, being found on the lawn around the State capitol building, as well as in mountain pastures. The tattler frequents beaches and tidal pools. The proposed construction will have no adverse effects on either of these migratory birds.

The Pueo or Hawaiian Owl (Asio flammeus sandwichensis) is now classified as an "endangered" species by the State Division of Forestry and Wildlife (although not by the Federal Fish & Wildlife Service). It is possible that it forages over the West Beach area although I did not see any during my field studies in 1973 or 1979. The owl prefers grassland areas and not sugarcane fields or kiawe thickets at low elevations. Therefore, it is my opinion that the proposed construction will not impact adversely on the Pueo.

There are no suitable ponds, marshes, or other wetland areas in the West Beach area to accomodate any of the endemic Hawaiian waterbirds. Hence, they are not found in this region. Similarly, there is no habitat for the endangered Hawaiian forest birds.

Sincerely, A. J. Berger

Andrew J. Berger
1349 Kainui Drive
Kailua, HI 96734

BIRDS OF WEST BEACH

Region Follow-up Report
April-May 1979

Ewa, Oahu

Revised August 27, 1979

Report by:
Andrew J. Berger

TABLE OF CONTENTS

Section	Page
Birds of the West Beach Area	1
The migratory shorebirds	1
Family Charadriidae, Plovers, Turnstones, Surfbirds	2
Family Scolopacidae, Woodcock, Sandpipers, Curlews	2
Introduced birds	2
Family Ardeidae, Herons and Egrets	2
Family Columbidae, Pigeons and Doves	2
Family Sturnidae, Starlings and Mynas	3
Family Zosteropidae, White-eyes	4
Family Ploceidae, Weaverbirds and Their Allies	4
Family Fringillidae, Sparrows, Cardinals, and Buntlings	6
Discussion and Conclusion	7
Literature Cited	9
Figure	
1	11
ADDENDUM	12

This report updates the information given in my November 1973 study of the birds found in the West Beach Region of Oahu. I am familiar with the dominant exotic plants found in dry habitats in Hawaii and discussed them in relationship to the birds in the 1973 report. At this time, however, the plants are being studied by a botanical consultant. I found only the same bird species given in my November 1973 report. A discussion of these follows. The sequences of bird families follows Van Tyne and Berger (1976).

Birds of the West Beach Area. Two general groups of birds are found in the West Beach area: migratory shorebirds and introduced or exotic species. It is possible that the Hawaiian Owl or Pueo (Asio flammeus sandwichensis) occurs in the dry leeward regions but I did not see any during my study, either in 1973 or 1979. The scant native vegatation in the dry leeward areas of Oahu was destroyed so long ago that there are no records of any other endemic landbirds that may have occupied such habitat, that is, prior to 1786 (Berger 1972; Charles H. Lamoureux, personal communication). There are no suitable ponds or marshes in the West Beach area to accommodate the endemic Hawaiian water birds.

I made an intensive study (12 field days) of all habitats in the West Beach area during the fall of 1973. The nesting season had ended for most species and they were quiet and inconspicuous. Under such conditions it is not possible to estimate accurately the numbers of birds per square mile or other unit of measurement; numbers given would be sheer guesses. During April and May of 1979, I stopped the field work after four days because I found no species that I had not identified during 1973. All but two of these species (Golden Plover and Wandering Tattler) are exotic birds that have been introduced to the Hawaiian Islands. The West Beach area contains several diverse habitats (e.g., shoreline, kiawe thickets, sugarcane fields) so that an estimate of abundance (other than rare, uncommon, common, and abundant) of most species would be misleading because few of the species are of any concern in relationship to the Endangered Species Act of 1973 (16 U.S.C. §1531 et seq, 1974) and some of these species have, in the past, caused considerable damamge to agricultural crops in Hawaii, and, therefore, often are serious nuisance birds. I do plan to do further field work at the West Beach site as soon as information on sink holes is provided by the Archaeology consultant.

On all field trips, transects were walked slowly in all major habitats (e.g., shoreline, kiawe thickets, cane roads); I recorded in a field notebook the species seen or heard as well as their particular activity at the time (e.g., feeding, singing, perching quietly, flying, etc.). This made it possible to estimate relative abundance of each bird species. Map 1 shows the transects I studied.

The migratory shorebirds. These are birds that spend the breeding season in Alaska (and/or Siberia) and then migrate to Hawaii for the nonbreeding season. I observed only two such species in the West Beach area, both in very small numbers.

Family Charadriidae, Plovers, Turnstones, Surfbirds

1. Pacific Golden Plover (Pluvialis dominica fulva). This is a very common winter resident in the Hawaiian Islands, being found from sea level to approximately 10,000 feet elevation on Maui and Hawaii. It inhabits pastures, golf courses, city lanes, cutover sugarcane fields, and other disturbed or weedy areas. The cutover cane fields at West Beach were very dry on most visits during the period of my 1973 study, and I never saw more than six Golden Plover on any one day. During 1979, cane of different ages was growing in the several fields, and thus did not provide suitable habitat for the plovers, and I saw none. Moreover, the bulk of the wintering plovers leave Hawaii for the breeding grounds before May 2.

Family Scolopacidae, Woodcock, Sandpipers, Curlews

2. Wandering Tattler (Heteroscelus incanum). This shorebird breeds in Alaska and northwestern British Columbia, flying south to Hawaii and other Pacific islands for the nonbreeding season. I saw only one or two birds during each of my visits to the ocean shore, the birds being found in both sandy and rocky beach areas in 1973 and 1979.

Introduced birds. More than 160 different species of exotic birds have been introduced to the Hawaiian Islands since about 1800 (Berger, 1972). The dry leeward regions of the islands provide excellant habitat for a number of these foreign birds, and at least 14 species are found in the West Beach area.

Family Ardeidae, Herons and Egrets

1. Cattle Egret (Bubulcus ibis). This species was imported to Hawaii from Florida to aid "in the battle to control house flies, horn flies, and other flies that damage hides and cause lower weight gains in cattle" (Breese, 1959). A number of Cattle Egrets were released on Oahu in 1959 and 22 additional birds were released July 1961. Thistle (1962) reported that the population of Egrets on Oahu exceeded 150 birds by July 1962; the population has continued to increase since that time. In addition to their propensity for feeding near cattle, Cattle Egrets often feed in alfalfa fields and in plowed cane fields (the latter especially in the Pearl Harbor area). I saw three Cattle Egrets in flight over the cane fields on November 2 (8:45 p.m.) and two birds on November 11 (4:30 p.m.), 1973.

Family Columbidae, Pigeons and Doves

2. Spotted or Chinese Dove (Streptopelia chinensis). This Asian dove was introduced to the Hawaiian Islands at an early date; the exact date is unknown, but the birds are said to have been very common on Oahu by 1879. The species is now common on all the islands and is classified as a game bird. This dove is also called the Lace-necked Dove because of the conspicuous band of

the neck. Although this species occurs where rainfall exceeds 100 inches per year, the highest densities are found in drier areas where the introduced kiawe (mesquite) is one of the dominant plants. Schwartz and Schwartz (1949), for example, found densities as great as 200 birds per square mile in dry areas on Molokai. I would estimate densities between 50 and 100 birds per square mile in the West Beach area. The largest concentration of birds occurs in the kiawe thickets and the weedy borders and roads around them. The diet, as determined by examining crop contents of 91 birds, was found by the Schwartzes to consist of 77 percent weed seeds and about 23 percent fruits; animal matter was "almost negligible." Tapeworm parasitism was found to be heavy, however, indicating that the small amount of animal matter eaten by the doves was important in contracting the parasities.

3. Barred Dove (Geopelia striata). This species also is called the Zebra Dove in its native habitat in the Orient and Australia. This species is said to have been introduced to Hawaii sometime after 1922 (Bryan, 1958). It is now common to abundant on all of the main islands in the chain. The Barred Dove also prefers the drier areas where weed seeds are abundant. Schwartz and Schwartz (1949) reported densities as great as 400 to 800 birds per square mile in some areas on Oahu (e.g., from Barbers Point to Makaha) and Molokai in 1947. The Barred Dove is probably the most abundant species in the area, so that populations could well exceed 400 birds for square mile at this time. The Barred Dove also is classified as a game bird in Hawaii. One study of the food habits of the Barred Dove in Hawaii revealed that the diet consists of 97 percent seeds and other plant matter; the 3 percent animal matter include several species of beetles, weevils, and wireworm larvae. The Schwartzes emphasized that even though the Spotted Dove and the Barred Dove are both predominantly seed eaters, they do not compete for food because "only one plant occurred as more than 2 percent by volume in the diet of both birds. This one, uhaloa, occurs in great abundance throughout most dove range and is more than ample to supply the needs of both species of doves," as well as those of several species of other game birds (e.g., quail, pheasant) in Hawaii.

Family Sturnidae, Starlings and Mynas

4. Common Myna (Acridotheres t. tristis). The Common Myna which is native to Ceylon, India, Nepal, and adjacent regions. was introduced from India in 1865 by Dr. William Hillebrand to combat the plague of army worms that was ravaging the pasture lands of the islands. It has spread and multiplied to an amazing extent; reported to the abundant in Honolulu in 1879, it is now extremely common throughout the Territory" (Caum, 1933). The Myna is still common to abundant in lowland areas of the inhabited islands, being most common in residential and urban areas as well as in the vicinity of human habitation in rural areas. Mynas occur as birds of passage in the cane fields, and they undoubtedly nest in palm trees and other sites around the Campbell homestead along the beach; I saw a few birds along the edges of kiawe thickets and a

flock of 23 birds in a plowed cane field (November 11, 1973). On April 28 and during May 1979, the birds were conspicuous in the vegetation along the shore, especially.

Family Zosteropidae, White-eyes

5. Japanese White-eye (Zosterops j. japonicus). Long a favorite cage bird in the Orient, Caum (1933) wrote that the Japanese White-eye was first imported from Japan to Oahu by the Territorial Board of Agricultural and Forestry in 1929. Later importations were made by the Hui Manu and private individuals. The White-eye rivals the House Sparrow and the European Starling as a successful exotic species, and the White-eye is now undoubtedly the most common bird species in Hawaii (Berger, 1972). It is found from sea level to tree line (on Maui and Hawaii) and it is found in the driest and the wettest areas in the Hawaiian Islands. The White-eye is ubiquitous in the West Beach area, feeding in the cane fields and feeding and nesting in the kiawe thickets and other vegetation. The breeding season on Oahu extends from February to August. I did not hear any singing during October and November, but the birds were conspicuous by their callnotes; I found several old nests in kiawe trees. Singing birds were conspicuous during April and May 1979.

Family Ploceidae, Weaverbirds and Their Allies

This is a large family of birds, predominantly Old World in distribution; the best known example in Hawaii is the House Sparrow (Passer domesticus). However, since 1965 more than 15 different species of this family have been intentionally or accidentially released on Oahu (Elepaio, 26, 1966:79; 33, 1973:81-82). Some of these species obviously have become established as breeding birds and are spreading in distribution (Berger, 1972).

6. Orange-cheeked Waxbill (Estrilda melpoda). This weaverbird was first reported in the wild in Hawaii (on the slopes of Diamond Head) on January 2, 1966, during the annual Christmas count of the Hawaii Audubon Society (Elepaio, 26, March 1966, pp. 77-81). The species has been reported annually in the same area by the Audubon Society (Elepaio, 33, February 1973, pp. 77-86). The species apparently has not been reported outside of the Diamond Head-Kapiolani Park region previously. I saw one Orange-cheeked Waxbill at the edge of a cane field (perched on cane) along Malakole Road on November 2, 1973. There may have been more birds, but the waxbills have a habit when disturbed of dropping suddenly downward into the depths of the cane and out of sight, thus making positive identification very difficult or impossible.

7. Red-eared Waxbill (Estrilda troglodytes). This species (also called the Black-rumped and Common Waxbill) has the same history as the Orange-cheeked Waxbill: first reported at Diamond Head on January 2, 1966, and seen annually there since that time. I have not found any published records of the distribution of this species in other parts of Oahu. On November 7, 1973, I watched

a flock of between 20 and 25 birds feeding on grass seeds in a gully at the edge of a cane field. This suggests that a breeding population is established in the West Beach area. I saw small flocks on all other visits to the cane fields. As seed eaters, both species of waxbills constitute a threat to any grain crops that might be comtemplated on Oahu.

8. Strawberry Finch (Amandava amandava). Caum (1933) wrote that "it is not known with certainty just when these birds came to Hawaii, but it was probably sometime between 1900 and 1910. Many were imported as cage birds during this period and it is supposed that the present population is derived from individuals escaped from captivity." One of the puzzling features about the Strawberry Finch is that it appeared not to extend its range over a long period of time. Ord (1967), for example, wrote that the Strawberry Finch "can usually be found near grassy open areas around sugar-cane fields ... in the lowlands about Pearl Harbor." I know of no reports of the species having been seen in any other part of Oahu. However, on November 4, 1973, I saw two birds at the edge of a cane field along Malakole road; I also saw two birds in the same area on November 18.

9. Ricebird or Spotted Munia (Lochura punctulata). This Asian species was released in Hawaii by Dr. William Hillebrand about 1865 (Caum, 1933). Caum wrote that the Ricebird "feeds on the seeds of weeds and grasses and does considerable damage to green rice." Rice is no longer grown in Hawaii, but the Ricebird has recently become a serious pest by eating the seeds of sorghum, as already mentioned. The Ricebird is another abundant species on all of the inhabited islands, and it is tolerant of both very dry and very wet habitats. It is an abundant species in the West Beach area, and the birds spend much time eating the seeds of grasses and other plants along the edges of and within the cane fields. The birds also inhabit the kiawe thickets and adjacent disturbed areas.

10. Black-headed Mannikin (Lonchura malacca atricapilla). This is another Asian species that has long been a popular cage bird. The species apparently was first reported breeding in the wild by Udvardy (1960), who observed 10 adults and 15 juveniles birds near West Loch, Pearl Harbor, on April 26, 1959. Ord (1967) reported that the species was abundant "in open grassy areas around Middle and West Lochs of Pearl Harbor." Donaghho (1967) reported that he observed this species along the road to Palehua at the southern end of the Waianae Mountains in 1967. I saw three small flocks of Black-headed Mannikins on November 4, 1973, along the edge of a cane field. This species has a notable habit of flushing rapidily, flying upward, and then dropping downward quickly into the cane, where it is impossible to see the birds. I saw at least 12 birds in full adult breeding plumage on November 18. Many birds in immature plumage (all brown feathers) were seen during earlier visits to the area, and, on November 11, I watched that presumably was a family group consisting of one adult, two immature birds showing incoming black feathers on the

breast and belly, and two birds in the brown juvenile plumage. I saw both adult and juvenile birds in 1979.

11. House Sparrow (Passer domesticus). The House Sparrow (also erroneously called the English Sparrow) was first imported to Oahu in 1871 when nine birds were brought from New Zealand (where the species had previously been introduced from England). Caum (1933) wrote that "whether or not there were further importations is not known, but the species was reported to be numerous in Honolulu in 1879." The House Sparrow in North America (first introduced to Brooklyn, New York, in 1852) became a serious pest, and tens of thousands of dollars were spent in attempting to control the population. The House Sparrow apparently never became a serious pest in Hawaii; it is omnivorous in diet, eating weed seeds as well as insects and their larvae. House Sparrows are found around the houses as well as in the kiawe thickets, both inland and along the shore.

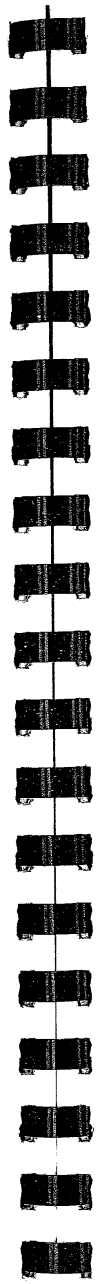
Family Fringillidae, Sparrows, Cardinals, and Buntings

12. Red-crested Cardinal (Paroaria coronata). This species traditionally has been called the Brazilian Cardinal in Hawaii, but the native range includes Uruguay, Paraguay, Brazil, and parts of Bolivia and Argentina. This species was released in Hawaii on several occasions between 1928 and 1931 (Caum, 1933). The Red-crested Cardinal is a common species in urban and residential areas as well as in the introduced vegetation in the leeward areas of Oahu. One of the interesting features of the West Beach area is that both species of cardinals occupy the same habitats and appear to be present in about equal numbers.

    There was very little irrigation water on November 18, and several species collected to bathe and drink in the small trickle of water in a ditch along Malakole Road. For about a half hour at midday, I watched the following species using the water: Red-crested Cardinal, Ricebirds, Black-headed Mannikin, and Red-cheeked Waxbill. The two Strawberry Finches were in the cane nearby, but they did not go to the water when I was watching.

    During my 1979 field work, the Red-crested Cardinal were even more conspicuous because of the territorial songs given by the males. Juvenile birds, with brown heads, were seen in several areas, as well.

13. Cardinal (Cardinalis cardinalis). This species has been given a number of vernacular names: e.g., Virginia Cardinal, Kentucky Cardinal. Its native range is the eastern part of mainland United States east of the plains and northward into Ontario. The Cardinal was released several times in Hawaii between 1929 and 1931 (Caum, 1933). The species is fairly common in some lowland areas, and is a characteristic bird of the leeward parts of Oahu, finding the dry introduced vegetation (kiawe, koa haole, etc.) suitable habitat for its annual cycle. The birds visit the edges of cane fields but spend most of their time in the kiawe areas and the vegetated areas along the shore.



14. House Finch (Carpodacus mexicanus frontalis). Also known as the Papayabird in Hawaii, the House Finch was introduced from California "prior to 1870, probably from San Francisco" (Caum, 1933). The House Finch is now an abundant species in both urban and rural areas on all of the islands, and probably is the second most common land bird species in Hawaii now. Although House Finches eat overripe papaya and other soft fruits at times, the species is predominantly a seed eater. House Finches and Ricebirds caused a great deal of damage to the experimental sorghum crops planted on Kauai and Hawaii during 1971-1972. "A report by the Senate Committee on Ecology, Environmental and Recreation says rice birds and linnets caused a 30 to 50 percent loss in the sorghum fields at Kilauea on Kauai last year. ... seed-eating birds at Kohala ate about 50 tons of sorghum grain in a 30-acre experimental field that was expected to produce 60 tons" ("Honolulu Advertiser," March 14, 1972, p. B-2). Senate Bill No. 1603-72 appropriated $25,000 to the Department of Agriculture "for the establishment of a system of protection and control of wildlife on the islands of Hawaii, Maui, Lanai, Molokai, and Kauai." The seriousness of the problem was outlined in a statement on Senate Bill No. 1603-72 by Mr. Fred Erskine, Chairman of the Department of Agriculture. Although I have seen no official report on the results of this initial control program, the unofficial report is that it was not very successful.

    The House Finch is an abundant species in the West Beach area. During the nonbreeding season in 1973, flocks varying from 25 to 50 birds were not uncommon. Even during the breeding season (April and May 1979), I saw several flocks of 20 or more birds. The birds feed in and along the edges of the cane fields as well as in virtually all other habitats in the area.

Discussion and conclusion. The portion of the West Beach Area that is proposed for development can be classified as an extensively disturbed habitat with no remaining endemic ecosystems. The vast majority of the dominant and subdominant plants (trees, shrubs, vines) consist of more than two dozen introduced species (a detailed discussion of all plant species is given in the "Botanical Survey of the Proposed West Beach Resort Project," by Winona P. Char). The major plant association include sugarcane fields, kiawe thickets, and vegetation (both aquatic and terrestrial) of the shoreline. Numerous species of introduced shurbs and vines grow along cane roads and the edges of the sugarcane fields and the kiawe thickets. These introduced plant species do not provide suitable habitat for the endemic Hawaiian birds (with the possible exception of the Hawaiian Owl, a species not classified as threatened or endangered). As a result, all permanent resident bird species are introduced species. The introduced birds consist of 14 species belonging to six bird families. When compared with the mainland United States, this represents a depauperate bird fauna. As pointed out earlier, some of these species have caused serious damage to agricultural crops in the past and several other seed eaters have the potential of doing so in the future. At the same time, some species (e.g., doves, myna, white-eye, cardinals) give pleasure to many people who enjoy seeing birds around their homes; if the introduced birds were not here, the lowland areas would be virtually devoid of birds most of

the year. In additiona, mynas, white-eyes, and cardinals eat insects and their larvae, and, therefore, are beneficial during at least part of their annual cycle.

There are no publications on the distribution, breeding biology, parasites and diseases, or interrelationships of any introduced bird species on an island-wide basis for any of the Hawaiian Islands. Two-year studies of the breeding biology of three species (Common Myna, Japanese White-eye, House Finch) have been confined to the Manoa campus of the University of Hawaii. Most of the published reports on the distribution and spread of introduced birds are my own (Berger, 1974, 1975a, 1975b, 1975c, 1975d, 1975e, 1976, 1977a, 1977b).

There have been no published studies for Hawaii that report on habitat modification and the resultant change in species' abundance. Therefore, one must use his own knowledge and experience in Hawaii gained over the past 15 years to predict the possible changes that would occur in the West Beach area because of the proposed development there. Most of the introduced bird species found in the West Beach area have a wide distribution on Oahu, being found in residential, urban, and rural regions; none are deep forest birds; they are adapted to live in close association with man. A mature sugarcane field does not provide much suitable habitat for any of the introduced species. Consequently, if the cane fields are converted to residential and recreational (e.g., a golf course) use, there will be more available habitat for the introduced bird species and I would anticipate an increase in the populations for nearly all of them. Because all of the birds are introduced species (and some have been pests), however, it appears to me that it would not be of significance whether changes in the habitat resulted in an increase, a decrease, or no change in the populations.

My conclusion is that the proposed West Beach Development Project will have absolutely no deleterious affect on any endemic Hawaiian bird, that it will not affect the few species of winter visitants (Tattler and Golden Plover) to Hawaii, and will have no significant ecological impact on the 14 species of introduced bird species that are known to inhabit the region. The Golden Plover is a common winter resident that finds golf courses and lawns (even at the State Capitol Building) to be excellent habitat during the winter months; the Tattler prefers the shoreline and can be found along rocky and sandy shores in the Waikiki region despite the number of people on the beaches; therefore, development at West Beach should not affect this species adversely.

With regard to the fossil bird bones found near Barber's Point, I will submit an addendum to this report after the archaeologists have completed their work at the proposed West Beach Development Project.

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----- 1975b. The Mockingbird on Hawaii Island. Elepaio, 35:139.

----- 1975c. The Java Sparrow in Hawaii. Elepaio, 36:14-16.

----- 1975d. Red-whiskered and Red-vented Bulbuls on Oahu. Elepaio, 36:16-19.

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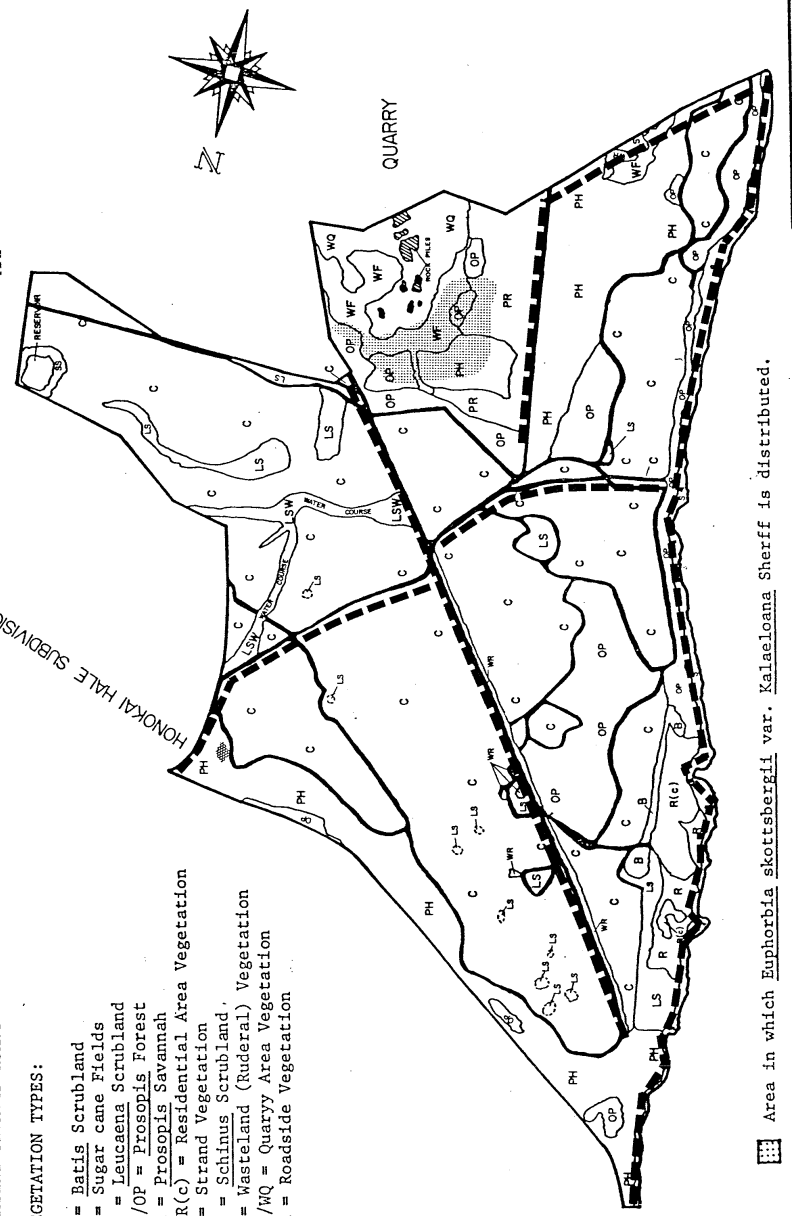
FIGURE 1. BIRD TRANSECTS ON VEGETATION BASE MAP



HEAVY LINES INSIDE THE PROJECT SITE INDICATES PRESENT UNPAVED ROADS

VEGETATION TYPES:

B = Batis Scrubland
C = Sugar cane Fields
LS = Leucaena Scrubland
PH/OP = Prosopis Forest
PR = Prosopis Savannah
R/R(c) = Residential Area Vegetation
S = Strand Vegetation
SS = Schinus Scrubland
W = Wasteland (Ruderal) Vegetation
WF/WQ = Quaryy Area Vegetation
WR = Roadside Vegetation

Area in which Euphorbia skottsbergii var. Kalaeloana Sherff is distributed.

Area in which Gossypium sandvicense Parl. is distributed.

BIRD TRANSECTS (Trails from which Berger observed avifauna.)

West Beach

FIGURE 1. BIRD TRANSECTS

DATE: JUNE 1979

WEST BEACH RESORT PROJECT

Birds of West Beach, Ewa, Oahu, Region
Statement on possible fossil bird sites
October 5, 1979
Andrew J. Berger

This is an addendum to my Revised Follow-up Report on the Birds of the West Beach region, dated August 27, 1979.

Ms. Jenny Peterson, an employee of the Archeology consultant for the West Beach study, and I visited the limestone region of the West Beach area on October 3, 1979. The limestone formation occurs in the southern (Barbers Point) end of the Campbell Estate property, and it extends on both sides of Malakole Road. The dominant vegetation there is classified as a Prosopis Forest (primarily closed forest) by Winona P. Char in her botanical survey. This also is an area designated to be developed as a lagoon and Hotel-Condo units in the "concept plan only" map dated 5/15/79 and signed by Trustees of the Campbell Estate.

Ms. Peterson and I identified more than 40 sinkholes of various diameters and depths, ranging from small shallow areas to those 6 feet in diameter and 8 to 10 feet in depth. Some of these contained soil sediments similar to those where fossil bird bones have been found previously; others had no soil deposits in them and undoubtedly are unlikely sites for fossil or other prehistoric material. We made no effort to map or locate all of the sinkholes in the limestone formation, nor did we attempt to examine the sediment in those sinkholes that contained a soil deposit because that was not our mission.

Discussion

The discovery of fossil bird bones in limestone sinks in the Barbers Point area adds a complicating factor to an environmental impact statement for the adjacent West Beach area. The possibility of the existence of similar fossil bones in one or more of the sinkholes in the limestone formation of the Campbell Estate land seems high. There is only one way to answer the question: to have the more promising sinkholes examined by a qualified archaeologist in order to determine the presence or absence of fossil bird bones or other prehistoric material.

The first Hawaiian fossilized bird was found on the island of Hawaii in 1926 (Wetmore 1943). Not until 1971, however, were other fossil bird bones found. Mrs. Joan Aidem found fossil goose bones on Molokai that were about 25,000 years old (Stearns 1973; Olson and Wetmore 1976). Additional fossilized bird bones were found on Kauai and Oahu (Barbers Point) during 1976. These bones have not yet been studied and no technical descriptions or ages of the specimens have been published. The ages of the bones and the deposits in which they are found are of critical importance with regard to their value scientifically. For example, are they truly prehistoric in a geological sense or are the deposits of more recent times, perhaps after the first Polynesians reached the Hawaiian Islands.

In addition to their intrinsic scientific value as clues to birdlife during past geological ages, aged fossil bird bones in Hawaii might enable ornithologists to understand much better the evolution and relationships of the living endemic bird species, although there is no certainty that this would be true. There is no way to make reliable predictions until

after the fossil bones have been studied thoroughly by a highly competent bird paleontologist.

Hence, one must agree with Storrs L. Olson (letter dated October 18, 1976, to Mr. Aki Sinoto of the Bernice P. Bishop Museum) that the deposits containing fossilized bird bones are of considerable scientific value and should be preserved and studied, even though one doubts the scientific wisdom of some of Dr. Olson's over-exuberant remarks after his "quite perfunctory" examination of the Barbers Point material. As a generalization it is true that the accuracy of the identification of fossil bird bones depends largely on the number of bones that are preserved; only rarely is an entire skeleton preserved; often a single bone, or even a fragment of a bone, is found. Obviously, in the latter case, the placement of that bone as to genus and species is far less accurate than the identification made from a complete, or nearly complete, skeleton.

Conclusions and Recommendations

1. On the basis of the living birds (introduced and migratory) found in the West Beach area, one can say that no detrimental affects on these species would result from development in the area.

2. The discovery of fossil bird bones in the adjacent Barbers Point region suggests a high possibility that similar fossil bird bones also occur in one or more of the limestone sinks on the Campbell Estate land.

3. The following actions are recommended for consideration:

a. An archaeologist should be hired to examine and excavate in the most promising limestone sinks on the Campbell Estate land.

b. If no fossil bird bones are found, a negative statement can be made.

c. If fossil bird bones are found, I see at least two possibilities for action.

1- Excavations could be completed and all fossil material taken to the Bernice P. Bishop for study and/or disposition (e.g., send the material to the Smithsonian Institution in Washington for final study). The limestone sinks have no intrinsic value themselves, so that construction could be continued as planned.

2- If one or more outstanding fossil sites are discovered on the Campbell Estate land, these could be preserved as prehistoric sites and used as a tourist attraction in a way similar to the La Brea Tar pits in Los Angeles, California. These visitor sites also would serve as "fossil banks" for future excavation if and when new archeological techniques are developed (see letter from Dr. Olson to Mr. Sinoto regarding "fossil banks").

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----- 1975c. The Java Sparrow in Hawaii. Elepaio, 36:14-16.

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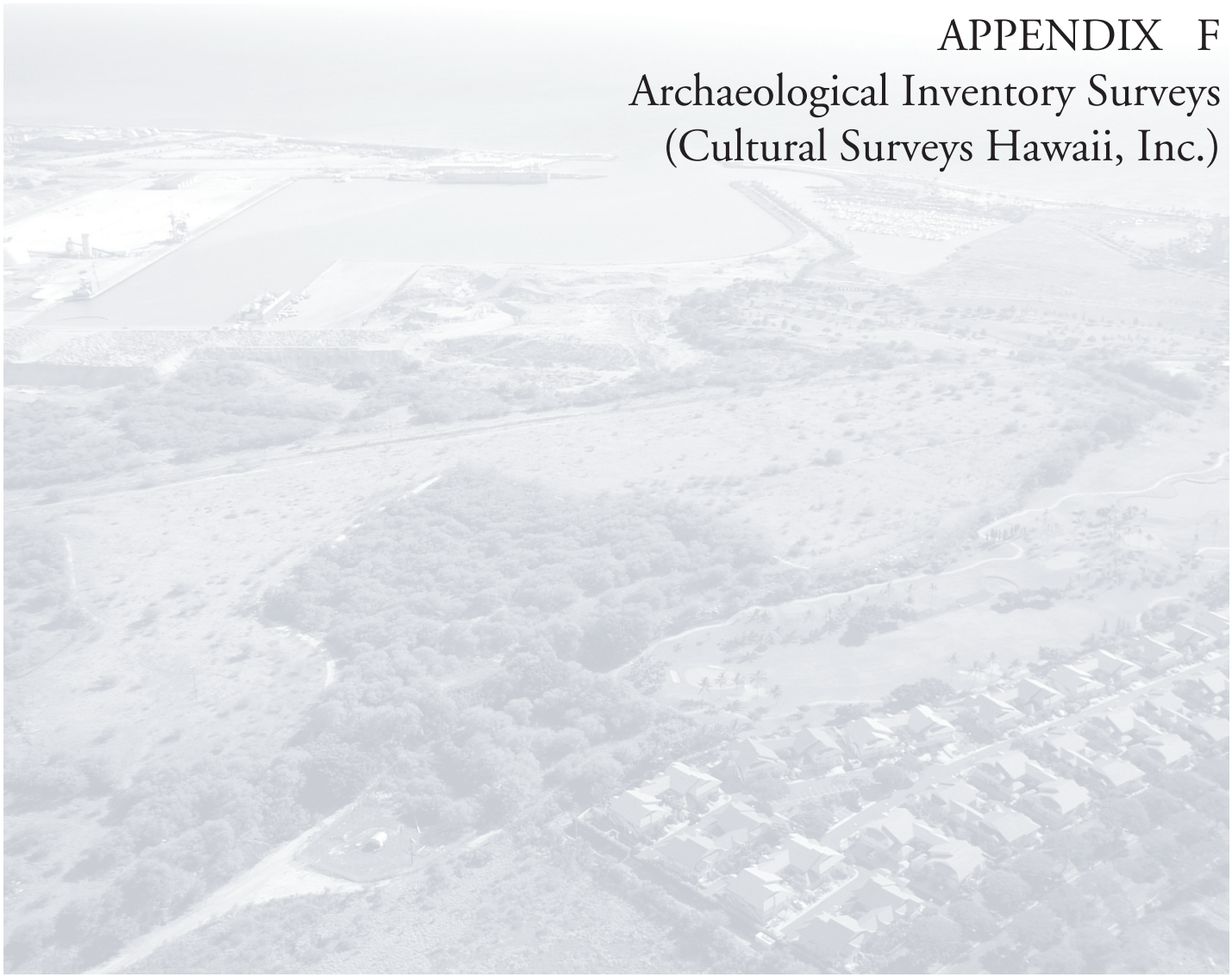

APPENDIX F
Archaeological Inventory Surveys (Cultural Surveys Hawaii, Inc.)

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

DAN DAVIDSON
DEPUTY DIRECTOR - LAND

ERNEST Y.W. LAU
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

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

November 26, 2003

David Shideler
Cultural Surveys Hawaii
733 N. Kalaheo Avenue
Kailua, Hawaii 96734

LOG NO: 2003.2440
DOC NO: 0311EJ38

Dear Mr. Shideler:

SUBJECT: **Chapter 6E-42 Historic Preservation Review – Request for Written Status Clarification on Lands in Kapolei Area of Honouliuli Ahupua`a Honouliuli, `Ewa, O`ahu**
TMK: (1) 9-1-016:001, 030, 034, 121-124

We believe that you have provided an accurate and complete summary of previous archaeological work and past review comments by the State Historic Preservation Division in your document entitled, *Request for Status Clarification Regarding Historic Preservation Concerns at Certain Lands at Kapolei, Honouliuli Ahupua`a, `Ewa District O`ahu* Hammatt and Shideler 2203.

Our earlier comments that archaeological surveys found no historic properties and that development of the lands covered in this status clarification will have "no effect" on significant historic sites, remains the same.

Should you have any questions, please feel free to call Sara Collins at 692-8026 or Elaine Jourdane at 692-8027.

Aloha,

P. Holly McEldowney

P. Holly McEldowney, Acting Administrator
State Historic Preservation Division

EJ:jk

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
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BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

DAN DAVIDSON
DEPUTY DIRECTOR - LAND

YVONNE Y. IZU
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
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ENGINEERING
FORESTRY AND WILDLIFE
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HISTORIC PRESERVATION DIVISION
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KAPOLEI, HAWAII 96707

November 30, 2004

David W. Shideler
Cultural Surveys Hawaii
P. O. Box 1114
Kailua, Hawaii 96734

LOG NO: 2004.3417
DOC NO: 0411EJ29

Dear Mr. Shideler:

SUBJECT: Chapter 6E-42 Historic Preservation Review – REVISIONS to a Report Documenting the Results of an Archaeological Inventory Survey at Kapolei Honouliuli, `Ewa, O`ahu
TMK: (1) 9-1-015:004

Thank you for the submission of a replacement page (page 1) to the report documenting the results of an inventory survey (*Archaeological Inventory Survey of Two Sinkholes at Kapolei, Honouliuli Ahupua`a, `Ewa District, O`ahu Island,* Terry, Cordy, Hoffman & Hammatt, 2004). The revisions were made to address our comments on the draft version of the report (SHPD Log 2004.2574 August 24, 2004).

We believe that the revisions have been acceptably made and we can now consider the report as final. The survey area of less than 1.0 acres included subsurface testing at two of four sinkholes that were recorded. The excavations yielded no evidence of pre-Contact or traditional Hawaiian use or occupation of the sinkholes. All recovered materials pertained to 20th century activities in the general vicinity. Both sinkholes were interpreted to have functioned as rubbish disposal areas for both ranching and military activities; recovered items included butchered animal bone, glass, ceramic, and metal objects, and items marked with US Navy and US Army identifications. The two sinkholes are considered features of SIHP No. 50-80-12-6674, a disposal site that dates to WW II era. SIHP No. -6674 is not deemed significant, and no further work is recommended. We concur with these findings and recommendations.

The report will be placed in our library where it will be available for public use.

Should you have any questions, please feel free to call Sara Collins at (808) 692-8026 or Elaine Jourdane at (808) 692-8027.

Aloha,

Melanie A. Chinen, Administrator
State Historic Preservation Division

EJ:jen

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KAPOLEI, HAWAII 96707

January 8, 2004

Mr. David Shideler
Cultural Surveys Hawaii
733 N. Kalaheo Avenue
Kailua, Hawaii 96734

LOG NO: 2004.0037
DOC NO: 0401EJ04

Dear Mr. Shideler:

SUBJECT: **Chapter 6E-42 Historic Preservation Review – Request for Written Status Clarification on Lands in Kapolei Area of Honouliuli Ahupua`a Honouliuli, `Ewa, O`ahu**
TMK: (1) 9-1-015:004 and 008

Thank you for the opportunity to consider two documents pertaining to lands in the Kapolei area: Hammatt & Shideler. 2003 *Request for Status Clarification Regarding Historic Preservation Concerns at Certain Lands at Kapolei, Honouliuli Ahupua`a, `Ewa District O`ahu TMK: 9-1-15:4 and 18,* and Cordy & Hammatt. 2003. *Archaeological Assessment of an Approximately 100-Acre Project Area at Kapolei, Honouliuli Ahupua`a, `Ewa, District, O`ahu, TMK: 9-1-15:4.*

We believe that you have provided an accurate and complete summary of previous archaeological work and past review comments by the State Historic Preservation Division in your document entitled, *Request for Status Clarification Regarding Historic Preservation Concerns at Certain Lands at Kapolei, Honouliuli Ahupua`a, `Ewa District O`ahu TMK: 9-1-15:4 and 18,* Hammatt and Shideler 2003.

As noted we previously commented that past archaeological surveys found no historic properties within these parcels and that development of these lands would have "no effect" on significant historic sites. You have noted that historic flume and ditch plantation infrastructures appear in the area and that documentation of these resources should be conducted. We appreciate your bringing this to our attention and agree with your determination that with the documentation of these resources that no further work would be necessary for the project area contained in this study. We look forward to reviewing the documentation for these features.

Cultural Surveys Hawaii also conducted an archaeological assessment of a c.100-acre parcel to the southwest of the 468 and 5.88 acre parcel reviewed in the report above (*Archaeological Assessment of an Approximately 100-Acre Project Area at Kapolei, Honouliuli Ahupua`a, `Ewa, District, O`ahu, TMK: 9-1-15:4*, Cordy, D. and Hammatt 2003). The assessment was undertaken to determine whether or not historic sites are present within this 100-acre area. The results of the survey indicate that the vast majority of the project area has been heavily impacted by either past sugar cultivation, grading and grubbing activities that are partly related to past use of the area as a chicken/chicken-egg ranch and possible military alteration. No pre-twentieth surface features with the exception of a portion of the OR&L alignment were found.

However, 4 sinkholes were observed (CSH 1-4) that provide the best examples of sinkholes in the project area and have the potential to contain cultural or faunal deposits. Cultural Surveys Hawaii has recommended that further archaeological research, in the form of subsurface testing be conducted at two of the sinkholes. We agree with the recommendation that an archaeological inventory survey in the form of subsurface testing be conducted for sinkholes CSH2A and CSH3. We look forward to review for acceptance the results of the inventory survey testing report.

Should you have any questions, please feel free to call Sara Collins at (808) 692-8026 or Elaine Jourdane at (808) 692-8027.

Aloha,

P. Holly McEldowney

P. Holly McEldowney, Administrator
State Historic Preservation Division

EJ:ak

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FEB - 1 2005

Mr. David Shideler
Cultural Survey Hawaii
733 N. Kalaheo Avenue
Kailua, Hawaii 96734

Log #: 2004.2037, 2005.0194
Doc #: 0502tl01

Dear Mr. Shideler:

SUBJECT: Chapter 6E-42 Historic Preservation Review – Request for Documentation of Plantation Infrastructure in Kapolei area of Honouliuli Ahupua`a, Honouliuli, `Ewa, O`ahu
TMK:(1) 9-1-015:004,008

Thank you for the opportunity to comment on the submitted report of the Documentation of Plantation Infrastructure in the Kapolei area of Honouliuli Ahupua`a, `Ewa District O`ahu TMK: 9-1-15:004 and 018. This study was requested by the State Historic Preservation Division (Doc. 0401EJ04) to conclude historic preservation requirements within the project area. The scope of work includes archival historical background research, fieldwork documentation of sugar plantation infrastructure remains currently on the parcel and a report on the archival and field results. The documentation of the Ewa Plantation's irrigation system including the ditches and flumes appears to be complete.

We acknowledge acceptance of this study and have no further comments. Thank you for the opportunity to review the study. Should you have any questions about architecture, please feel free to Thomas Lim at (808) 692-8030.

Aloha,

Melanie A. Chinen, Administrator
State Historic Preservation Division

TL:

REQUEST FOR STATUS CLARIFICATION REGARDING HISTORIC PRESERVATION CONCERNS AT CERTAIN LANDS AT KAPOLEI, HONOULIULI AHUPUA‘A, ‘EWA DISTRICT O‘AHU

(TMKs 9-1-15:4 and 18)

By

Hallett H. Hammatt, Ph.D.
and
David W. Shideler, M.A.

for

Helber, Hastert and Fee, Planners

Cultural Surveys Hawai‘i, Inc.

November 2003

I. INTRODUCTION TO REQUEST FOR STATUS CLARIFICATION

Cultural Surveys Hawai‘i. Inc. has entered into a contractual agreement with Helber, Hastert and Fee to summarize and present the previous archaeological work on certain former cane lands located in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu. We are presenting a summary of our findings below and are requesting a written State Historic Preservation Division (SHPD) position in regard to the review status of these lands. The lands in question are shown on Figures 1 (USGS map) and 2 (Tax Map Key 9-1-16) and include the following parcels:

TMK	Acreage	General Area
9-1-15:4	468.278 Acres	South of Farrington Highway and north of the OR&L alignment, west of Kalaeloa Blvd and east of Ali‘i Nui/Ko‘i‘o Drive
9-1-15:18	5.888 Acres	Kamōkila Park, south of Farrington Highway and east of Honokai Hale

We believe that the vast majority of these lands have been covered in two previous archaeological studies discussed further below. An approximately 100-acre area (shaped somewhat like Diamond Head) in the southwestern corner of the project area adjacent on the north side of the OR&L alignment (see Figure 4) is the subject of a companion archaeological assessment study.

This matter has previously been informally explored in a face-to-face discussion with Ms. Muffet Jourdane, State Historic Preservation Division O‘ahu archaeologist.

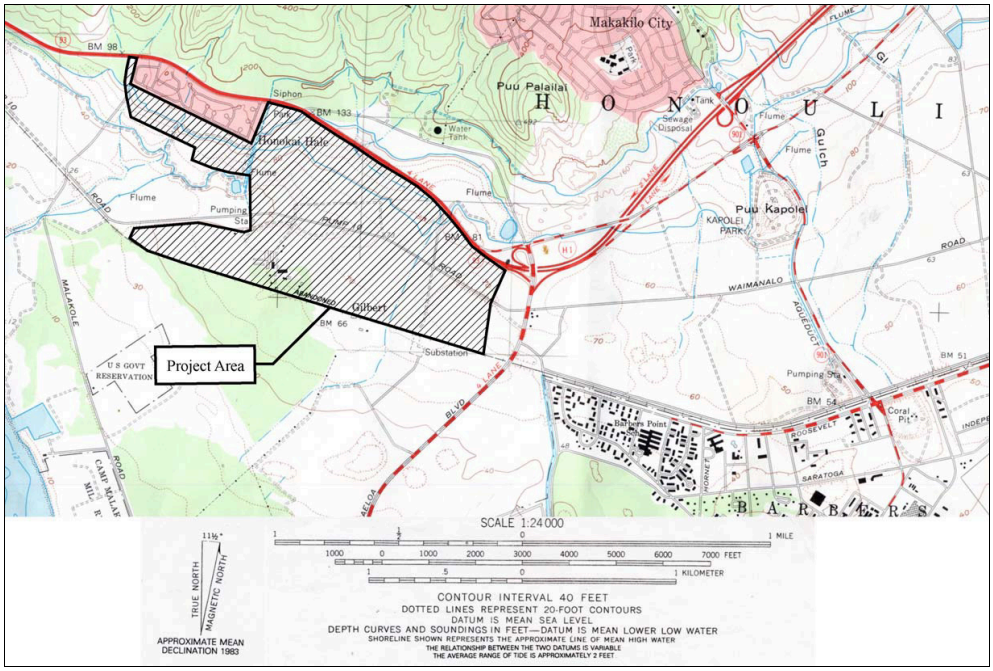

Figure 1 **Portion USGS Barbers Point Map Showing Present Project Area(s)**

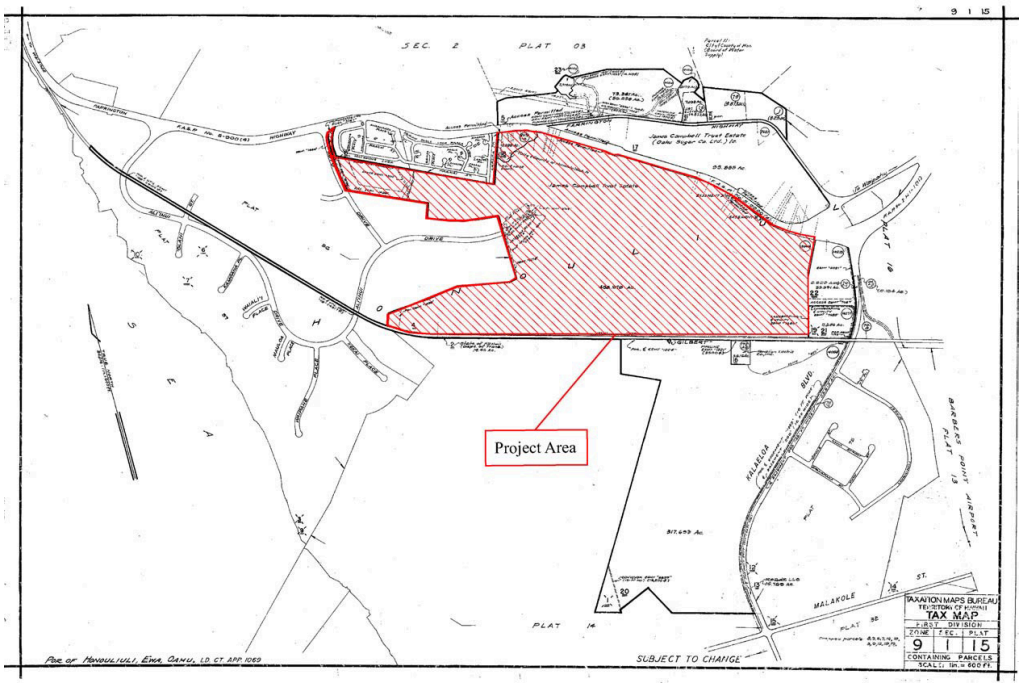

Figure 2 **Tax Map Key 9-1-15 Showing Project Area(s)**

II. PREVIOUS ARCHAEOLOGICAL STUDY

The most germane archaeological study was a letter report entitled *Preliminary Archaeological Reconnaissance Survey for Environmental Assessment (EA) Ewa Town Center/ Secondary Urban Center, Land of Honouliuli, Ewa, Island of Oahu (TMK: 9-1-15: Por. 4, 5, 17; 9-1-16:1, Por. 4, 6, 9, 16, 18, 24, 30: 9-2-19: Por. 1*)(Haun 1986, PHRI report # 275-111886). This study covered a petition area of approximately 1,400 acres (Figure 3). The Haun study notes the extensive modification for sugarcane cultivation and concludes that only two sites had been previously reported in the vicinity: the OR&L alignment on the southern border of the study area and a *heiau* and large rock shelter on Puʻu Kapolei. (outside of the Haun study area and outside the present area of concern). The Haun study identified two new sites: an irrigation ditch north of the H-1 and a WWII military structure on Puʻu Palailai but both lie outside the present area of concern and both were regarded as of minimal significance. The Haun study (1986:4) concluded that "no further archaeological work is recommended.

The Haun (1986) study area encompassed the vast majority of the areas of present concern with the notable exception of an approximately 100-acre area (shaped somewhat like Diamond Head) in the southwestern corner of the project area adjacent on the north side of the OR&L alignment (Figure 4). This approximately 100-acre area, which we believe has never been the subject of prior archaeological study and includes certain scrublands never under cane cultivation are the subject of a companion archaeological assessment study.

There are certain minor discrepancies between the depiction of the Haun 1986 study area (Figure 3) and the present study area (Figures 1 & 2) on the south and west sides of the Nanakai Gardens/Honokai Hale subdivision in the northwest corner of the area of present concern. We do not believe these differences are of any consequence at present as this area was the subject of a fairly intensive study by Burgett and Rosendahl (discussed further below) and because grading and drainage improvements have greatly modified this area in recent years.

A second study of particular interest was entitled *Subsurface Archaeological Testing Ko Olina Resort Phase II Development Site, Land of Honouliuli, ʻEwa District, Island of Oʻahu* (Burgett and Rosendahl 1989). This study (which may never have been formally reviewed by the State Historic Preservation Division) recounts the results of some seventy-two backhoe trenches scattered across much of the area of present concern (Figure 5). Sixty-seven trenches were excavated to bedrock that was typically encountered at depths of 55 to 161 cmbs. No archaeologically significant remains of any kind were encountered (Burgett and Rosendahl 1989:4).

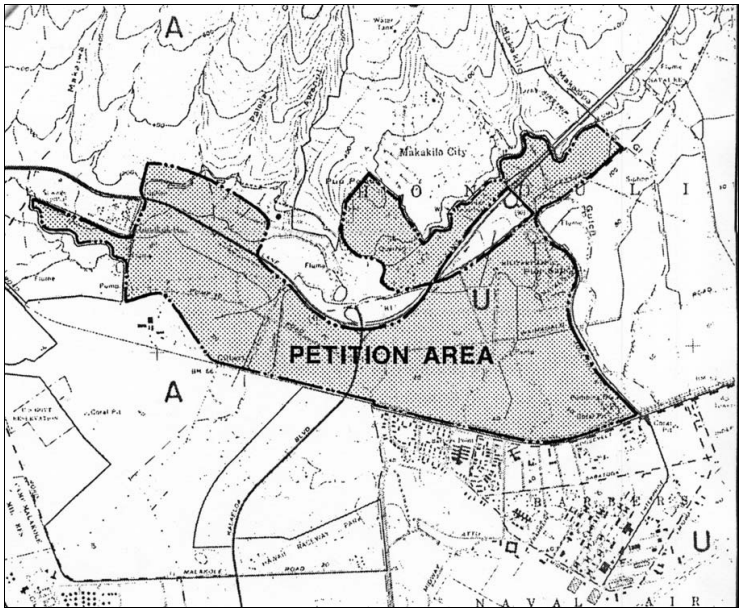

Figure 3 **Map Showing Haun (1986) Ewa Town Center/Secondary Urban Center 1,400 Acre Study Area**

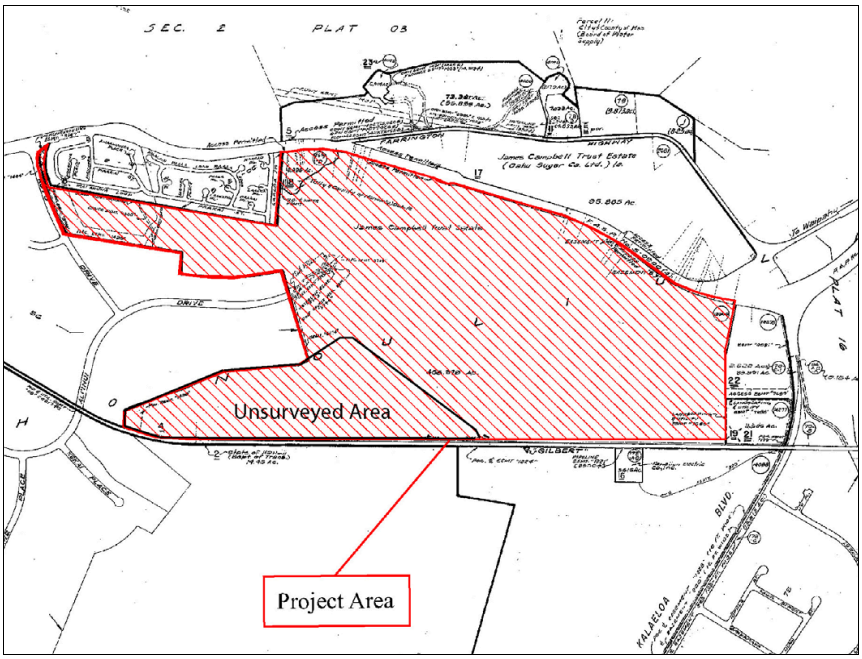

Figure 4 **Map Showing Previously Unsurveyed Portion of the Present Project Area**

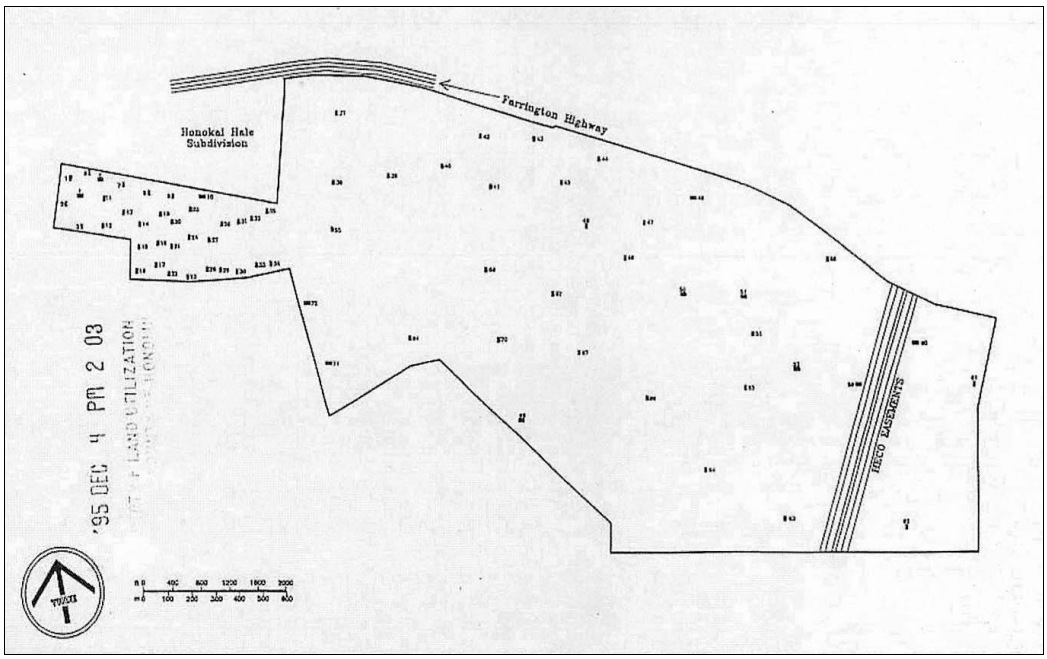

Figure 5 **Map Showing Location of Seventy-two Backhoe Test Trenches in the Area of Present Concern (adapted from Burgett and Rosendahl 1989:5)**

III. STATE HISTORIC PRESERVATION DIVISION REVIEWS OF THE HAUN 1986 STUDY

As noted above and supported with Figures 3 and 4, two archaeological studies by Alan Haun (1986) and Burgett and Rosendahl (1989) covered the vast majority of the areas of present concern. We have found no indication the Burgett and Rosendahl study was ever formally reviewed by the SHPD but the Haun 1986 study appears to have been the basis of several prior State Historic Preservation Division (SHPD) SHPD determinations. The first SHPD determination appears to have been in a letter from Ralston H. Nagata to Roger C. Evans dated January 28, 1987 entitled *Environmental Review – Secondary Urban Center in Ewa Oahu. Honouliuli, Ewa, Oahu TMK: 9-1-15, por. 4, 5, 17, 9-1-16, 1, por 4, 6, 9, 16, 18, 24, 30; 9-2-19: por. 1*(Letter included below) which concluded:

> The majority of this area has long been under sugarcane cultivation. The remaining portions have recently had reconnaissance-level archaeological survey (Haun, for PHRI). No significant sites were recorded. We believe therefore that there will be "no effect" on significant historic sites. (Nagata to Evans, January 28, 1987).

This was basically the same wording used in subsequent SHPD evaluations of an LUC boundary petition for the secondary urban center (Ralston H. Nagata to Roger C. Evans dated August 26, 1987, copy enclosed), for the Final EIS for the Kapolei Town Center (William W. Patty to Donald Clegg, July 6, 1988, copy enclosed), and for an LUC motion for incremental districting of Kapolei City (Don Hibbard to Roger C. Evans, February 17, 1993, copy enclosed).

Thus it appears that the development of lands that were covered in the Haun 1986 study (and subsequently in the Burgett and Rosendahl 1989 study) have been previously evaluated by the SHPD as having "no effect" on significant historic sites. Some time has elapsed since formal SHPD consideration of these lands, however, and we are thus requesting a statement from the SHPD regarding any historic preservation concerns.

We do feel the need to point out that we believe there is certain former O'ahu Sugar Plantation flume and ditch infrastructure extant within the area of concern in the areas just seaward of Honokai Hale, Kamōkila Park, and Farrington Highway. With the possible exception of a caveat for documentation of this flume and ditch plantation infrastructure it would appear reasonable and consistent with prior SHPD determinations to require no further work in the areas covered by the Haun (1986) and Burgett and Rosendahl (1989) studies. We are requesting a written SHPD position in regard to the review status of these lands.

State Historic Preservation Division Review Letters

Involving Parcels in Question

1. Ralston H. Nagata to Roger C. Evans dated January 28, 1987 entitled: *Environmental Review – Secondary Urban Center in Ewa Oahu. Honouliuli, Ewa, Oahu TMK: 9-1-15, por. 4, 5, 17, 9-1-16, 1, por 4, 6, 9, 16, 18, 24, 30; 9-2-19: por. 1*
2. Ralston H. Nagata to Roger C. Evans dated August 26, 1987 entitled: *LUC Boundary Petition 87-613, Campbell Estate, Ag. to Urban, Implementation of Honolulu General Plan Policy for Secondary Urban Center Honouliuli, Ewa, Oahu TMK: 9-1-15, por. 4, 9-1-16, 1, por 4, 6, por. 9, 16, 18, 24, and 30; 9-2-03: por. 2; 9-2-19: por. 1*
3. William W. Patty to Donald Clegg, dated July 6, 1988 entitled: *Final EIS, Kapolei Town Center Honouliuli, Ewa, Oahu TMK: 9-1-16, various; 9-2-19: 1; 9-2-03: 2 and 12*
4. Don Hibbard to Roger C. Evans, February 17, 1993 entitled: *LUC Docket No. A87-613: Motion for Incremental Districting (Kapolei City) by the Estate of James Campbell (File No. 93-384) Honouliuli, Ewa, Oahu TMK: 9-1-15: por. 4; 9-1-16 por. 1, por. 4, 5, 6, por. 9, 12, 13, por. 16, 18, por. 24, 30; ; 9-2-3: por. 2, 12; 9-2-19: por. 1)*

Archaeological Assessment

of an Approximately 100-Acre Project Area at

Kapolei, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu

TMK: 9-1-15:4

by

Dominique Cordy, B.A.

and

Hallett H. Hammatt, Ph.D.

Prepared for

Helbert Hastert & Fee Planners, Inc.

733 Bishop St, Suite 2590

Honolulu, HI 96813

by

Cultural Surveys Hawai‘i, Inc.

November 2003

TABLE OF CONTENTS

I. INTRODUCTION 1
A. Project Background 1
B. Scope of Work 1
C. Methods 5
1. Background Research 5
2. Field Methods 5
D. Natural Setting 5
II. HISTORICAL BACKGROUND 7
A. Precontact and Early History 7
B. Mid to late 19th Century 8
C. Modern Land Use 9
III. Honouliuli Settlement Patterns 13
A. The Physical Layout 13
B. The Coastal Zone 14
1. Kalaeloa (Barber's Point) 14
2. Ko‘olina (West Beach) 14
C. Honouliuli Taro Lands 15
D. Pu‘u Ku‘ua: Inland Settlement 15
E. Summary of Settlement Patterns in Honouliuli 16
F. Summary of Settlement Patterns in Project Area 17
IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES 18
A. Overview of Archaeological Studies in Western Honouliuli 18
B. Predictive Model 26
V. FIELD INVESTIGATION 27
A. Survey Methods 27
B. Field Survey Findings 27
VI. SUMMARY AND RECOMMENDATIONS 33
VII. BIBLIOGRAPHY 34

LIST OF FIGURES

Figure 1: Portion of U.S.G.S. 7.5 Minute Series Topographical Map (1983), Barbers Point Quadrangle Showing Project Area 2
Figure 2: Portion of TMK 9-1-15 Showing Location of Project Area 3
Figure 3: Aerial Photograph Showing the Location of the Project Area..... 4
Figure 4: Map Showing Location of Honouliuli Ahupua‘a in West O‘ahu (adapted from Sterling and Summers 1978)..... 6
Figure 5 Portion of War Department Fire Control Nanakuli and Barber’s Point Quad Maps Showing Project Area..... 10
Figure 6 Portion of 1928 USGS Barbers Point Quad Map Showing Project Area..... 11
Figure 7 Portion of 1943 War Department Barbers Point Quad Map Showing Project Area.... 12
Figure 8: Map Showing General Areas of Archaeological Study Near the Project Area..... 23
Figure 9: Aerial Photo of Project Parcel Showing Areas A and B, and CSH Sinkholes..... 29
Figure 10: CSH-3 Sinkhole, View to Southwest..... 30
Figure 11: CSH-4 Sinkhole, View to Northeast..... 30
Figure 12: CSH-1 Sinkhole Before Surface Clearing, View to Northwest..... 31
Figure 13: CSH-1 Sinkhole After Surface Clearing, View to Northwest 31
Figure 14: CSH-2A and 2B Sinkholes (from left to right) 32

LIST OF TABLES

Table 1: Archaeological and Related Studies in Western Honouliuli Ahupua‘a..... 18
Table 2: Sites Near the Project Area..... 25

I. INTRODUCTION

A. Project Background

At the request of Helbert Hastert and Fee Planners, Cultural Surveys Hawai‘i, Inc. (CSH) completed an archaeological assessment of approximately 100 acres within the parcel designated TMK: 9-1-15:4, lying north of the O.R.&L. alignment, west of Kalaeloa Blvd., and east of Ali‘i Nui/ Ko‘i‘o Drive (Figures 1, 2 and 3) in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southeastern O‘ahu. The project area lies in the southwest corner of the 468-acre parcel, and includes two large wooded areas that have not undergone previous archaeological survey. This report is an archaeological assessment of this 100-acre area.

B. Scope of Work

The purpose of this archaeological assessment was to determine whether significant archaeological or historic sites are present. Part of the archaeological concern here involves filled limestone sinkholes that may contain burials, other cultural finds, or extinct species. In addition we have checked for WWII and plantation era infrastructure that would now be regarded as of historic significance. Background research was conducted to provide a historical and archaeological context on the project area. The assessment does not meet the SHPD/DLNR requirements for a more intensive inventory-level survey, but does provide sufficient data to make recommendations for future work.

The scope of work includes:

1) Historical 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.

2) Relatively intensive field inspection (four man-days in the field) of the project area to identify any surface archaeological features and to investigate the potential for impacts to such sites. This assessment will identify any sensitive areas that may require further investigation or mitigation before future development projects proceed.

3) Preparation of a report including 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. It will also provide mitigation recommendations if there are archaeologically sensitive areas that need to be taken into consideration.

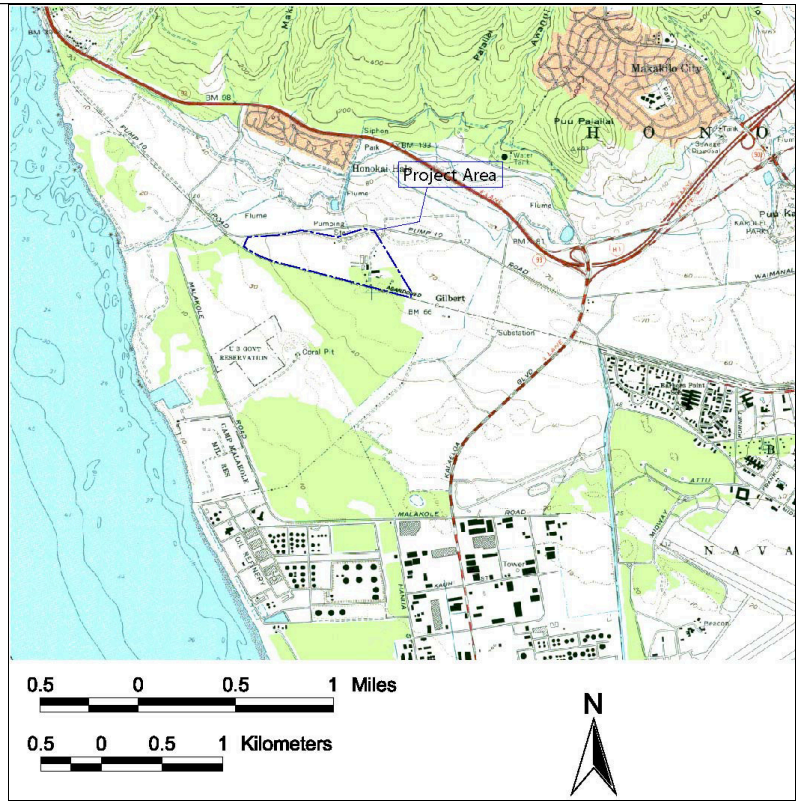

Figure 1: Portion of U.S.G.S. 7.5 Minute Series Topographical Map (1983), Barbers Point Quadrangle Showing Project Area

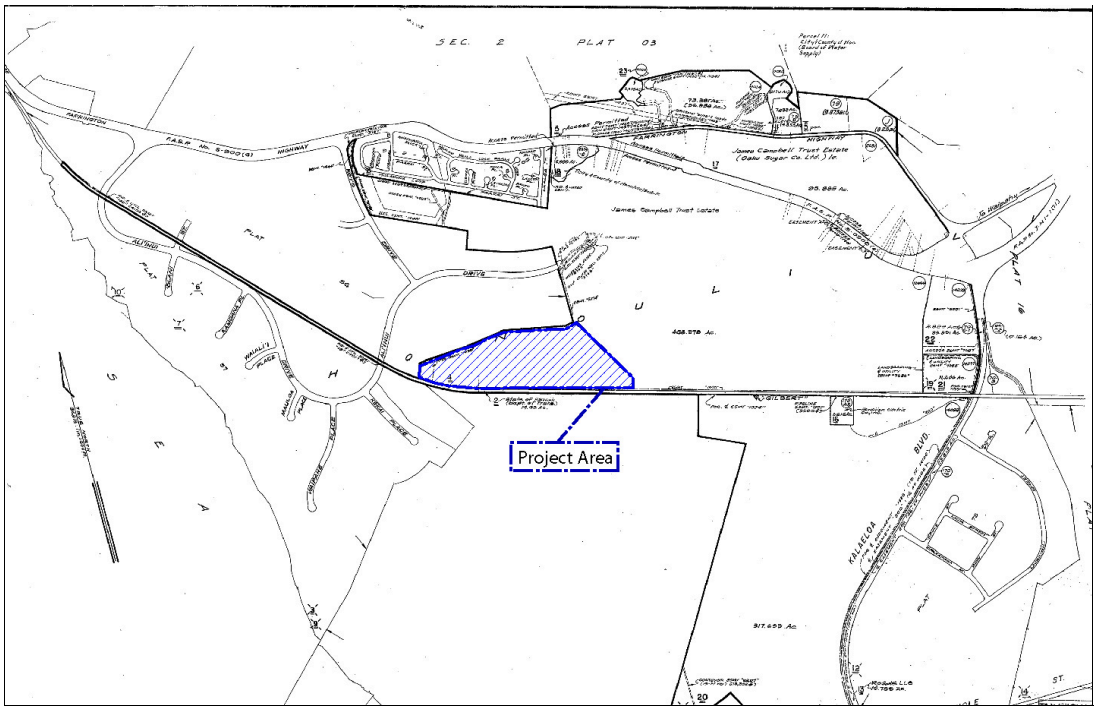

Figure 2: Portion of TMK 9-1-15 Showing Location of Project Area

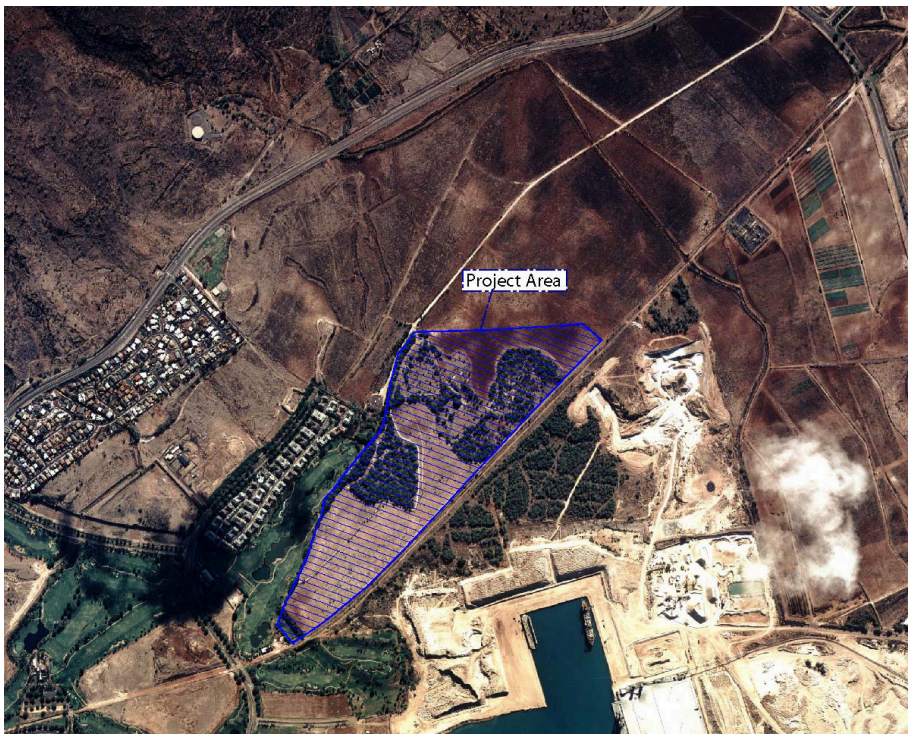

Figure 3: Aerial Photograph Showing the Location of the Project Area

C. Methods

1. Background Research

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division of the Department of Land and Natural Resources and a review of documents and maps at the Cultural Surveys Hawai'I library.

2. Field Methods

Field inspection of the project area was conducted on November 4th through the 6th, by CSH archaeologists David Shideler, Todd Tulchin, Tracy Hoffman and Dominique Cordy. The field inspection consisted of a surface survey focusing on, but not limited to, the two *kiawe* forested areas that had not previously been under cane cultivation. Surface clearing of sample sinkholes was also conducted within these two forested areas.

The field inspection was initiated at the southern boundary with the O.R.&L. railway. The surface survey proceeded to sweep the open field area at the west and southern portion of the parcel and the adjoining forested areas; all of which were inspected for cultural resources. Particular attention was given to the possible presence of limestone sinkholes.

D. Natural Setting

The project area is loacated on the 'Ewa plain, south of the Wai'anae Mountain Range in the southwest corner of O'ahu. The terrain is limestone and alluvial deposits, overlying flows of the Wai'anae volcanic series (Macdonald et al. 1983:423). The project area is generally quite level varying between 30 and 70 feet elevation above sea level.

The project area is largely covered with clay soils including a moderately shallow 'Ewa silty clay loam, and Mamala stony silty clay loam. The two forested areas of the study parcel include unbulldozed sections of coral (limestone) outcrop intermixed with sections of clay and silty clay loam (Foote et al. 1972). Some of these clay and silty clay loam deposits are most likely of historic deposition owing to increased erosion from introduced grazing animals and the deliberately induced erosion to improve agricultural fields. In traditional Hawaiian times, the areas of coral outcrop were probably more extensive.

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 receiving about 18 inches of rainfall annually (Juvik and Juvik 1998:56). In pre-contact Hawai'i the project area would have been mostly lowland dry shrubland and grassland but this area has been extensively disturbed and transformed by human activity with a variety of exotic grasses, weeds and shrubs now dominating. These grasses and shrubs, along with pockets of *kiawe* forest, and a few scattered banyan trees are characteristic of the vegetation of the two areas of archaeological interest.

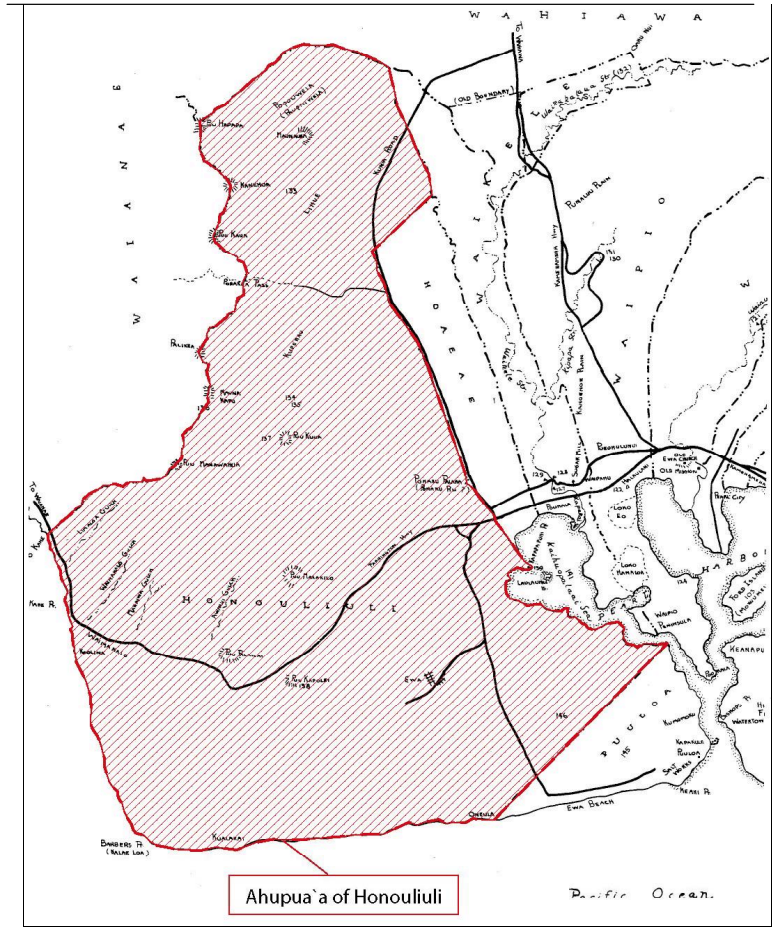

Figure 4: Map Showing Location of Honouliuli Ahupua'a in West O'ahu (adapted from Sterling and Summers 1978)

II. HISTORICAL BACKGROUND

A. Precontact and Early History

Various legends and early historical accounts indicate that the *ahupua'a* of Honouliuli (shown in Figure 4) was once heavily populated by pre-contact Hawaiians. This substantial settlement is attributable for the most part to the plentiful marine and estuarine resources available at the coast and lowlands suitable for wetland taro cultivation. The lower mountain slopes would have provided the inhabitants of the lowland with a variety of forest goods.

Forest resources along the slopes of the Wai'anae Range - as suggested by E. S. and E.G. Handy - probably acted as a viable subsistence alternative during times of famine and/or low rainfall.

> ...The length or depth of the valleys and the gradual slope of the ridges made the inhabited lowlands much more distant from the 'wao, or upland jungle, than was the case on the windward coast. Yet the 'wao here was more extensive, giving greater opportunity to forage for wild foods during famine time [Handy and Handy 1972:469-470].

The upper valley slopes may have also been a resource for sporadic quarrying of basalt for the manufacturing of stone tools. At least one probable quarrying site (50-80-12-4322) is present in Maka'īwa Gulch at 152 m. (500 ft.) a.m.s.l. (Hammatt et al. 1991).

The Hawaiian *ali'i* were also attracted to the region. One historical account of particular interest refers to an *ali'i* residing in Ko'olina, just west of the project area:

> Ko'olina 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'olina 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 in Sterling and Summers 1978:41].

John Papa 'Ī'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'u Kapolei and Waimānalo Gulch to the Wai'anae coast and onward, circumscribing the shoreline of O'ahu ('Ī'ī 1959:96-98). Following 'Ī'ī's description, a portion of this trail network would have passed close to the presently existing Farrington Highway.

Other 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 pre-contact and early post-contact populations also adapted to less inviting areas, despite the environmental hardships.

Barber's Point is named after Captain Henry Barber who ran aground on October 31, 1796. 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 due to overharvesting, and the

introduction of domesticated animals and exotic plant species. Domesticated animals including goats, sheep and cattle were brought to the Hawaiian Islands by Capt. George Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. L.A. Henke reports the existence of a longhorn cattle ranch in Wai'anae by at least 1840 (in Frierson 1972:10).

During this same time, perhaps as early as 1790, exotic vegetation species were introduced to and flourished in the area. The following dates of specific vegetation introduced to Hawai'i, given by R. Smith and outlined by Frierson (1972:10-11), are relevant when identifying and selecting charcoal samples used for radio carbon dating:

> 1) "early", c. 1790: Prickly pear cactus, *Opuntia tuna*; *Haole koa*, *Leucaena glauca*; Guava, *Psidium guajava*
>
> 2) 1835-1840: Burmuda [sic] grass, *Cynodon dactylon;* Wire grass, *Eleusine indica*
>
> 3) 1858: Lantana, *Lantana camara*
>
> The *kiawe* tree was also introduced during this period, either in 1828 or 1837 (Frierson 1972:11).

B. Mid to late 19th Century

Following the Mahele of 1848, 99 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III. The present study area appears to have been included in the largest award (Royal Patent 6071, LCA 11216, 'Āpana 8) granted in Honouliuli Ahupua'a to Miriam Ke'ahi-Kuni Kekau'onohi on January 1848 (Native Register). Kekau'onohi acquired a deed to all unclaimed land within the *ahupua'a*, totaling 43,250 acres.

Kekau'onohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahala'i'a, who was governor of Kaua'i. Subsequently, Kekau'onohi ran away with Queen Ka'ahumanu's stepson, Keli'i-ahonui, 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. When Levi Ha'alelea died the property went to his surviving wife, who in turn leased it to James Dowsett and John Meek in 1871 for stock running and grazing.

In 1877 James Campbell purchased most of Honouliuli Ahupua'a -including the present study area- for a total of $95,000. He then drove off 32,347 head of cattle belonging to Dowsett, Meek and James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva, 1983:C-12). By 1881 the Campbell property of Honouliuli prospered as a cattle ranch with "abundant pasturage of various kinds" (Briggs in Haun and Kelly 1984:45).

In 1889, Campbell leased his property to Benjamin Dillingham, who subsequently formed the O'ahu Railway and Land Company (O.R. & L.) in 1890. To attract business to his new railroad system, Dillingham subleased all land below 200 feet to William Castle who in turn sublet the area to the 'Ewa Plantation Company for sugar cane cultivation (Frierson, 1972:15).

'Ewa Plantation Co. grew quickly and continued in full operation up into modern times. As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the 'Ewa Plantation Co. installed ditches running from the lower slopes of the mountain range to the

lowlands and then plowed the slopes vertically just before the rainy season to induce erosion (Frierson 1972:17).

C. Modern Land Use

Modern land use of the project area has been for transportation along the former O.R.& L. alignment. The 1919 War Department Fire Control Map (Figure 5) shows a compound of four structures along the middle of the inland edge of the parcel (likely associated with a plantation railway) but this appears to have been no longer extant in the 1928 USGS map (Figure 6). Both the 1919 and 1928 maps show walls and fences within the project area but these configurations are rather dissimilar on these two early twentieth century maps. The 1943 war department map (Figure 7) indicates that only the northeast portion of the project area (light shading) may have been under cultivation at that time. None of these three maps shows any significant development within the area of present concern.

Much of this parcel was under sugar cane cultivation by the first half of the twentieth century. Today the project area borders the Ko'olina resort complex on the west, the O.R.&L. alignment to the south and old cane land to the east. The property appears to have had no formal use for quite some time, though it is adjacent to areas of active development including the Barber's Point Deep Draft Harbor and Ko'olina resort areas.

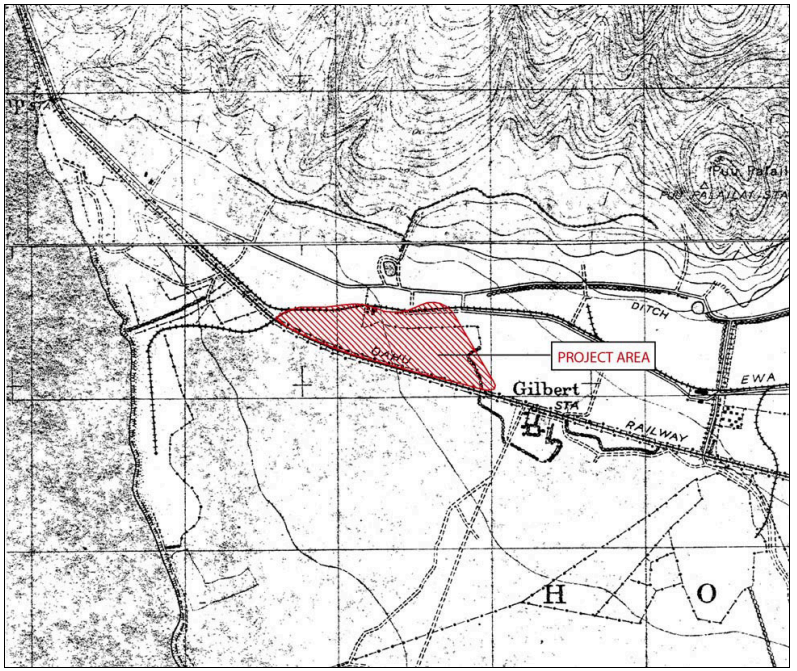

Figure 5 **Portion of War Department Fire Control Nanakuli and Barber's Point Quad Maps (1919) Showing Project Area**

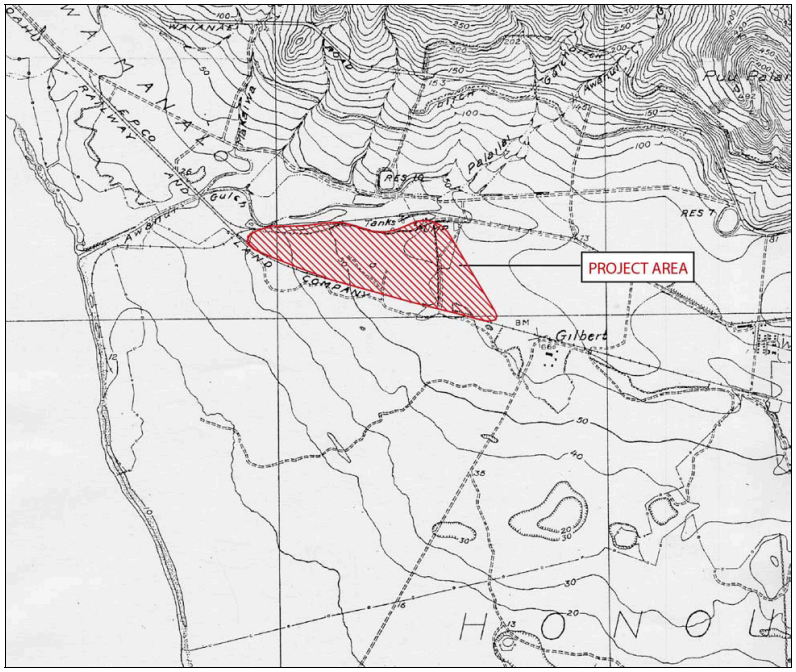

Figure 6 **Portion of 1928 USGS Barbers Point Quad Map Showing Project Area**

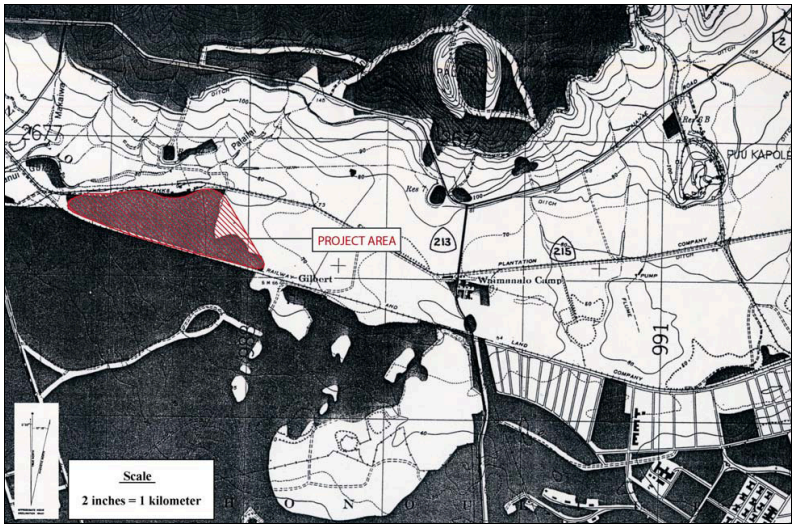

Figure 7 **Portion of 1943 War Department Barbers Point Quad Map Showing Project Area**

III. HONOULIULI SETTLEMENT PATTERNS

A. The Physical Layout

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* 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 does Honouliuli boast a long coastline along the normally calm waters of leeward O'ahu, but there are four miles of waterfront running along the west side of West Loch. The land immediately inland of the sea coast consists of a flat karstic raised limestone reef forming a level, nearly featureless "desert" plain covered in pre-contact times by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas, created by chemical weathering (dissolution) of the limestone shelf. Proceeding inland, this plain is overlain by alluvium deposited through a series of gulches draining the Wai'anae Mountains. The largest of which, Honouliuli gulch, is on the east side of the plain draining into West Loch. To the west are fairly steep gradient gulches forming a more linear than dendritic drainage pattern. The major gulches are (from east to west) Awanui, Palailai, Makaīwa, Waimānalo and Lumaloa. These gulches are 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 inland portions of the plain. These gulches are generally dry, but during seasonal Kona storms they 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 in their upper reaches. These gulches do not have valleys suitable for extensive irrigated agriculture. However, this lack is more than compensated for by the rich, watered lowlands at the base of Honouliuli Gulch (the '*ili* of Honouliuli).

Honouliuli Ahupua'a, as a traditional land unit, had tremendous and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain (which is the most readably visible terrain) does not do justice to the *ahupua'a* as a whole. The following available resources mark the richness of this land unit:

1. Twelve 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-Laulaunui for example.
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 of 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*: 1) the coastal zone including Kalaeloa (Barber's Point), Ko'olina (West Beach), and One'ula ('Ewa Marina), 2) the Honouliuli Taro Lands and 3) the inland area of Pu'u Ku'ua,

B. The Coastal Zone

1. Kalaeloa (Barber's Point)

Archaeological research at Barber's Point has focused on the areas in and around the newly constructed Deep Draft Harbor (see Table 1). A 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 petrel occurs at Site -2763 located 1 km. south of the project area (Hammatt and Folk 1981:213). Initial heavy exploitation of nesting seabirds and other species, in conjunction with habitat destruction, probably led to early extinction of these bird communities.

There is some indication of agriculture in mulched sinkholes and soil areas. Considering rainfall, this activity would have been constrained by accessibility to water, probably involving tree crops and roots (sweet potatoes). The archaeological content of the sites indicates a major focus on marine resources.

Bertel Davis (1990a:135), in his Ph.D. dissertation, summarizes our knowledge of traditional Hawaiian use of the coastal zone of Honouliuli:

> I suggest the west coast of O'ahu, including the area off Barbers Point, (a) probably became a well established fishery at least by AD 1000, perhaps much earlier; (b) the initial settlement at Barbers Point also began around this time or possibly earlier; and (c) the settlement initially involved task-specific groups exploiting the adjacent fishery on a seasonal round, probably during the winter months.

2. Ko'olina (West Beach)

Studies associated with the Ko'olina area, which includes the western portion of the present project, document around 200 component features at approximately 50 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 (1987:37) describe as "one of the longest local sequences in Hawaiian prehistory." The earliest part of the

sequence relates to the discovery of an inland marsh but early dates were also obtained for a beachfront site and an inland rock shelter.

C. 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 *ʻili* of Honouliuli which give the *ahupuaʻa* its name. This area bordering West Loch was clearly a major focus of population within the Hawaiian Islands. 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. As early as 1825 all the roads of southwest Oʻahu coalescing and descending the *pali* as they funnel into the locality which gave the district of Honouliuli its name. 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. Prehistoric population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census 1831-1832, the land *(ʻāina*) of Honouliuli contained 1026 men, women, and children (Schmitt 1973:19). It is not clear whether this population relates to Honouliuli Village or district 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 pre-contact population of Honouliuli Village may well have been significantly greater than it was in 1831-1832.

D. Puʻu Kuʻua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupuaʻa is more problematic in the general absence of archaeological studies. However, it is probable that the area around Puʻukuʻua, on the east side of the Waiʻanae Ridge seven miles inland of the coast, was a Hawaiian place of some importance.

In 1899 Hawaiian Newspaper "*Ka Loea Kalaiaina*" relates a story of Puʻu Kuʻua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

1) This place was entirely deserted and left uninhabited and it seems that this happened before the coming of righteousness to Hawaiʻi 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 (in Sterling and Summers 1978:33).

McAllister (1933:134, 137) recorded three sites in this area: two *heiau,* Puʻu Kuina and Puʻu Kuʻua (both destroyed), and most interesting, a series of enclosures in Kukuilua which he calls "kuleana sites." There is no direct archaeological evidence available that Hawaiian settlement occurred here but extensive settlement appears likely from traditional accounts. Geographically, the area is well-watered and would have had abundant locally available forest resources.

E. Summary of Settlement Patterns in Honouliuli

Based on the above summary of areas of Honouliuli settlement the following general considerations are made to place the project area in the context of the *ahupuaʻa* settlement pattern. There are three areas of Hawaiian settlement in the *ahupuaʻa*; two are well documented while one is more problematic:

a. The extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;

b. The rich cultivated lands of Honouliuli *ʻili* for extensive wetland taro and clearly the *ahupuaʻa* population center;

c. The uplands around Puʻukuʻua for presently uncertain reasons but probably agriculture and forest resource utilization.

Honouliuli, as a unit, contains all the geographic elements of a typical Hawaiian valley *ahupuaʻa*, except they are arranged geomorphically in an atypical relationship. The *ahupuaʻa* is not organized around a single drainage network but shares the west portions of Waikele drainage in its upper reaches. A highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, as well as an extensive limestone plain that 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 forestland for foraging for wood, birds, feathers, etc. would have been the east slope of the Waiʻanae Range. The *mauka/makai* route would have been up Honouliuli Gulch or up the Makakilo ridge, paralleling the coast from Honouliuli Gulch to Kahe. The most convenient route to *mauka* lands, even from the western end of the coast (Koʻolina), would have been *mauka* only to the base of the hills and then either up the Makakilo Ridge or northeast to a trail to Puʻu Kuʻua. The *makai* slope is the dry side of the ridgeline. Here streams would respond to rainfall quickly but drain quickly leaving little available water for even short-term use.

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 Koʻolina 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. Supported by seasonal dry land planting and forest foraging, this *mauka* habitation could have been the lower portion of a thinly scattered, but widespread zone of settlement stretching eastward and northeast along the east Waiʻanae Range slopes; possible increasing in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

There is to date no archaeological evidence of high status residences in Honouliuli. Large residential structures are not present along the 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 ʻEwa District was Waipiʻo. Whatever activities of this class occurred in Honouliuli would have been in or near the rich lands fronting West Loch (the *ʻili* of Honouliuli) but to date there is no direct archaeological evidence of this. Concerning status associations with

Honouliuli it is interesting to note the connection of the Puʻukuʻua settlement with pariah (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

The central place of the *ahupuaʻa* of Honouliuli in terms of population, as well as cultivated foods, was the *ʻili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other locations during prehistoric times, that all other habitation zones were economically and socially co-dependent.

F. Summary of Settlement Patterns in Project Area

The project area lies well inland, on the extensive ʻEwa limestone plain, which was, according to Honouliuli settlement predictions, probably never permanently inhabited. It could have, however, provided temporary habitation for gatherers and fisherman traveling inland to the coast. A relatively barren and waterless area, it nonetheless might have been occasionally transversed, as the project area lay between the greater populated and watered uplands and *makai* resources. The extended limestone plain would have been used for bird catching, and would include the temporary habitations that would result from such forays. Planters could have also used the natural limestone sinks for agriculture, though it would have been seasonal and on a small scale. In general the project area lies in a region that would have been less than bountiful, and therefore sparsely utilized, even in ancient times.

IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES

A. Overview of Archaeological Studies in Western Honouliuli

The Barbers Point area (western Honouliuli Ahupuaʻa) has a reputation as the most archaeologically studied place in Polynesia. An overview of archaeological studies in the west half of Honouliuli Ahupuaʻa is presented in Table 1 and Figure 8. A discussion of archaeological findings germane to the present project area follows.

Table 1: Archaeological and Related Studies in Western Honouliuli Ahupuaʻa

Reference	Nature of Study	General Location of Study
Thrum 1907	*Heiau* Study	Hawaiian Islands
McAllister 1933	All island survey	Oʻahu Island
Kikuchi 1959	Site letter report	Barbers Point
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
Frierson 1972	Study of land use & vegetation change	Honouliuli
Barrera 1975	Reconnaissance survey	Barbers Point (harbor area)
Clark & Connolly 1975	Reconnaissance survey	Barbers Point (harbor area)
Oshima 1975	Reconnaissance survey	Barbers Point
Sinoto 1976	Cultural resources survey	Barbers Point (harbor area)
Bordner 1977	Reconnaissance survey	Kaloʻi Gulch
Davis 1978	Scholarly paper	Barbers Point (harbor area)
Davis & Griffin 1978	Archaeological Survey	Barbers Point (harbor area)
Hawaiʻi Marine Research Inc. 1978	Geoarchaeological reconnaissance	Barbers Point (harbor area)
Kirch 1978	Land snail study	Barbers Point (harbor area)
Sinoto 1978	Archaeological & Paleontological salvage	Barbers Point (harbor area)

Reference	Nature of Study	General Location of Study
Barrera, 1979b	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)
Komori & Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
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 & Folk 1981	Archaeological & Paleontological Investigation	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 & Homon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch
Ahlo & Homon 1984	Test excavations	Barbers Point (harbor area)
Hammatt 1984	Reconnaissance survey	Kahe Point
Haun & Kelly 1984	Research Design	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
Neller 1985	Review & evaluation	West Beach

Reference	Nature of Study	General Location of Study
Barrera 1986	Archaeological Investigations	West Beach
Davis & Haun 1986	Intensive survey & test excavations	West Beach
Davis et al. 1986 a&b	Research Design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Davis & Haun 1987	Intensive survey & test excavations	West Beach
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Survey Report	Kapolei Town
Welch 1987	Reconnaissance survey	Naval Air Station
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial Documentation	Kahe
Burgett and Rosendahl 1989	Subsurface Archaeological Testing	S. of Farrington Hwy., N. of OR&L, W. of Kalaeloa Blvd.
Hammatt & Shideler 1989a	Archaeological Assessment	Barbers Point (harbor area)
Hammatt & Shideler 1989b	Reconnaissance survey	Kahe
Carlson & Rosendahl 1990	Inventory Survey	Kaomi Loop Subdivision
Cleghorn & Davis 1990	Archaeological & Paleontological Investigation	Barbers Point (harbor area)
Davis 1990b	Archaeological & Paleontological Investigation	Barbers Point (HECO area)
Davis 1990a	Archaeological & Paleontological Study (Ph.D. dissertation)	Barbers Point (harbor area)
Rosendahl 1990	Letter Report	Kapolei Town
Kennedy 1991	Subsurface Testing	Pu‘u o Kapolei
Hammatt et al. 1991	Inventory Survey	Makaiwa Hills
Hammatt & Shideler 1991	Archaeological assessment	Barbers Point (harbor area)

Reference	Nature of Study	General Location of Study
Haun 1991	Survey Report	Naval Air Station
Burgett & Rosendahl 1992	Inventory Survey	Barbers Point (harbor area)
Pond & Davis 1992	Data recovery excavations	West Beach
Hammatt & Folk 1992	Subsurface Testing	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Jones 1993	Fossil coral reefs study (Ph.D. dissertation)	Hawaiian Islands
Landrum 1993	Reconnaissance & Subsurface Testing	Naval Air Station
Miller 1993	Data recovery	Barbers Point (harbor area)
Hammatt & Shideler 1994	Archaeological Assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory Survey	Barbers Point (harbor area)
Davis 1993	Archaeological & Paleontological Investigation	Barbers Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Hammatt & Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
O'Hare et al. 1996	Intensive survey & testing	Naval Air Station
Wulzen & Rosendahl 1996	Subsurface testing & data recovery	Naval Air Station
Athens et al. 1997	Cultural resource inventory, Paleoenvironmental Investigation	'Ewa Plain:Naval Air Station
Denfield 1994	History	Naval Air Station
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	'Ewa Plain

Reference	Nature of Study	General Location of Study
Tuggle & Tomonari 1997a	Cultural resource inventory survey	Naval Air Station
Wickler & Tuggle 1997	Cultural resource inventory, Inventory Survey	Naval Air Station
Hammatt & Shideler 1999	Inventory Survey	Waimānalo Gulch
McDermott et al. 2000	Data recovery	Barbers Point (harbor area)

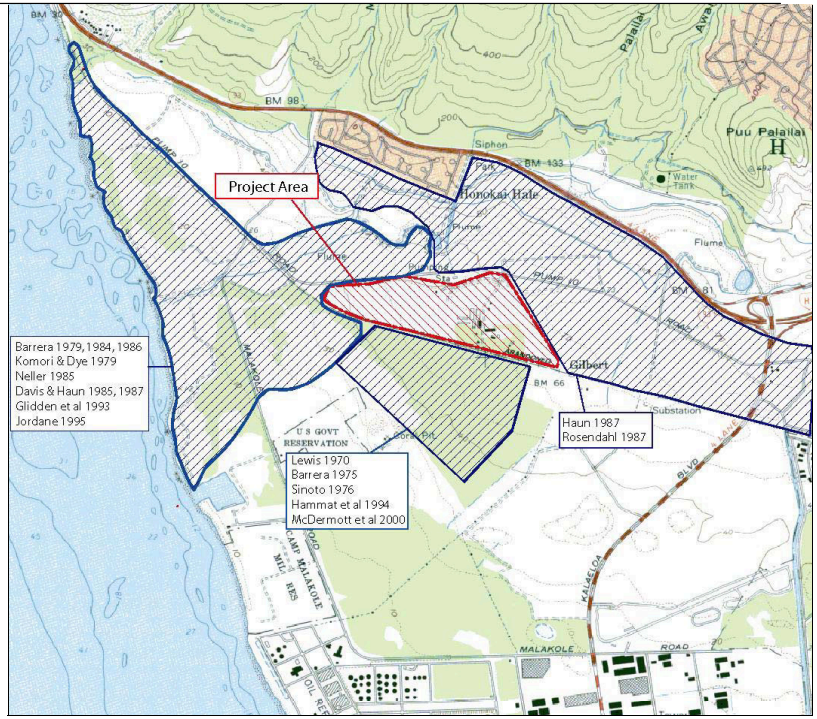

Figure 8: Map Showing General Areas of Archaeological Study Near the Project Area

The first effort to record sites at Honouliuli was by Thrum (1907:46) and references "a *heiau* on Kapolei hill, Ewa-size and class unknown. Its walls thrown down for fencing." This *heiau*, Pu‘u Kapolei, is 3.3 kilometers north of the present study area.

In his surface survey of 1930, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister (1933:107-108) recorded seven specific sites at Honouliuli (numbered 133-139) and these became the first seven sites in the Bishop Museum's Site Numbering System (OA-B6-1 through OA-B6-7). The nearest of these to the present project area is McAllister Site 138, including the Pu‘u Kapolei Heiau and an adjacent rock shelter are so distant from the project area that they are not discussed further. However, McAllister (1933:109) includes a rather general site description (Site 146) as follows:

> ‘Ewa coral plains, throughout which are remains of many sites. The great extent of old stone walls, particularly near the Pu‘uloa Salt Works belongs to the ranching period of about 75 years ago. It is probable that the Hawaiians formerly used the holes and pits in the coral. Frequently the soil on the floor of larger pits was used for cultivation, and even today one comes upon bananas and Hawaiian sugar cane still growing in them. They afford shelter and protection, but I doubt if previous to the time of Cook there was ever a large population here.

These Hawaiian sites of the ‘Ewa coral plains would be the subjects of some 37 archaeological reports in the 1970s and 1980s.

Between McAllister's 1930 study and the flurry of work, which began in 1969, there are only a few sporadic pieces of poorly documented research. "In 1933, Dr. Kenneth P. Emory examined a well-preserved house site and a possible *heiau* in the western part of the coral plain; these sites were later destroyed by sugar-cane planting" (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, approximately 1.8 km. due south of the present project area (Kikuchi 1959; Davis 1990: 146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling made note of a house site (BPBM. Site OA-B6-8). “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 (per Sinoto 1960), Lloyd Soehren "carried out salvage excavations at BPBM. Site # 50-OA-B6-13 (a possible fishing shrine.)” 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.

In the Fall of 1969, Mr. Ellis Cross, a supervisory employee at the nearby oil refinery on the coast, informed Dr. Sinoto that he had found house sites and walls at various locations on Campbell Estate land, near Campbell Industrial Park and the coral quarry (Lewis, 1970:2). This resulted in a number of visits by Dr. Sinoto and student volunteers in late 1969 and early 1970. A University of Hawaii graduate student, Mr. Ernest Lewis, did a preliminary survey and test excavations for a graduate seminar in Polynesian Archaeology and donated his report to the Bishop Museum. Lewis was the first to document sites so near to the project area (just seaward of the railroad alignment).

The sites Lewis documented just south of the O.R. & L. line were subject to a number of further studies including Barrera 1975, Sinoto 1976, Hammatt et al. 1994 and McDermott et al. 2000. Sites in relatively close proximity to the present project area are listed below in Table 2.

Table 2: Sites Near the Project Area

Site # (50-80-12-)	Type of Site	Source
4893	Sink	Hammatt et al. 1994:35
4894	Enclosure	Hammatt et al. 1994:35
4895	Mounds	Hammatt et al. 1994:39
4896	Sink complex	Hammatt et al. 1994:39
4897	Mound complex	Hammatt et al. 1994:43
4898	Mounds	Hammatt et al. 1994:43
4900	Complex of sinks and wall	Hammatt et al. 1994:46
9546	Wall ("Long Wall")	Lewis 1970:33; Barrera 1975:8; Sinoto 1976:16 (B6-23)
9547	Enclosure	Lewis 1970:36 (B6-24)
9548	Enclosure	Lewis 1970:35; Barrera 1975:8; Sinoto 1976:16(B6-25)
9551	Mound	Lewis 1970:356 (B6-29)
9552	Mound cluster	Lewis 1970:36 (B6-30)
9553	Cluster of mounds	Lewis 1970:36 (B6-31)
9555	*Ahu*	Lewis 1970:35 (B6-33)
9556	Terrace, mounds, paved area, enclosure	Lewis 1970:35 (B6-34)

To the west of the project area, Paradise Cove, Lanikūhonua, and West Beach have been the subject of numerous archaeological studies (Barrera 1979, 1984, 1986, Komori & Dye 1979; Neller 1985; Davis & Haun 1986, 1987; Glidden et al. 1993; and Jourdane 1995).

Of particular relevance to the present study were the work of Haun (1986) and Burgett and Rosendahl (1989). The Haun archaeological reconnaissance survey for the 'Ewa Town Center/Secondary Urban Center study covered an area of approximately 1,400 acres immediately adjacent to the east and northeast portions of the present project area. There were no finds anywhere near the present project area. The Burgett and Rosendahl study carried out seventy-two backhoe test trenches in a 360-acre portion of the Haun study area immediately adjacent to the east and northeast portions of the present project area. Again, there were no significant finds.

B. Predictive Model

The one general observation regarding the archaeology of southwestern O'ahu is that there was more precontact utilization of the area than might be expected given its present day uninviting ambiance and "marginal ecology" (Sinoto 1976:71). In our area of interest however, back from the coast and seaward of the forested inlands, pre-contact land use appears to have dropped off dramatically. Coupled with the land alteration associated with ranching, sugarcane cultivation, and the construction of the O.R. & L. railroad, and given the shallow sediments overlying limestone bedrock, little in the way of intact archaeological resources is to be expected. This limestone bedrock, similar to that in the project area, has in previous studies (Hammatt et al. 1994) yielded sinkholes with historic deposits. Given that the project area is within the 'Ewa karstic limestone plain, the occurrence of sinkholes is likely, and should be investigated as potential depositional sites that may yield significant cultural deposits.

V. FIELD INVESTIGATION

A. Survey Methods

Field investigation of the 100-acre portion of the land parcel in the southwest of TMK:9-1-15:4 was undertaken on 4 - 6 November, 2003 by four archaeologists from Cultural Surveys Hawai'i, Inc: Tracy Hoffman, M. A., Todd Tulchin, B. S., and Dominique Cordy, B. A. under the general direction of David W. Shideler, M. A. The purpose of this archaeological assessment was to determine whether significant archaeological or historic sites are present. Part of the archaeological concern here involves filled limestone sinkholes that may contain burials, other cultural finds, or extinct species. In addition we have checked for WWII and plantation era infrastructure that would now be regarded as of historic significance. The entire parcel was surveyed intensively by foot, with people abreast, approximately five meters apart (based on ground cover), sweeping the forested and cleared areas.

The O.R.&L. alignment within the project was followed with attention to adjacent limestone sinkholes and other potential sites more easily located from this slightly elevated vantage point. The railway alignment was followed on foot from the border of the project area with Ko'olina resort property on the west to its eastern boundary with former sugarcane lands.

B. Field Survey Findings

While the O.R.&L. alignment is preserved, the immediate margins are much impacted and are typically graded service roads on one or both sides. Unfortunately, the project's southern border, with the O.R.&L. alignment (with the exception of the railway itself) has been leveled and is dotted with bulldozer piles. No sinks were found in the immediate railway area.

The eastern portion of the project area was clearly under sugar cane cultivation for many decades, up to the margins of Kalaeloa Boulevard. Any archaeological remains appear to have been destroyed due to this intensive use.

All findings of historic interest were within the two forested areas. No pre-twentieth century surface archaeological features were identified. However, there were numerous twentieth century construction foundations throughout the forested areas that have been attributed to a chicken farm. There are also numerous twentieth century field clearance piles, like those described by Rosendahl (1987a: 3). Most of these are simply bulldozer push, but some piles show some hand stacking. None of the field clearance piles examined gave any indication of a function other than twentieth century commercial agriculture. The frequency of cement foundations in both forested areas, along with considerable historic debris, indicates that the structural remnants are beyond what would be expected from a chicken farm alone.

For better clarity we have designated the smaller forested area to the east, Area A and the larger forested area to the west, Area B (see Figure 9).

Within Area A, there are numerous cement foundations, debris including fragments of metal roofing, as well as intermittent bulldozer piles. Near the center of this area there is also a graded area that is either dug out or there has been extensive piling around its sides. Two sinkholes, designated CSH-3 (Figure 10) and CSH-4 (Figure 11), are relatively near to each other. CSH-4 has a banyan tree growing within it. It is a little under 1m deep and a little over 1m wide. CSH-3, by far the largest sinkhole in the project area, is just *mauka* of the graded coral road that skirts

this area. CSH-3 is 2.2m deep, 1.38 m wide and roughly 3.3m long. Like CSH-4, CSH-3 is also associated with a banyan tree, though in this case it is growing alongside the sink, rather than in it.

Area B is much larger than Area A and contains more concrete foundation remnants. There are cement strips that are about the width of an average sidewalk, six abreast running for more than 30 meters. In addition to poured cement foundations are the occasional small wall, metal chicken coops, fencing and one platform of composite brick or rock and cement. This raised platform is roughly $3m^2$, around one meter tall, composed of cemented quarried basalt with several steps leading off the west side. North and east of this platform is a standing permanent structure: a bare metal frame over a cement foundation that is roughly the size of a small barn. Heading towards the former cane fields from this structure is a dirt road, on the far side of which is a still-standing Quonset hut with a partially collapsed roof. The remainder of Area B is comprised of numerous bulldozed piles and wire mesh chicken coops that also border the western edge of this forested area.

Several sinks were found within Area B, the largest of which was several meters deep. Though the size is of interest, excavator claw scoring on one wall indicates modification, so we believe this sink has limited value for future examination. Two potential sinks were cleared of surface coral, cement, and barbed wire debris near the raised platform described above; one was designated site number CSH-1 (Figure 12 & 13). Near the western corner of Area B and the O.R.&L. is an ungraded area adjoining the most concentrated area of cement foundations, within which is a raised limestone platform with several sinkholes. CSH-2A and CSH-2B are adjoining sinkholes, both roughly rounded and a little under 1m in diameter each (Figure 14). CSH 2A is the larger, though both are about 40 cm deep.

There are more remnants of large-scale bulldozer piles in Area A than in Area B. Area B also has a sizeable amount of historic ceramics and bottle trash, whereas Area A has little. The roughness of the poured cement platforms, gravel inclusions in the cement composition and the integration of surrounding limestone into walls and construction in Area B, compared to the cleaner edges of cement platforms of Area A, seem to suggest older and less uniform construction, possibly over an extended time period within Area B.

Each Area has two sinks, designated with CSH temporary site numbers, that provide the best sample of sinkholes in the entire project area and warrant further examination. Though all of the sinks have surface historic trash, they are natural in formation within an intact limestone shelf and could potentially yield cultural or faunal material.

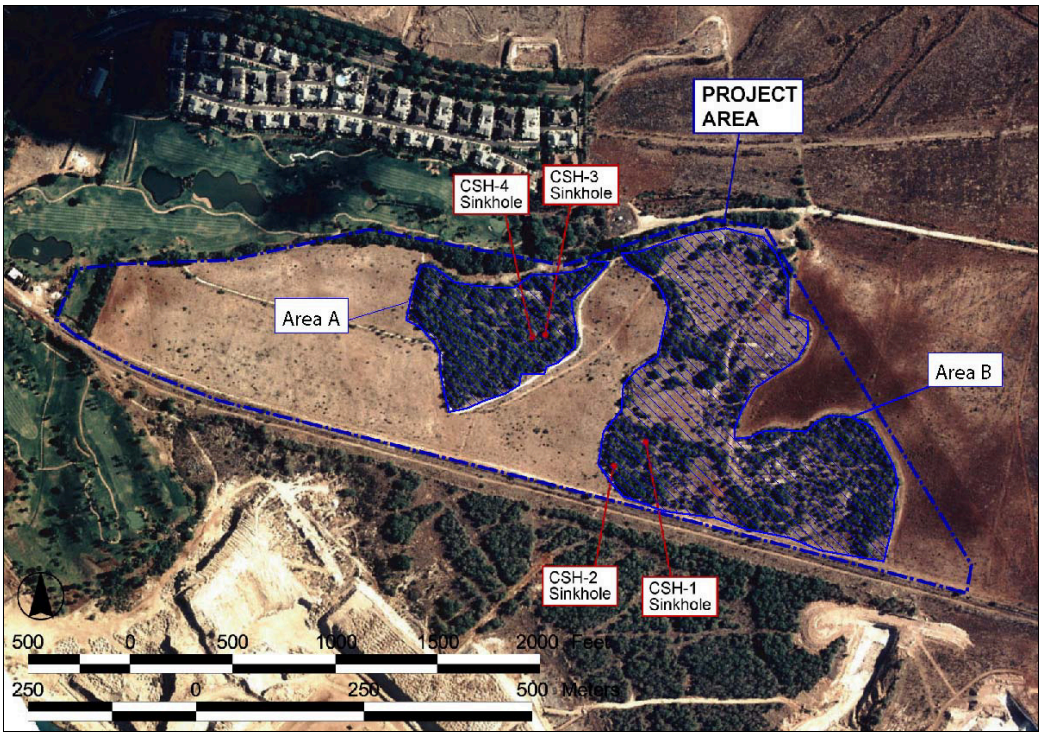

Figure 9: Aerial Photo of Project Parcel Showing Areas A and B, and CSH Sinkholes

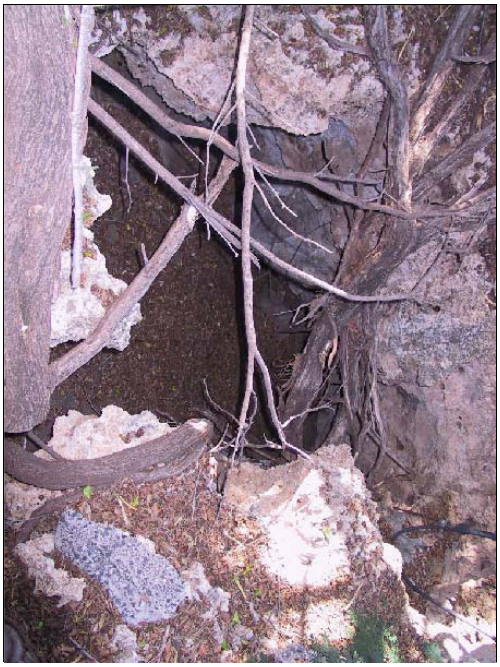

Figure 10: CSH-3 Sinkhole, View to Southwest



Figure 11: CSH-4 Sinkhole, View to Northeast



Figure 12: CSH-1 Sinkhole Before Surface Clearing, View to Northwest



Figure 13: CSH-1 Sinkhole After Surface Clearing, View to Northwest



Figure 14: CSH-2A and 2B Sinkholes (from left to right)

VI. SUMMARY AND RECOMMENDATIONS

The predicted settlement patterns in the region of the project area indicate that the area was utilized in ancient times mostly for bird hunting, sinkhole agriculture and temporary habitation. The intensity of land use would be anticipated to have been higher nearer the coast with significantly less intensive use in more inland areas of the coastal plains such as the vicinity of the present study area. This background research indicates the importance of sinkholes as potential locations for historic deposits. Based on previous archaeological study in nearby land parcels (Hammatt et al. 1994), that have yielded historic deposits from sinkhole excavations, the potential to encounter subsurface deposits in sinks is evaluated as fairly high.

It was anticipated that the large areas of former cane lands that dominate the eastern margin and west, southwest, and central portions of the project area (see Figure 9) would be largely devoid of sites. This indeed proved to be the case with not even any sugar cane plantation infrastructure present. It was hoped that some traditional Hawaiian or early historic sites might be present within the two wooded areas designated areas A and B (see Figure 9) but these areas proved to have also been massively impacted by grading and grubbing activities. Aside from two sinkholes (designated CSH-3 and CSH-4) we have no concerns in area A. Similarly the vast majority of designated area B was observed to have been massively graded and grubbed at least in part in association with a chicken farm. Again our concern largely focused on two sinkholes (CSH-1 and CSH-2).

The south-central and southeast portion area B (Figure 9) have a surprisingly large number of cement platforms which seemingly would have required scores of cement mixer loads to construct. While the presence of fences built out of what appears to be old chicken coops and parallel alignments of relatively narrow foundations appear commensurate with the use as a large chicken/chicken-egg ranch. However, the sheer volume of cement suggests the possibility of some prior military related occupation. We have found no clear evidence of military use (no military use is shown on the 1943 map; see Figure 7) and although Quonset huts, barbed wire, and at least one military style Gerry-can were observed, such military surplus was widely used in the region for domestic and agricultural purposes in the post-WWII years. In short the possible military use of this area is uncertain. A number of these cement platforms were clearly deliberately destroyed by large earth-moving machinery and/or explosives. While the thoroughness of the destruction again suggests military use, the extent of the destruction is so great as to have obliterated context and integrity.

Therefore, we recommend that further archaeological research focus on subsurface testing of sinkholes. We recommend a modest program of archaeological subsurface inventory survey focusing on test excavations at the sinkholes designated CSH-2A and CSH-3. This would serve as a good faith effort to look in two of the most likely areas for the possible presence of pre-contact cultural material, human remains, or significant paleo-avifauna deposits. Recommendations for further work, if any, would depend on the finds within the sinkhole excavations.

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Archaeological Inventory Survey

of Two Sinkholes at Kapolei,

Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu Island

TMK: 9-1-15:4

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TABLE OF CONTENTS

I. INTRODUCTION 1
A. Project Background 1
B. Scope of Work 1
C. Methods 5
1. Background Research 5
2. Field Methods 5
D. Natural Setting 5
II. HISTORICAL BACKGROUND 6
A. Precontact and Early History 6
B. Mid to late 19th Century 8
C. Modern Land Use 9
III. HONOULIULI SETTLEMENT PATTERNS 13
A. The Physical Layout 13
B. The Coastal Zone 14
1. Kalaeloa (Barber's Point) 14
2. Ko‘olina (West Beach) 14
C. Honouliuli Taro Lands 15
D. Pu‘u Ku‘ua: Inland Settlement 15
E. Summary of Settlement Patterns in Honouliuli 16
F. Summary of Settlement Patterns in Project Area 17
IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES 18
A. Overview of Archaeological Studies in Western Honouliuli 18
B. Predictive Model 25
V. FIELD INVESTIGATION 26
A. Field Methods 26
B. Laboratory Analysis Methods 26
1. Artifact Analysis 26
2. Faunal and Midden Analysis 26
VI. SINKHOLE EXCAVATION RESULTS 29
A. Stratigraphy Overview 29

B. Sinkhole CSH-2a 29
C. Sinkhole CSH-3 (State Site 50-80-12-6674) 35

VII. SUMMARY DISCUSSION AND RECOMMENDATIONS 42
A. Site Description 42
B. Summary of Findings 42
C. Recommendations 43

VIII. BIBLIOGRAPHY 44
Appendix A: Vertebrate Remains from CSH-2a. 52
Appendix B-Bottles and Ceramics From CSH-3 55

LIST OF FIGURES

Figure 1. Portion of U.S. Geological Survey map (1983), Barbers Point Quadrangle showing sinkholes excavated. 2
Figure 2. Portion of TMK 9-1-15 showing location of sinkholes excavated 3
Figure 3. Aerial photograph showing the location of Areas A and B and of sinkholes excavated 4
Figure 4. Map showing location of Honouliuli Ahupua‘a in west O‘ahu (adapted from Sterling and Summers 1978) 7
Figure 5. Portion of War Department Fire Control Maps, Nanakuli and Barber’s Point Quads (1919) showing the location of sinkholes excavated 10
Figure 6. Portion of 1928 USGS Barbers Point Quad Map showing the location of sinkholes excavated 11
Figure 7. Portion of 1943 War Department Barbers Point Quad Map showing the location of sinkholes excavated. 12
Figure 8. Map showing general areas of archaeological study near the project area 22
Figure 9. Aerial photo of Cordy & Hammatt (2003) project area showing Areas A and B, and sinkholes identified 28
Figure 10. Sinkhole CSH-2a (on left) prior to excavation, view to east 30
Figure 11. Sinkhole CSH-3 prior to excavation, view to west 30
Figure 12. Sinkhole CSH-2a prior to excavation 31
Figure 13. Plan view of CSH-2a, showing test unit 32
Figure 14. Profile of CSH-2a, northeast wall 34
Figure 15. Plan view of CSH-3 (designated State Site 50-80-12-6674) showing test unit 36
Figure 16. Profile of CSH-3, south wall 37
Figure 17. Photograph of sinkhole CSH-3 prior to excavation, view to southwest 38
Figure 18. Photograph of high-power sprayer and cement troughs on the west edge of sinkhole CSH-3 38
Figure 19. Vacuum-sealed medical bottles with rubber stoppers for withdrawl by syringe found in sinkholes CSH-2a and CSH-3 41
Figure 20. Fragment of a dish marked with “United States Army Medical Department” stamp 41

LIST OF TABLES

Table 1: Archaeological and Related Studies in Western Honouliuli Ahupua‘a. 18
Table 2: Sites Near the Project Area. 24

I. INTRODUCTION

A. Project Background

At the request of Helber Hastert and Fee Planners, Cultural Surveys Hawai‘i, Inc. (CSH) completed an archaeological inventory survey of two sinkholes within an approximately 100-acre project area (Cordy and Hammatt 2003) in TMK: 9-1-15:4, lying north of the O.R.&L. alignment, west of Kalaeloa Blvd., and east of Ali‘i Nui/ Ko‘i‘o Drive (Figures 1, 2 and 3) in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southeastern O‘ahu. These sinkholes are on lands owned by The Estate of James Campbell. This project area lies in the southwest corner of the 468-acre TMK parcel, and includes two large wooded areas, designated as Area A and Area B in the previous archaeological assessment (Cordy & Hammatt 2003, see Figure 3) that had not previously undergone archaeological survey. Four sinkholes were located during the archaeological assessment, two in each of these areas. One sinkhole was tested in each area.

B. Scope of Work

The purpose of this inventory survey was to determine whether limestone sinkholes in this area contained burials, other cultural finds, or extinct species. Background research was conducted to provide a historical and archaeological context for the project area.

The scope of work includes:

1. Fieldwork to excavate stratigraphically and record the stratigraphy and finds within two specific sinkholes (CSH 2a and CSH 3). This includes the written description and photographing of the excavations and the drawing of representative plan and profile views.
2. Laboratory work including the separation and identification of midden samples and artifactual material.
3. Preparation of a report including the results of the historical research, fieldwork, laboratory work and specialized studies documenting the nature and history of the sinkholes in question, including the production of maps, photographs, and drafted plan and profile views.

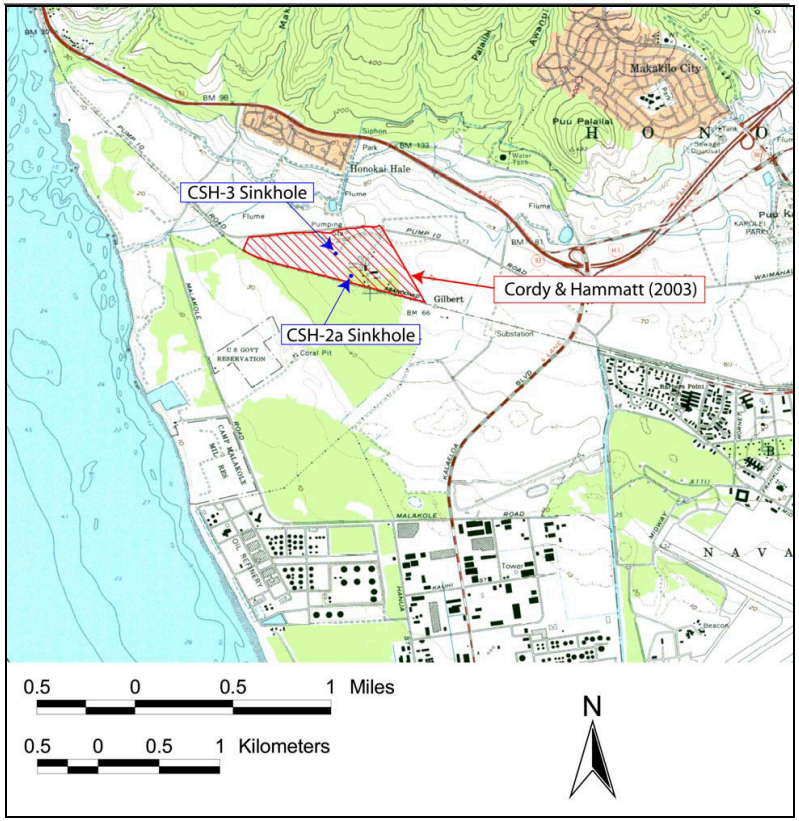

Figure 1. Portion of U.S. Geological Survey map (1983), Barbers Point Quadrangle showing sinkholes excavated.

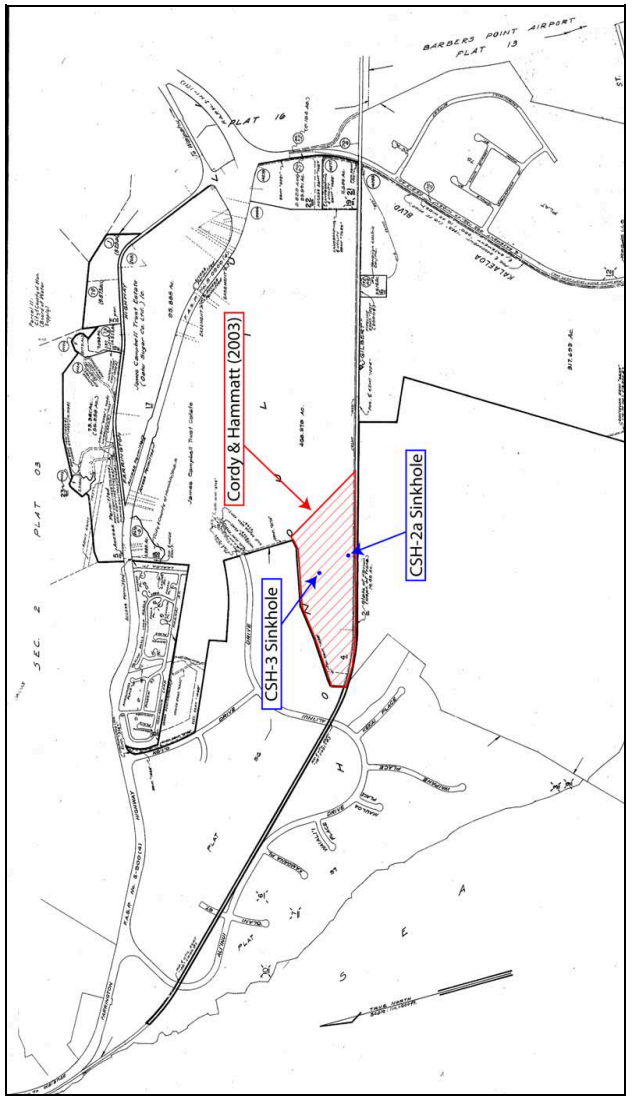

Figure 2. Portion of TMK 9-1-15 showing location of sinkholes excavated

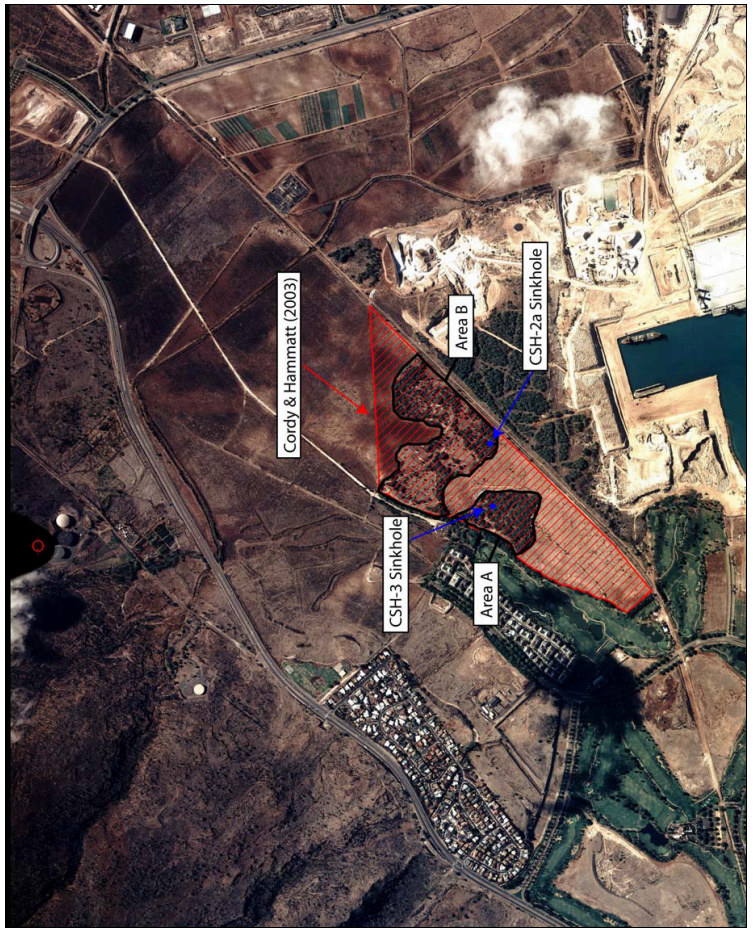

Figure 3. Aerial photograph showing the location of Areas A and B and of sinkholes excavated

C. Methods

1. Background Research

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division of the Department of Land and Natural Resources and a review of documents and maps at the Cultural Surveys Hawai‘i library.

2. Field Methods

Test excavation of sinkholes CSH-2a and CSH-3 (designated State Inventory of Historic Places Site 50-80-12-6674) was conducted on April 19th through the 22nd, and April 26th, by CSH archaeologists, Tracy Hoffman, Daniel Terry, David Perzinski, and Karl Van Ryzin, under the supervision of David Shideler. The test excavations focused on determining if any subsurface cultural, and/or extinct avifauna remains are present.

The test excavations consisted of 1 x 1 meter test units within each of the two sinkholes, each excavated by hand, conducted by cultural strata or in arbitrary 10 cm levels where cultural strata exceed 10 cm in thickness, and documented with scale profiles, photographs, and sediment descriptions. Samples of artifacts and sediments were taken.

D. Natural Setting

The project area is located on the ‘Ewa plain, south of the Wai‘anae Mountain Range in the southwest corner of O‘ahu. The terrain is limestone and alluvial deposits, overlying flows of the Wai‘anae volcanic series (Macdonald et al. 1983:423). The project area is generally quite level varying between 30 and 70 feet elevation above sea level.

The project area is largely covered with clay soils including a moderately shallow ‘Ewa silty clay loam, and Mamala stony silty clay loam. The two forested areas of the study parcel include unbulldozed sections of coral (limestone) outcrop intermixed with sections of clay and silty clay loam (Foote et al. 1972). Some of these clay and silty clay loam deposits are most likely of historic deposition owing to increased erosion from introduced grazing animals and the deliberately induced erosion to improve agricultural fields. In traditional Hawaiian times, the areas of coral outcrop were probably more extensive.

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 receiving about 18 inches of rainfall annually (Juvik and Juvik 1998:56). In pre-contact Hawai‘i the project area would have been mostly lowland dry shrubland and grassland but this area has been extensively disturbed and transformed by human activity with a variety of exotic grasses, weeds and shrubs now dominating. These grasses and shrubs, along with pockets of *kiawe* forest, and a few scattered banyan trees are characteristic of the vegetation of the two areas of archaeological interest.

II. HISTORICAL BACKGROUND

A. Precontact and Early History

Various legends and early historical accounts indicate that the *ahupua'a* of Honouliuli (shown in Figure 4) was once heavily populated by pre-contact Hawaiians. This substantial settlement is attributable for the most part to the plentiful marine and estuarine resources available at the coast and lowlands suitable for wetland taro cultivation. The lower mountain slopes would have provided the inhabitants of the lowland with a variety of forest goods.

Forest resources along the slopes of the Wai'anae Range - as suggested by E. S. and E. G. Handy - probably acted as a viable subsistence alternative during times of famine and/or low rainfall.

> ...The length or depth of the valleys and the gradual slope of the ridges made the inhabited lowlands much more distant from the 'wao, or upland jungle, than was the case on the windward coast. Yet the 'wao here was more extensive, giving greater opportunity to forage for wild foods during famine time [Handy and Handy 1972:469-470].

The upper valley slopes may have also been a resource for sporadic quarrying of basalt for the manufacturing of stone tools. At least one probable quarrying site (State Site 50-80-12-4322) is present in Maka'īwa Gulch at 152 m. (500 ft.) a.m.s.l. (Hammatt et al. 1991).

The Hawaiian *ali'i* were also attracted to the region. One historical account of particular interest refers to an *ali'i* residing in Ko'olina, just west of the project area:

> Ko'olina 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'olina 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 in Sterling and Summers 1978:41].

John Papa 'Ī'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'u Kapolei and Waimānalo Gulch to the Wai'anae coast and onward, circumscribing the shoreline of O'ahu ('Ī'ī 1959:96-98). Following 'Ī'ī's description, a portion of this trail network would have passed close to the presently existing Farrington Highway.

Other 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 pre-contact and early post-contact populations also adapted to less inviting areas, despite the environmental hardships.

Barber's Point is named after Captain Henry Barber who ran aground on October 31, 1796. 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 due to overharvesting, and the

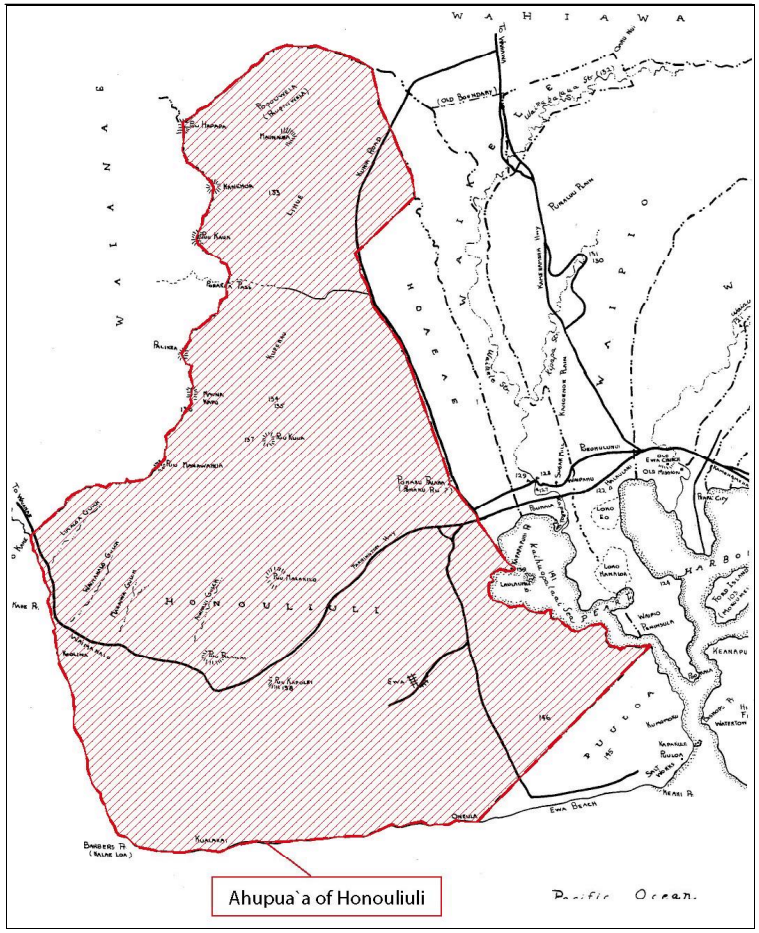

Figure 4. Map showing location of Honouliuli Ahupua'a in west O'ahu (adapted from Sterling and Summers 1978)

introduction of domesticated animals and exotic plant species. Domesticated animals including goats, sheep and cattle were brought to the Hawaiian Islands by Capt. George Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. L.A. Henke reports the existence of a longhorn cattle ranch in Waiʻanae by at least 1840 (in Frierson 1972:10).

During this same time, perhaps as early as 1790, exotic vegetation species were introduced to and flourished in the area. The following dates of specific vegetation introduced to Hawaiʻi, given by R. Smith and outlined by Frierson (1972:10-11), are relevant when identifying and selecting charcoal samples used for radiocarbon dating:

> 1) "early", c. 1790: Prickly pear cactus, *Opuntia tuna*; *Haole koa*, *Leucaena glauca*; Guava, *Psidium guajava*
>
> 2) 1835-1840: Burmuda [sic] grass, *Cynodon dactylon;* Wire grass, *Eleusine indica*
>
> 3) 1858: Lantana, *Lantana camara*
>
> The *kiawe* tree was also introduced during this period, either in 1828 or 1837 [Frierson 1972:11].

B. Mid to late 19th Century

Following the Mahele of 1848, 99 individual land claims in the *ahupuaʻa* of Honouliuli were registered and awarded by King Kamehameha III. The present study area appears to have been included in the largest award (Royal Patent 6071, LCA 11216, ʻĀpana 8) granted in Honouliuli Ahupuaʻa to Miriam Keʻahi-Kuni Kekauʻonohi on January 1848 (Native Register). Kekauʻonohi acquired a deed to all unclaimed land within the *ahupuaʻa*, totaling 43,250 acres.

Kekauʻonohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanuʻu Kahalaʻiʻa, who was governor of Kauaʻi. Subsequently, Kekauʻonohi ran away with Queen Kaʻahumanu's stepson, Keliʻi-ahonui, and then became the wife of Chief Levi Haʻalelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. When Levi Haʻalelea died the property went to his surviving wife, who in turn leased it to James Dowsett and John Meek in 1871 for stock running and grazing.

In 1877 James Campbell purchased most of Honouliuli Ahupuaʻa -including the present study area- for a total of $95,000. He then drove off 32,347 head of cattle belonging to Dowsett, Meek and James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). By 1881 the Campbell property of Honouliuli prospered as a cattle ranch with "abundant pasturage of various kinds" (Briggs in Haun and Kelly 1984:45).

In 1889, Campbell leased his property to Benjamin Dillingham, who subsequently formed the Oʻahu Railway and Land Company (O.R. & L.) in 1890. To attract business to his new railroad system, Dillingham subleased all land below 200 feet to William Castle who in turn sublet the area to the ʻEwa Plantation Company for sugar cane cultivation (Frierson 1972:15).

ʻEwa Plantation Co. grew quickly and continued in full operation up into modern times. As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the ʻEwa Plantation Co. installed ditches running from the lower slopes of the mountain range to the

lowlands and then plowed the slopes vertically just before the rainy season to induce erosion (Frierson 1972:17).

C. Modern Land Use

Modern land use of the project area has been for transportation along the former O.R.& L. alignment. The 1919 War Department Fire Control Map (Figure 5) shows a compound of four structures along the middle of the inland edge of the parcel (likely associated with a plantation railway) but this appears to have been no longer extant in the 1928 USGS map (Figure 6). Both the 1919 and 1928 maps show walls and fences within the project area but these configurations are rather dissimilar on these two early twentieth century maps. The 1943 war department map (Figure 7) indicates that only the northeast portion of the project area (light shading) may have been under cultivation at that time. None of these three maps shows any significant development within the area of present concern.

Much of this parcel was under sugar cane cultivation by the first half of the twentieth century. Today the project area borders the Koʻolina resort complex on the west, the O.R.&L. alignment to the south and old cane land to the east. The property appears to have had no formal use for quite some time, though it is adjacent to areas of active development including the Barber's Point Deep Draft Harbor and Koʻolina resort areas.

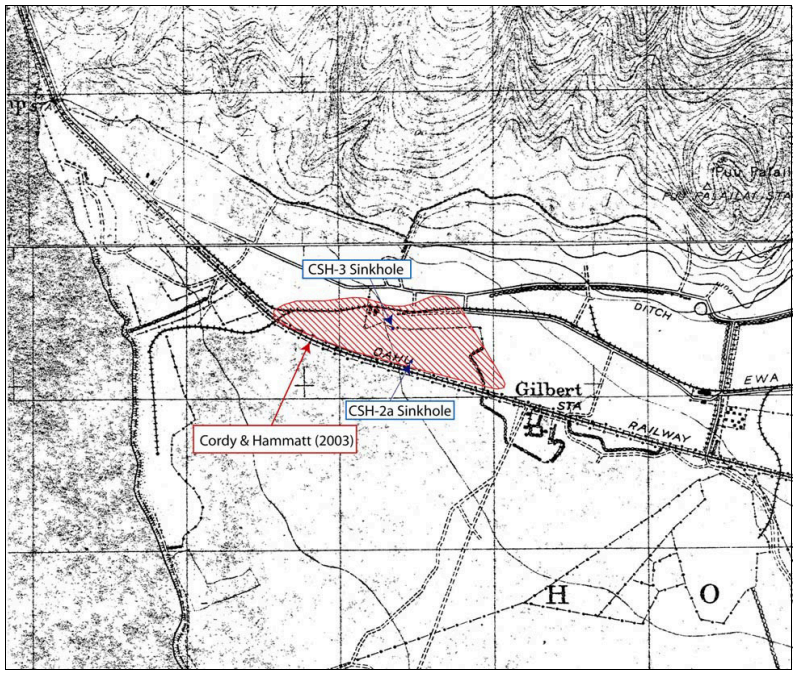

Figure 5. Portion of War Department Fire Control Maps, Nanakuli and Barber's Point Quads (1919) showing the location of sinkholes excavated

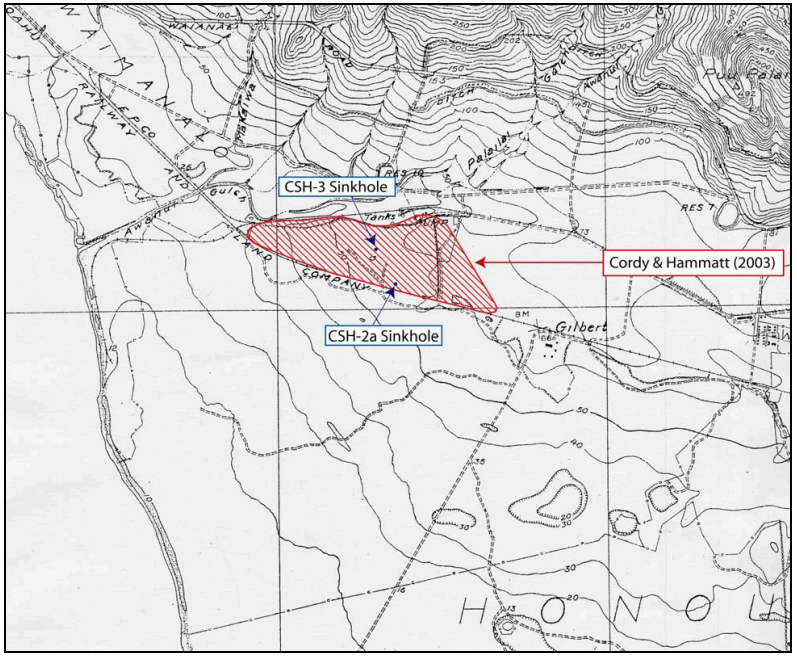

Figure 6. Portion of 1928 USGS Barbers Point Quad Map showing the location of sinkholes excavated.

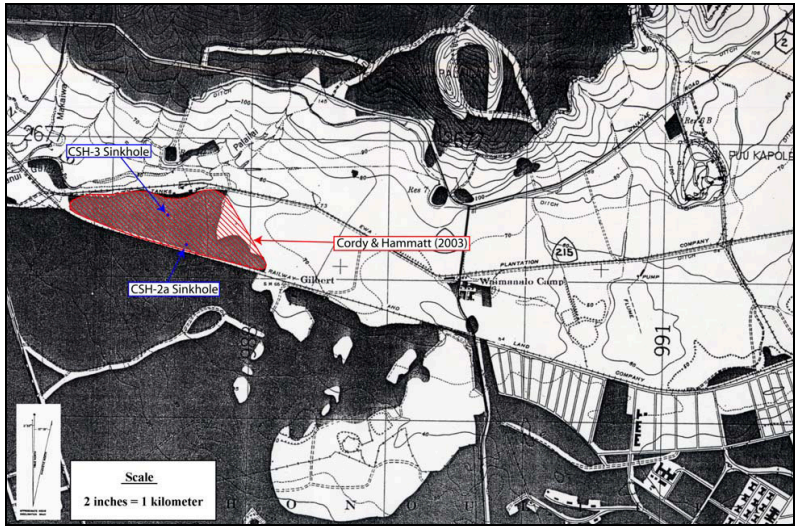

Figure 7. Portion of 1943 War Department Barbers Point Quad Map showing the location of sinkholes excavated.

III. HONOULIULI SETTLEMENT PATTERNS

A. The Physical Layout

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* 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 does Honouliuli boast a long coastline along the normally calm waters of leeward O'ahu, but there are four miles of waterfront running along the west side of West Loch. The land immediately inland of the sea coast consists of a flat karstic raised limestone reef forming a level, nearly featureless "desert" plain covered in pre-contact times by a thin or non-existent soil mantle. The microtopography is notable in containing countless sinkholes in some areas, created by chemical weathering (dissolution) of the limestone shelf. Proceeding inland, this plain is overlain by alluvium deposited through a series of gulches draining the Wai'anae Mountains. The largest of which, Honouliuli gulch, is on the east side of the plain draining into West Loch. To the west are fairly steep gradient gulches forming a more linear than dendritic drainage pattern. The major gulches are (from east to west) Awanui, Palailai, Makaīwa, Waimānalo and Lumaloa. These gulches are 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 deltaic fashion over the inland portions of the plain. These gulches are generally dry, but during seasonal Kona storms they 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 in their upper reaches. These gulches do not have valleys suitable for extensive irrigated agriculture. However, this lack is more than compensated for by the rich, watered lowlands at the base of Honouliuli Gulch (the *'ili* of Honouliuli).

Honouliuli Ahupua'a, as a traditional land unit, had tremendous and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain (which is the most readably visible terrain) does not do justice to the *ahupua'a* as a whole. The following available resources mark the richness of this land unit:

1. Twelve 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-Laulaunui for example.
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 of 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*: 1) the coastal zone including Kalaeloa (Barber's Point), Ko'olina (West Beach), and One'ula ('Ewa Marina), 2) the Honouliuli Taro Lands and 3) the inland area of Pu'u Ku'ua,

B. The Coastal Zone

1. Kalaeloa (Barber's Point)

Archaeological research at Barber's Point has focused on the areas in and around the newly constructed Deep Draft Harbor (see Table 1). A 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 petrel occurs at Site -2763 located 1 km. south of the project area (Hammatt and Folk 1981:213). Initial heavy exploitation of nesting seabirds and other species, in conjunction with habitat destruction, probably led to early extinction of these bird communities.

There is some indication of agriculture in mulched sinkholes and soil areas. Considering rainfall, this activity would have been constrained by accessibility to water, probably involving tree crops and roots (sweet potatoes). The archaeological content of the sites indicates a major focus on marine resources.

Bertel Davis (1990a:135), in his Ph.D. dissertation, summarizes our knowledge of traditional Hawaiian use of the coastal zone of Honouliuli:

> I suggest the west coast of O'ahu, including the area off Barbers Point, (a) probably became a well established fishery at least by AD 1000, perhaps much earlier; (b) the initial settlement at Barbers Point also began around this time or possibly earlier; and (c) the settlement initially involved task-specific groups exploiting the adjacent fishery on a seasonal round, probably during the winter months.

2. Ko'olina (West Beach)

Studies associated with the Ko'olina area, which includes the western portion of the present project, document around 200 component features at approximately 50 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 (1987:37) describe as "one of the longest local sequences in Hawaiian prehistory." The earliest part of the

sequence relates to the discovery of an inland marsh but early dates were also obtained for a beachfront site and an inland rock shelter.

C. 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. This area bordering West Loch was clearly a major focus of population within the Hawaiian Islands. 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. As early as 1825 all the roads of southwest O'ahu coalescing and descending the *pali* as they funnel into the locality which gave the district of Honouliuli its name. Dicks et al. (1987:78-79) conclude, on the basis of 19 radiocarbon 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. Prehistoric population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census 1831-1832, the land *('āina*) of Honouliuli contained 1026 men, women, and children (Schmitt 1973:19). It is not clear whether this population relates to Honouliuli Village or district 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 pre-contact population of Honouliuli Village may well have been significantly greater than it was in 1831-1832.

D. Pu'u Ku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic in the general absence of archaeological studies. 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 Kalaiaina*" relates a story of Pu'u Ku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

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 (in Sterling and Summers 1978:33).

McAllister (1933:134, 137) recorded three sites in this area: two *heiau,* Pu'u Kuina and Pu'u Ku'ua (both destroyed), and most interesting, a series of enclosures in Kukuilua which he calls "kuleana sites." There is no direct archaeological evidence available that Hawaiian settlement occurred here but extensive settlement appears likely from traditional accounts. Geographically, the area is well-watered and would have had abundant locally available forest resources.

E. Summary of Settlement Patterns in Honouliuli

Based on the above summary of areas of Honouliuli settlement the following general considerations are made to place the project area in the context of the *ahupua'a* settlement pattern. There are three areas of Hawaiian settlement in the *ahupua'a*; two are well documented while one is more 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;

c. The uplands around Pu'uku'ua for presently uncertain reasons but probably agriculture and forest resource utilization.

Honouliuli, as a unit, contains 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 highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, as well as an extensive limestone plain that 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 forestland for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The *mauka/makai* route would have been up Honouliuli Gulch or up the Makakilo ridge, paralleling the coast from Honouliuli Gulch to Kahe. The most convenient route to *mauka* lands, even from the western end of the coast (Ko'olina), would have been *mauka* only to the base of the hills and then either up the Makakilo Ridge or northeast to a trail to Pu'u Ku'ua. The *makai* slope is the dry side of the ridgeline. Here streams would respond to rainfall quickly but drain quickly leaving little available water for even short-term use.

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'olina 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. Supported by seasonal dry land planting and forest foraging, this *mauka* habitation could have been the lower portion of a thinly scattered, but widespread zone of settlement stretching eastward and northeast along the east Wai'anae Range slopes; possible increasing in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

There is to date no archaeological evidence of high status residences in Honouliuli. Large residential structures are not present along the 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) but to date there is no direct archaeological evidence of this. Concerning status associations with

Honouliuli it is interesting to note the connection of the Pu'uku'ua settlement with pariah (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

The central place of the *ahupua'a* of Honouliuli in terms of population, as well as cultivated foods, was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other locations during prehistoric times, that all other habitation zones were economically and socially co-dependent.

F. Summary of Settlement Patterns in Project Area

The project area lies well inland, on the extensive 'Ewa limestone plain, which was, according to Honouliuli settlement predictions, probably never permanently inhabited. It could have, however, provided temporary habitation for gatherers and fisherman traveling inland to the coast. A relatively barren and waterless area, it nonetheless might have been occasionally transversed, as the project area lay between the greater populated and watered uplands and *makai* resources. The extended limestone plain would have been used for bird catching, and would include the temporary habitations that would result from such forays. Planters could have also used the natural limestone sinks for agriculture, though it would have been seasonal and on a small scale. In general the project area lies in a region that would have been less than bountiful, and therefore sparsely utilized, even in ancient times.

IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES

A. Overview of Archaeological Studies in Western Honouliuli

The Barbers Point area (western Honouliuli Ahupua'a) has a reputation as the most archaeologically studied place in Polynesia. An overview of archaeological studies in the west half of Honouliuli Ahupua'a is presented in Table 1 and Figure 8. A discussion of archaeological findings germane to the present project area follows.

Table 1: Archaeological and Related Studies in Western Honouliuli Ahupua'a.

Reference	Nature of Study	General Location of Study
Thrum 1907	*Heiau* Study	Hawaiian Islands
McAllister 1933	All island survey	O'ahu Island
Kikuchi 1959	Site letter report	Barbers Point
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
Frierson 1972	Study of land use & vegetation change	Honouliuli
Barrera 1975	Reconnaissance survey	Barbers Point (harbor area)
Clark & Connolly 1975	Reconnaissance survey	Barbers Point (harbor area)
Oshima 1975	Reconnaissance survey	Barbers Point
Sinoto 1976	Cultural resources survey	Barbers Point (harbor area)
Bordner 1977	Reconnaissance survey	Kalo'i Gulch
Davis 1978	Scholarly paper	Barbers Point (harbor area)
Davis & 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 1978	Archaeological & Paleontological salvage	Barbers Point (harbor area)
Barrera, 1979b	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)

Reference	Nature of Study	General Location of Study
Komori & Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
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 & Folk 1981	Archaeological & Paleontological Investigation	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 & Homon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch
Ahlo & Homon 1984	Test excavations	Barbers Point (harbor area)
Hammatt 1984	Reconnaissance survey	Kahe Point
Haun & Kelly 1984	Research Design	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
Neller 1985	Review & evaluation	West Beach
Barrera 1986	Archaeological Investigations	West Beach
Davis & Haun 1986	Intensive survey & test excavations	West Beach
Davis et al. 1986 a&b	Research Design	West Beach
Haun 1986	Reconnaissance survey	Kapolei Town
Davis & Haun 1987	Intensive survey & test excavations	West Beach
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Survey Report	Kapolei Town
Welch 1987	Reconnaissance survey	Naval Air Station
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial Documentation	Kahe
Burgett and Rosendahl 1989	Subsurface Archaeological Testing	S. of Farrington Hwy., N. of OR&L, W. of Kalaeloa Blvd.
Hammatt & Shideler 1989a	Archaeological Assessment	Barbers Point (harbor area)

Reference	Nature of Study	General Location of Study
Hammatt & Shideler 1989b	Reconnaissance survey	Kahe
Carlson & Rosendahl 1990	Inventory Survey	Kaomi Loop Subdivision
Cleghorn & Davis 1990	Archaeological & Paleontological Investigation	Barbers Point (harbor area)
Davis 1990a	Archaeological & Paleontological Study (Ph.D. dissertation)	Barbers Point (harbor area)
Davis 1990b	Archaeological & Paleontological Investigation	Barbers Point (HECO area)
Rosendahl 1990	Letter Report	Kapolei Town
Kennedy 1991	Subsurface Testing	Pu‘u o Kapolei
Hammatt et al. 1991	Inventory Survey	Makaiwa Hills
Hammatt & Shideler 1991	Archaeological assessment	Barbers Point (harbor area)
Haun et al. 1991	Survey Report	Naval Air Station
Burgett & Rosendahl 1992	Inventory Survey	Barbers Point (harbor area)
Charvet-Pond & Davis 1992	Data recovery excavations	West Beach
Erkelens 1992	Archaeological survey	Naval Air Station
Hammatt & Folk 1992	Subsurface Testing	Barbers Point (harbor area)
Davis 1993	Archaeological & Paleontological Investigation	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Jones 1993	Fossil coral reefs study (Ph.D. dissertation)	Hawaiian Islands
Landrum 1993	Reconnaissance & Subsurface Testing	Naval Air Station
Miller 1993	Data recovery	Barbers Point (harbor area)
Hammatt & Shideler 1994	Archaeological Assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory Survey	Barbers Point (harbor area)
Hammatt & Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
O’Hare et al. 1996	Intensive survey & testing	Naval Air Station
Wulzen & Rosendahl 1996	Subsurface testing & data recovery	Naval Air Station

Reference	Nature of Study	General Location of Study
Athens et al. 1997	Cultural resource inventory, Paleoenvironmental Investigation	‘Ewa Plain:Naval Air Station
Denfield 1994	History	Naval Air Station
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	‘Ewa Plain
Tuggle & Tomonari 1997	Cultural resource inventory survey	Naval Air Station
Wickler & Tuggle 1997	Cultural resource inventory, Inventory Survey	Naval Air Station
Hammatt & Shideler 1999	Inventory Survey	Waimānalo Gulch
McDermott et al. 2000	Data recovery	Barber’s Point (harbor area)
Cordy & Hammatt 2003	Archaeological Assessment	‘Ewa Plain
Hoffman & Hammatt	Field Inspection	Barber’s Point

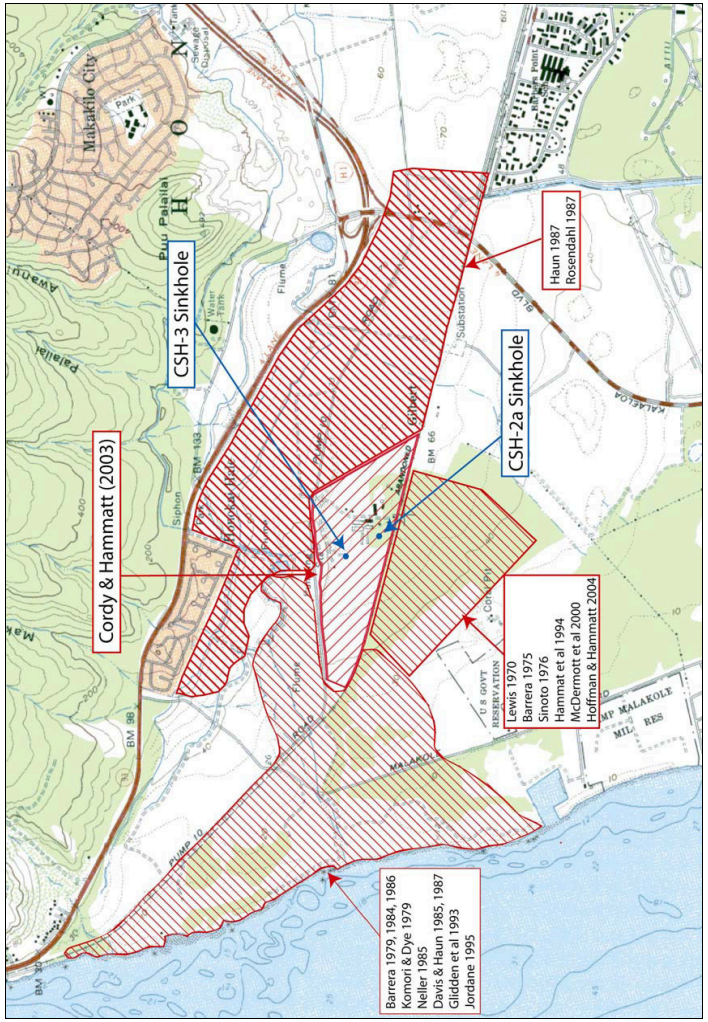

Figure 8. Map showing general areas of archaeological study near the project area

The first effort to record sites at Honouliuli was by Thrum (1907:46) and references "a heiau on Kapolei hill, Ewa-size and class unknown. Its walls thrown down for fencing." This *heiau*, Pu‘u Kapolei, is 3.3 kilometers north of the present study area.

In his surface survey of 1930, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of less important sites (at least at Honouliuli). McAllister (1933:107-108) recorded seven specific sites at Honouliuli (numbered 133-139) and these became the first seven sites in the Bishop Museum's Site Numbering System (OA-B6-1 through OA-B6-7). The nearest of these to the present project area is McAllister Site 138, including the Pu‘u Kapolei Heiau and an adjacent rock shelter are so distant from the project area that they are not discussed further. However, McAllister (1933:109) includes a rather general site description (Site 146) as follows:

> ‘Ewa coral plains, throughout which are remains of many sites. The great extent of old stone walls, particularly near the Pu‘uloa Salt Works belongs to the ranching period of about 75 years ago. It is probable that the Hawaiians formerly used the holes and pits in the coral. Frequently the soil on the floor of larger pits was used for cultivation, and even today one comes upon bananas and Hawaiian sugar cane still growing in them. They afford shelter and protection, but I doubt if previous to the time of Cook there was ever a large population here.

These Hawaiian sites of the ‘Ewa coral plains would be the subjects of some 37 archaeological reports in the 1970s and 1980s.

Between McAllister's 1930 study and the flurry of work, which began in 1969, there are only a few sporadic pieces of poorly documented research. "In 1933, Dr. Kenneth P. Emory examined a well-preserved house site and a possible *heiau* in the western part of the coral plain; these sites were later destroyed by sugar-cane planting” (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, approximately 1.8 km. due south of the present project area (Kikuchi 1959; Davis 1990: 146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling made note of a house site (BPBM. Site OA-B6-8). “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 BPBM. Site # 50-OA-B6-13, a possible fishing shrine (Barrera 1975:1,12). 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.

In the Fall of 1969, Mr. Ellis Cross, a supervisory employee at the nearby oil refinery on the coast, informed Dr. Sinoto that he had found house sites and walls at various locations on Campbell Estate land, near Campbell Industrial Park and the coral quarry (Lewis 1970:2). This resulted in a number of visits by Dr. Sinoto and student volunteers in late 1969 and early 1970. A University of Hawaii graduate student, Mr. Ernest Lewis, did a preliminary survey and test excavations for a graduate seminar in Polynesian Archaeology and donated his report to the Bishop Museum. Lewis was the first to document sites so near to the project area (just seaward of the railroad alignment).

The sites Lewis documented just south of the O.R. & L. line were subject to a number of further studies including Barrera 1975, Sinoto 1976, Hammatt et al. 1994 and McDermott et al. 2000. Sites in relatively close proximity to the present project area are listed below in Table 2.

Table 2: Sites Near the Project Area.

Site # (50-80-12-)	Type of Site	Source
4893	Sink	Hammatt et al. 1994:35
4894	Enclosure	Hammatt et al. 1994:35
4895	Mounds	Hammatt et al. 1994:39
4896	Sink complex	Hammatt et al. 1994:39
4897	Mound complex	Hammatt et al. 1994:43
4898	Mounds	Hammatt et al. 1994:43
4900	Complex of sinks and wall	Hammatt et al. 1994:46
9546	Wall ("Long Wall")	Lewis 1970:33; Barrera 1975:8; Sinoto 1976:16 (B6-23)
9547	Enclosure	Lewis 1970:36 (B6-24)
9548	Enclosure	Lewis 1970:35; Barrera 1975:8; Sinoto 1976:16(B6-25)
9551	Mound	Lewis 1970:356 (B6-29)
9552	Mound cluster	Lewis 1970:36 (B6-30)
9553	Cluster of mounds	Lewis 1970:36 (B6-31)
9555	*Ahu*	Lewis 1970:35 (B6-33)
9556	Terrace, mounds, paved area, enclosure	Lewis 1970:35 (B6-34)

To the west of the project area, Paradise Cove, Lanikūhonua, and West Beach have been the subject of numerous archaeological studies (Barrera 1979, 1984, 1986, Komori & Dye 1979; Neller 1985; Davis & Haun 1986, 1987; Glidden et al. 1993; and Jourdane 1995).

Of particular relevance to the present study were the work of Haun (1986) and Burgett and Rosendahl (1989). The Haun archaeological reconnaissance survey for the 'Ewa Town Center/Secondary Urban Center study covered an area of approximately 1,400 acres immediately adjacent to the east and northeast portions of the present project area. There were no finds anywhere near the present project area. The Burgett and Rosendahl study carried out seventy-two backhoe test trenches in a 360-acre portion of the Haun study area immediately adjacent to the east and northeast portions of the present project area. Again, there were no significant finds.

B. Predictive Model

The one general observation regarding the archaeology of southwestern O'ahu is that there was more precontact utilization of the area than might be expected given its present day uninviting ambiance and "marginal ecology" (Sinoto 1976:71). In our area of interest however, back from the coast and seaward of the forested inlands, pre-contact land use appears to have dropped off dramatically. Coupled with the land alteration associated with ranching, sugarcane cultivation, and the construction of the O.R. & L. railroad, and given the shallow sediments overlying limestone bedrock, little in the way of intact surface archaeological resources are to be expected. Sinkholes, however, have yielded historic deposits in previous studies (Hammatt et al. 1994). In addition to historic deposits, the excavations of sinkholes have also yielded human burials and faunal remains, including those of extinct avifauna. McDemott et al. (2000) documented the identification of twenty-seven categories of avifaunal remains, eight of which were extinct species, found in sinkholes near the current project area. The discovery of human burials and the remains of extinct avifauna were primary concerns in the excavations of sinkholes CSH-2a and CSH-3. It was also anticipated that historic deposits relating to ranching or military activity might be expected.

V. FIELD INVESTIGATION

A. Field Methods

Fieldwork consisted of the excavation of two sinkholes selected from the four located during the 2003 Cordy and Hammatt archaeological assessment of the 100 acre project area indicated in Figure 9. Sinkholes CSH-2a and CSH-3 (State Site 50-80-12-6674) were selected for subsurface testing. A 1 by 1 meter test pit was excavated in each sinkhole by cultural strata, and arbitrary 10 cm levels where cultural strata exceed 10 cm in thickness. Sinkhole CSH-2a, located in the southernmost, sub-area B, of the Cordy and Hammatt (2003) project area, is approximately 130 cm across, making the test pit representative of almost the entire sinkhole. Sinkhole CSH-3 (State Site 50-80-12-6674), located in the northern, sub-area A, is approximately 3 x 1.5 meters wide, and a test unit was placed in the widest part of the sinkhole.

Excavations were conducted by hand and documented with scale profiles, photographs, sediment descriptions and sediment samples. Sediment descriptions include Munsell color designations, consistency, texture, structure, inclusions, cultural material present and boundary distinctness and topography. The test pit in sinkhole CSH-2a was excavated to bedrock. Sinkhole CSH-3 had very deep deposits, and after approximately 1 meter of sterile deposits, excavations were halted at a depth of 250 cm below surface due to safety concerns. Pre and post-excavation photos were taken. All excavated material was labeled according to strata, depth, site number, date, and category. Representative samples of sediment from the various levels were screened through a 1/8th inch mesh screen in the field. When sediment levels displayed a high likelihood of cultural deposits, the entire level was screened in the same manner. All elevations in the sinkholes were taken using string and line level from an arbitrary datum. Profiles and plan views were drawn immediately following the completion of the excavation of each test unit. All artifactual and midden material uncovered in the course of the excavations dated to the twentieth century, so only representative samples of both were collected in the field for analysis.

B. Laboratory Analysis Methods

1. Artifact Analysis

Artifact analysis included standard identification and cataloging of all excavated material (i.e. measurements, weight, material type, artifact type, and additional notes). The analysis then focused on distinguishing among artifact types as they related to specific activities and/or time periods. Among the bottles collected, the dates given were based on the book *Bottle Makers and Their Marks* by Julian Harrison Toulouse, and the ceramics were identified using *Lehner's Encyclopedia of U.S. Marks on Pottery, Porcelain & Clay* by Lois Lehner.

2. Faunal and Midden Analysis

Analysis of vertebrate remains included standard identification and cataloguing (i.e. species, bone identification, measurements, and additional notes). Marine invertebrate midden analysis was carried out to species where possible. Midden analysis did not include Concentration Index (CI; gms/cubic meter) values or other statistical techniques due to the lack of pre-twentieth

century remains. Instead, samples of historic midden were analyzed to provide an overall impression of the kinds and variety of midden present within historic trash deposits.



Figure 9. Aerial photo of Cordy & Hammatt (2003) project area showing Areas A and B, and sinkholes identified

VI. SINKHOLE EXCAVATION RESULTS

Two sinkholes previously designated with temporary site numbers CSH-2a (Figure 10) and CSH-3 (Figure 11) were investigated. Field results are given below.

A. Stratigraphy Overview

The stratigraphy in the excavations was similar between the two sinkholes tested (see Figures 14 & 16). Stratum I is a historically disturbed A-horizon. The sediment of Stratum I in both the sinks consisted of 7.5 YR 3/3 dark brown, loose, structureless, non-plastic sandy loam. This layer in both sinkholes contained significant amounts of historic trash including vertebrate bones. Roots and rootlets were also present.

Stratum II in both sinkholes consisted of 7.5 YR 4/6 strong brown, structureless, very fine silt with limestone cobble and pebble inclusions. Sediments from Stratum II were dry, slightly hard, and slightly plastic. This stratum was culturally sterile.

Stratum III was only encountered in sinkhole CSH-2a and consisted of 7.5 YR 4/4 brown, blocky, hard, and slightly plastic silt clay, decomposing bedrock, and a moderate to small amount of charcoal flecks. This stratum was culturally sterile.

B. Sinkhole CSH-2a

Sinkhole CSH-2a is the larger of two sinkholes immediately adjacent to each other, within the site given temporary site number CSH-2. The site, CSH-2, is located in the central south portion of the Cordy and Hammatt (2003) project area. CSH-2a covered an area of approximately 1.4 square meters (see Figures 12 and 13). The 1 x 1 meter test unit was centrally located and occupied the majority of the sinkhole. In the northern corner of the sinkhole there was an overhang with a pocket eroded approximately 70 cm into the wall. Concentrated vertebrate remains, including chicken (*Gallus domesticus*), dog (*Canis familiaris*), and pig (*Sus scrofa*), were located within the loose topsoil beneath the overhang.

A datum point was established at the general surface level at the south corner of the sinkhole, and sediments within the sinkhole began roughly 55 cm below this datum. The first stratum was slightly less than 30 cm deep and included numerous vertebrate bones, some saw cut and some burnt (see Appendix A). Vertebrate species represented in Stratum I include; *Gallus domesticus* (chicken), *Canis familiaris* (dog), *Sus scrofa* (pig), *Felis felis* (cat), and *Bos taurus* (cow). The canine remains were most common. The majority of the cut bone was of cow and pig. A high number of the pig remains, based on the presence of unfused and underdeveloped bones, were those of juveniles and infants. Individual specimens of all species represented in Stratum I show evidence of burning.

Also located within Stratum I were fragments of a wire mesh with a 2.5 cm^2 grid. Other historic deposits included a couple of bottles, silverware, and several whole, vacuum-sealed, medical bottles with rubber stoppers for withdrawl by syringe (see Figure 19). These bottles ranged from 30-60 ml, and based on several manufacture marks (Ownes-Illinois Glass Co.) could only have been produced between 1929 and 1954.

Stratum II and III were essentially sterile. Stratum II was roughly 62 cm thick. Stratum III was divided into two sub-layers, Stratum IIIa contained some charcoal flecking, but no other



Figure 10. Sinkhole CSH-2a (on left) prior to excavation, view to east



Figure 11. Sinkhole CSH-3 prior to excavation, view to west



Figure 12. Sinkhole CSH-2a prior to excavation

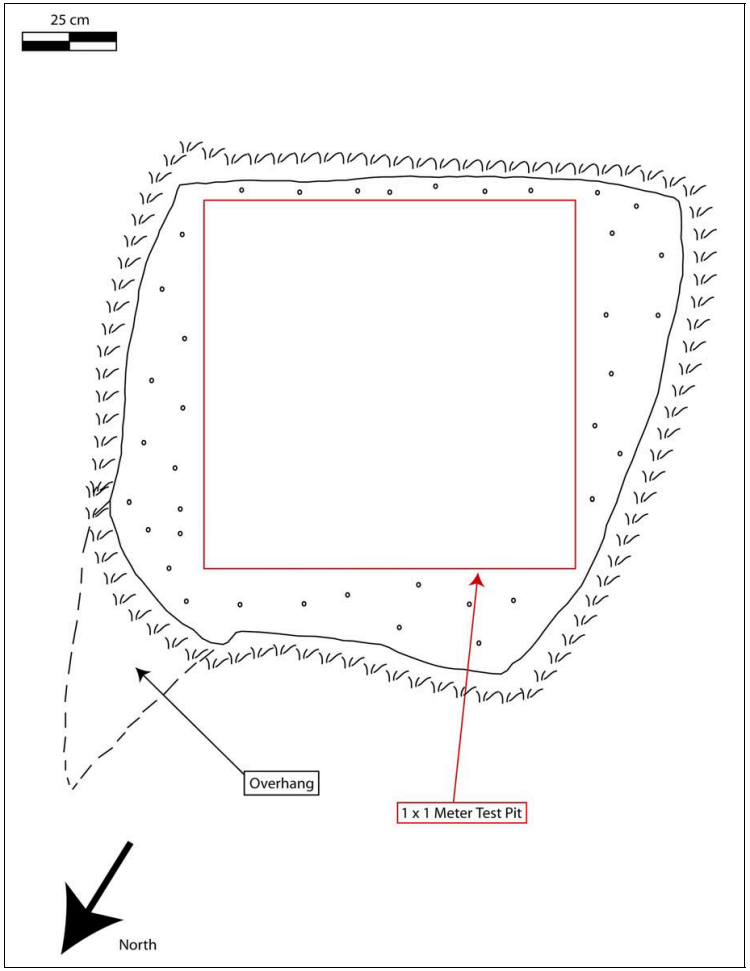

Figure 13. Plan view of CSH-2a, showing test unit



Figure 14. Sinkhole 2a test unit in progress



Figure 15. View of Sinkhole 2a southwest wall

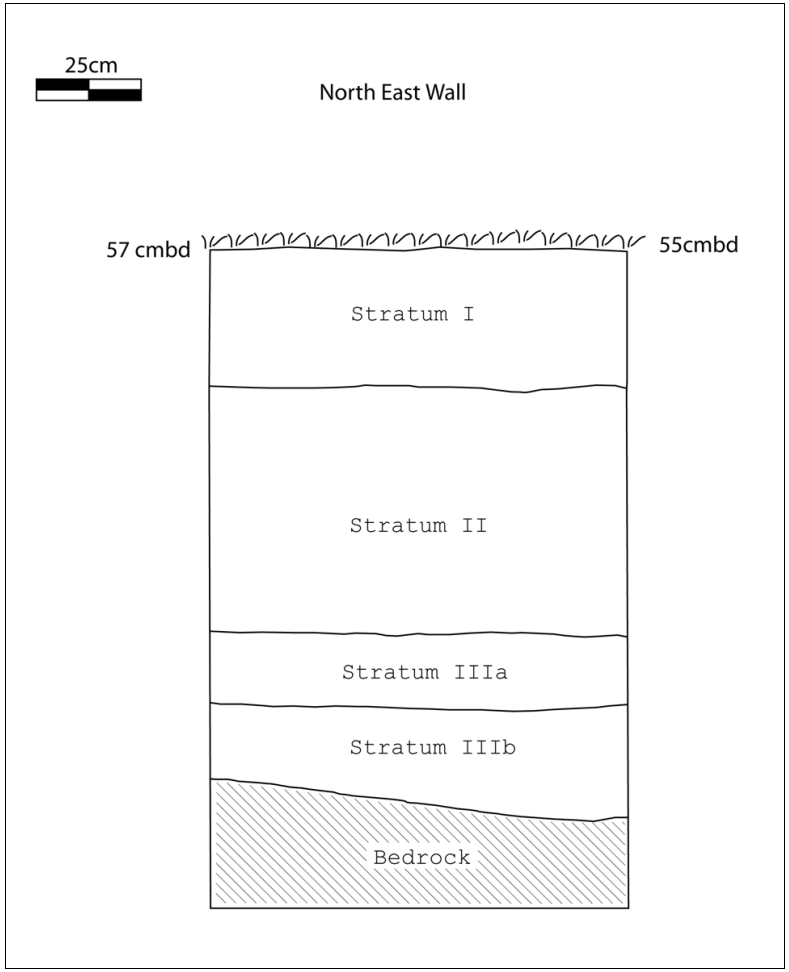

Figure 16. Profile of CSH-2a, northeast wall

evidence of cultural activity, while Stratum IIIb was completely sterile down to the limestone bedrock at 219 cm below datum.

C. Sinkhole CSH-3 (State Site 50-80-12-6674)

Sinkhole CSH-3 (State Site 50-80-12-6674) is located in the central portion of the Cordy and Hammatt (2003) project area, within Area A. At approximately 3 x 1.5 meters, this sinkhole was the largest of the four located during the Cordy and Hammatt (2003) archaeological assessment. The 1 x 1 meter test unit was placed in the eastern half of the sinkhole (Figure 15). Two cement troughs run east, from the cement foundation of a historic structure into the sinkhole, just over a meter away. Also on the west end of the sinkhole was an old high power sprayer (Figure 17).

A datum point was established at the general surface level at the northeast corner of the sinkhole, and sediments within the sinkhole began 140-146 cm below this datum. Stratum I here was significantly deeper than in sinkhole CSH-2a, reaching a depth of 125 cm. While sediments were consistent throughout Stratum I, it was divided into two sub-layers due to a significant change in the concentration of historic trash. Stratum Ia contained some bones and historic glass. Stratum Ib had very highly concentrated deposits of historic glass, ceramics, and metal. Approximately 206 cm below datum the rim of what appeared to be a 50-gallon metal drum was found. It is assumed that Stratum Ib represents the contents of this drum, which included large amounts of historic glass, including many intact bottles, ceramic tableware, rusted metal objects, and some animal bone, much of it burnt.

The majority of the bottles found in CSH-3 were products of the Owens-Illinois Glass Co. While several marks represent the company, each mark is specific to a time period. The most common mark was an "I," within a circle in front of a horizontal diamond, and represents the production period from A.D. 1929-1954. Another frequently occurring mark was "Duraglas," which is also Owens Illinois Glass Co., but was only used after A.D. 1940. The bottles' functions included, medical, liquor, soda, sauces, and food items. Vacuum-sealed medical bottles with rubber stoppers for withdrawl by syringe were found in both sinkholes CSH-2a and CSH-3 (Figure 19). These bottles are consistent with ranching in the area and may be associated with veterinary uses. The ceramics were found only in CSH-3, with the vast majority of the pieces being products of, Shenango China, Inc. The particular stamp present on these pieces was used on commercial ware after 1948. These stamps were present on two of the military associated samples, including the fragment marked with the, "United States Army Medical Department," pictured in Figure 20, indicating a post World War II use of these items.

Stratum II was culturally sterile with the exception of a few small vertebrate bones that were interspersed with fragments of historic glass, near the boundary of Stratum Ib and II. Following more than one meter of sterile soil, at approximately 250 cm below the sinkhole surface, and 390 cm below datum, excavations were halted due to safety concerns.

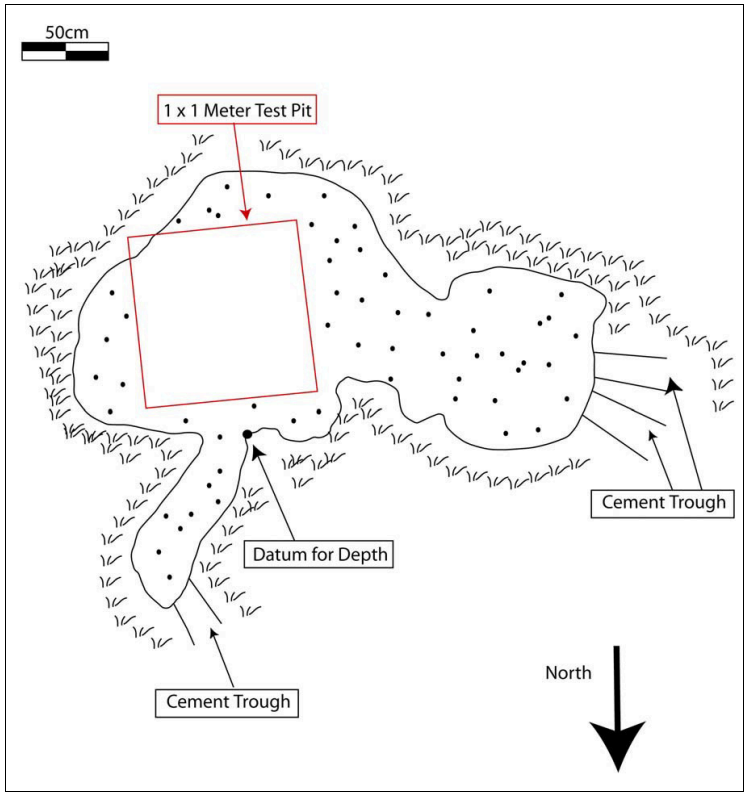

Figure 17. Plan view of CSH-3 (designated State Site 50-80-12-6674) showing test unit

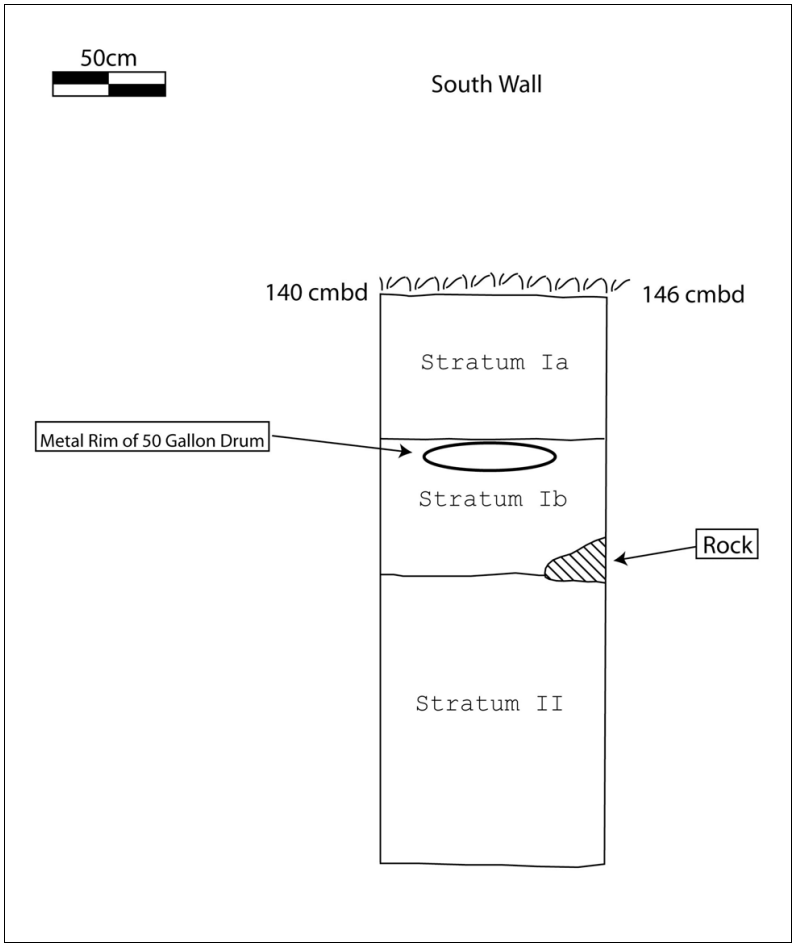

Figure 18. Profile of CSH-3, south wall



Figure 19. Photograph of sinkhole CSH-3 prior to excavation, view to southwest



Figure 20. Photograph of high-power sprayer and cement troughs on the west edge of sinkhole CSH-3



Figure 21. Site 50-80-12-6674 (CSH-3) excavation unit in progress showing rim of drum



Figure 22 Site 50-80-12-6674 (CSH-3) excavation unit

VII. LABORATORY RESULTS

A. Midden Analysis

A total of 195 midden fractions were recovered from the sinkhole designated CSH-2a.

B. Artifact Analysis



Figure 23. Vacuum-sealed medical bottles with rubber stoppers for withdrawl by syringe found in sinkholes CSH-2a and CSH-3



Figure 24. Fragment of a dish marked with “United States Army Medical Department” stamp

VIII. SUMMARY DISCUSSION AND RECOMMENDATIONS

A. Site Description

The current inventory survey identified no traditional Hawaiian cultural remains, but a single State Inventory of Historic Properties (SIHP) Site number was assigned to sinkhole CSH-3, as the large amount of mid-twentieth century rubbish indicates its use as a dump just after, and possibly during, World War II.

SIHP Site #: 50-80-12-6674

Site Type: Filled sinkhole

Function: Historic trash dump

Features (#): 1

Age: Mid-twentieth century

Description: This site consists of a sinkhole measuring approximately 3 x 1.5 meters. A one by one meter test unit within the sink yielded historic trash deposits to a depth of 1.5 meters. The historic trash included the remains of a 50-gallon metal drum containing large amounts of historic glass, including many intact bottles, ceramic tableware, rusted metal objects, and some animal bone, much of it burnt. This dump appears to be associated with historic ranching activities in the area.

B. Summary of Findings

The excavations of sinkholes CSH-2a and CSH-3 (#50-80-12-6674) provided a significant amount of historic deposits, but no traces of pre-contact use. As indicated in the predictive model, human burials, other traditional cultural materials, and extinct avifauna were all potential findings during this inventory survey. Neither sinkhole contained pre-contact remains of any kind, nor was there any evidence for prehistoric faunal remains. The only cultural materials were the historic trash deposits of Stratum I in both sinkholes. The most significant of the historic deposits was the 50-gallon metal drum, the contents of which provided an abundant source of easily datable bottles and chinaware. Artifacts from CSH-3 included vacuum-sealed, medical bottles with rubber stoppers for withdrawl by syringe (Figure 19), glass bottles, cups, bowls and eating utensils inscribed with the initials U.S.N. (United States Navy), and a plate with a stamp reading, "United States Army Medical Department," (Figure 20). The vast majority of this historic trash related to food consumption, and it is possible that this sinkhole was used as a dump for the U.S. Navy after World War II, the 50-gallon drum possibly being trash from a ship's galley. It is seems more likely, however, that all of the artifacts relate to ranching activities in this area, as the tableware may have been acquired by ranchers as Navy surplus items. Considering the high number of datable artifacts older than fifty years, a request to designate sinkhole CSH-3 as a state site was granted by the State Historic Preservation Division, and it was assigned SIHP Site number 50-80-12-6674.

In addition to the Navy related artifacts in CSH-3, a single Quonset hut was located in Area B during the Cordy and Hammatt (2003) archaeological assessment of the area. The nearest documented World War II military sites to the project area were the Marine Corps Air Station, 'Ewa (Barber's Point), and the nearby Barber's Point Naval Air Base. Both these sites were between four and five miles east of the sinkholes.

The faunal remains discovered in sinkhole CSH-2a, with evidence of burning and saw cutting, appear to be primarily the remains of human consumption. Several species represented by the excavation, such as pig (juvenile and adult), chicken, cow and even dog, were, and still are often used as food items. All of the faunal remains, along with several datable, vacuum-sealed medical bottles, discovered were from within Stratum I. The medical bottles associated with the faunal remains in CSH-2a were very similar to the ones found within Stratum I of CSH-3 (#50-80-12-6674), and date from A.D. 1929-1954, with two that date post A.D. 1946 Considering the presence of extremely similar medical bottles in both sinkholes they were most likely associated with each other and used during the same time period during and just after World War II.

C. Recommendations

Neither of the sinkholes yielded any pre-twentieth century cultural material. Sinkhole CSH-2a was excavated to bedrock and CSH-3 (#50-80-12-6674) was excavated through one meter of sterile deposits. It is therefore concluded that no further investigation of these sinkholes is required, and that the sinkholes excavated provided an adequate representation of the sinkhole use in the Cordy and Hammatt (2003) project area. No further work is recommended for the Cordy and Hammatt (2003) project area.

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Appendix A : Vertebrate Remains from CSH-2a.

AC #	Feature	Species	Portion	L/W (cm)	Notes
2a-1	Bone	Dog (*Canis Familiaris*)	Cranium	14.2/8.0	10 teeth
2a-2	Bone	Dog (*Canis Familiaris*)	Cranium	15.1/8.9	8 teeth
2a-3	Bone	Dog (*Canis Familiaris*)	Cranium	14.2/8.0	10 teeth
2a-4	Bone	Dog (*Canis Familiaris*)	Cranial Vault	11.1/8.8	
2a-5	Bone	Dog (*Canis Familiaris*)	Mandible	9.4/6.7	10 teeth
2a-6	Bone	Dog (*Canis Familiaris*)	Right Maxilla	8.6/3.1	3 teeth
2a-7	Bone	Dog (*Canis Familiaris*)	Left Mandible	8.2/1.0	5 teeth
2a-8	Bone	Dog (*Canis Familiaris*)	Left Maxilla	10.3/3.0	5 teeth
2a-9	Bone	Dog (*Canis Familiaris*)	Orbital Fragment	5.8/3.9	
2a-10	Bone	Cat (*Felis felis*)	Cranium	8.1/5.7	4 teeth
2a-11	Bone	Dog (*Canis Familiaris*)	Right Mandible	7.2/1.1	5 teeth
2a-12	Bone	Dog (*Canis Familiaris*)	Right Maxilla Fragment	4.0/1.6	2 teeth
2a-13	Bone	Dog (*Canis Familiaris*)	Humerus Fragment	12.0/2.7	Burnt
2a-14	Bone	Cow (*Bos Taurus*)	Distal End of Femur	12.5/9.0	
2a-15	Bone	Cow (*Bos Taurus*)	Talus Fragment	6.6/3.5	
2a-16	Bone	Pig (*Sus scrofa*)	Femur	8.3/2.6	Juvenile
2a-17	Bone	Dog (*Canis Familiaris*)	Rib	8.3/0.2	
2a-18	Bone	Pig (*Sus scrofa*)	Rib #1 or #2	5.5/0.4	
2a-19	Bone	Pig (*Sus scrofa*)	Rib Fragment	6.3/0.7	Juvenile
2a-20	Bone	Chicken (*Gallus domesticus*)	Rib	4.2/0.1	
2a-21	Bone	Cow (*Bos Taurus*)	Femoral head	6.0/4.9	
2a-22	Bone	Dog (*Canis Familiaris*)	Rib	8.4/0.4	
2a-23	Bone	Avian	Cranium	3.3/1.2	
2a-24	Bone	Avian	Corocoid	4.8/2.3	
2a-25	Bone	Dog (*Canis Familiaris*)	Occipital Fragment (Bulla)	5.0/3.1	
2a-26	Bone	Cow (*Bos Taurus*)	Femoral Ball	6.8/5.4	
2a-27	Bone	Cow (*Bos Taurus*)	Vertebrae Fragment	7.1/5.3	
2a-28	Bone	Dog (*Canis Familiaris*)	Occipital Fragment (Bulla)	5.0/3.1	
2a-29-48	Bone	Miscellaneous	Miscellaneous (20 pieces)	64.3 grams	Burnt Fragments
2a-49-53	Bone	Miscellaneous	Long Bone Fragments (5 pieces)	109.6 grams	Cut and Burnt

AC #	Feature	Species	Portion	L/W (cm)	Notes
2a-54-58	Bone	Pig (*Sus scrofa*)	Phalanges (5 pieces)	11.7 grams	
2a-59	Bone	Cow (*Bos Taurus*)	Femur Fragment	7.5/4.2	Cut and Burnt
2a-60	Bone	Unidentifiable	Cranium Fragment	4.2/3.7	Burnt
2a-61	Bone	Unidentifiable	Cranium Fragment	3.7/2.8	Cut and Burnt
2a-62	Bone	Pig (*Sus scrofa*)	Rib Fragment	4.6/2.0	Cut and Burnt
2a-63	Bone	Dog (*Canis Familiaris*)	Proximal Femur	6.3/3.1	
2a-64	Bone	Cow (*Bos Taurus*)	Proximal Tibia	7.2/3.9	Burnt
2a-65	Bone	Cow (*Bos Taurus*)	Distal Tibia	7.6/4.3	Cut and Burnt
2a-66	Bone	Unidentifiable	Parietal	4.5/2.9	
2a-67	Bone	Dog (*Canis Familiaris*)	Rib Fragment	3.6/0.3	
2a-68	Bone	Unidentifiable	Unidentifiable	3.6/2.2	Cut and Burnt
2a-69	Bone	Dog (*Canis Familiaris*)	Femoral Shaft Fragment	4.5/1.6	Burnt
2a-70	Bone	Pig (*Sus scrofa*)	Illium Fragment	6.1/3.9	Juvenile
2a-71	Bone	Pig (*Sus scrofa*)	Vertebrae Fragment	2.7/2.4	Juvenile
2a-72	Bone	Dog (*Canis Familiaris*)	Proximal Femur		
2a-73	Bone	Cow (*Bos Taurus*)	Unidentifiable	8.2/4.0	Cut and Burnt
2a-74	Bone	Cow (*Bos Taurus*)	Parietal Fragment	4.9/4.7	Burnt
2a-75	Bone	Cow (*Bos Taurus*)	Distal Tibia	5.0/5.0	Cut and Burnt
2a-76	Bone	Pig (*Sus scrofa*)	Unidentifiable	7.6/3.5	Burnt
2a-77-106	Bone	Miscellaneous	Miscellaneous (30 pieces)	6.6 grams	Crania Fragments
2a-107	Bone	Unidentifiable	Malleus	1.8/1.1	
2a-108	Bone	Pig (*Sus scrofa*)	Cevical Vertebrae Fragment	1.3/0.9	Juvenile, Burnt
2a-109	Bone	Pig (*Sus scrofa*)	Cervical Vertebrae Fragment	1.3/0.9	Juvenile
2a-110	Bone	Pig (*Sus scrofa*)	Thoracic Vertebrae	2.1/1.9	Juvenile, Burnt
2a-111	Bone	Pig (*Sus scrofa*)	Cervical Vertebrae	1.7/1.2	Juvenile
2a-112	Bone	Pig (*Sus scrofa*)	Thoracic Vertebrae Fragment	3.3/1.9	Juvenile
2a-113	Bone	Pig (*Sus scrofa*)	Sacrum/Lumbar Vertebrae	2.7/2.3	Juvenile
2a-114	Bone	Pig (*Sus scrofa*)	Maxilla Fragment	3.5/2.2	Juvenile, 1 tooth
2a-115	Tooth	Pig (*Sus scrofa*)	Canine	2.4/0.4	Sheared
2a-116	Tooth	Pig (*Sus scrofa*)	Canine	1.2/0.4	Sheared
2a-117	Tooth	Pig (*Sus scrofa*)	Premolar	0.9/0.5	Juvenile
2a-118	Bone	Chicken (*Gallus domesticus*)	Cranial Vault	0.9/0.6	

Appendix A

AC #	Feature	Species	Portion	L/W (cm)	Notes
2a-119-125	Bone	Miscellaneous	Rib Fragments (6 pieces)	6.9 grams	
2a-126	Bone	Unidentifiable	Cranium Fragment	2.0/1.3	Burnt
2a-127-143	Bone	Miscellaneous	Cranium Fragments (17 pieces)	6.7 grams	
2a-144-145	Bone	Miscellaneous	Metatarsals (2 pieces)	1.4 grams	
2a-146-166	Bone	Miscellaneous	Miscellaneous (21 pieces)	8.6 grams	
2a-167	Bone	Pig (*Sus scrofa*)	Distal Femur	2.6/2.6	Juvenile
2a-168	Bone	Dog (*Canis Familiaris*)	Distal Femur	4.7/1.8	
2a-169	Bone	Unidentifiable	Shaft Fragment	3.6/1.2	
2a-170	Bone	Unidentifiable	Shaft Fragment	3.7/1.0	
2a-171	Bone	Unidentifiable	Unidentifiable	6.9/2.9	Burnt
2a-172-191	Bone	Miscellaneous	Miscellaneous (20 pieces)	1.1 grams	
2a-192	Bone	Pig (*Sus scrofa*)	Occipital Fragment	4.6/4.5	
2a-193	Bone	Chicken (*Gallus domesticus*)	Cranium	4.0/2.5	
2a-194	Bone	Chicken (*Gallus domesticus*)	Tibiotaurus	5.5/1.1	
2a-195	Bone	Chicken (*Gallus domesticus*)	Tibiotaurus Fragment	2.0/1.0	

Appendix B

Table -Bottles and Ceramics From CSH-3

Acc#	Pieces	Function	Color	Labeling	Comments
3-1	Whole	Soda	Amber	Duraglas <I>	Post 1940
3-2	Whole	Soda	Amber	Unidentified Mark	
3-3	Whole	Milk	Clear	GC Mark	1935-1940
3-4	Whole	Liquor	Clear	Drene	Post 1920
3-5	Whole	Ink	Clear	Higgins Drawing Ink	1908-1935
3-6	Whole	Tabasco	Clear	Tabasco… <I>	1929-1954
3-7	Whole	Milk	Clear	Duraglas, CHA III	Post 1940
3-8	Whole	Milk	Clear	Duraglas, CHA III	Post 1940
3-9	Whole	Shoyu/Sauce	Clear	Duraglas <I>	Post 1940
3-10	Whole	Shoyu/Sauce	Tan/Brown	USA	Ceramic Jug
3-11	Whole	Medical	Clear	TCW co.	Post 1920
3-12	Whole	Medical	Clear	TCW co.	Post 1920
3-13	Whole	Food/Fruit	Clear	Design Patented Aug 5 1919	Post 1919
3-14	Whole	Ketchup/Sauce	Clear	HA mark	1920-1964
3-15	Whole	Liquor	Clear	Drene	Post 1920
3-16	Whole	Coke	Aqua	Coca-Cola 09<I>49	Post 1949
3-17	Whole	Fruit Jar	Clear	OI Mark	Post 1954
3-18	Whole	Soda	Clear	Duraglas <I>	1929-1954
3-19	Whole	Food/Fruit	Amber	Duraglas <I>	1929-1954
3-20	Whole	Ketchup/Sauce	Clear	Duraglas 20<I>	1929-1940
3-21	Base and Rim	Medical Tray	White	U.S. Army Medical Department, (SC*)	1901-1991, Porcelin
3-22	Base Fragment	Large Bowl	White	Made in Japan	Porcelin
3-23	Half	Plate	White	Anchor, (SC*)	1901-1991, Porcelin
3-24	Near Complete	Cup	White	(SC*)	1901-1991, Porcelin
3-25	Whole	Cosmetics	Milky		Post 1920
3-26	Whole	Food/Fruit	Clear	LC Mark	1940-1955
3-27	Partial	Sauce	Clear	2<I>8	1929-1954
3-28	Rim Fragment	Unknown	Clear		
3-29	Whole	Dressing	Clear	Best Foods, 20<I>	1929-1940
3-30	Whole	Liquor	Amber	<I>	1929-1954
3-31	Base and Rim	Cup	White	OPCO	1871-present
3-32	Rim Fragment	Bowl	White		Porcelin

Acc#	Pieces	Function	Color	Labeling	Comments
3-33	Rim Fragment	Bowl	White		Porcelin
3-34	Base and Rim	Medical Tray	White		1901-1991, Porcelin
3-35	Base and Rim	Bowl	White	U.S.N. (SC*)	1901-1991, Porcelin
3-36	Rim Fragment	Large Bowl	White		Porcelin
3-37	Rim Fragment	Plate	White	Anchor, (SC*)	1901-1991, Porcelin
3-38	Whole	Plate	White	Royal China	1933-present, Porcelin
3-39	Partial	Glass	Milky		
3-40	Whole	Bowl	White	Homer Laughilin	Porcelin
3-41	Rim Fragment	Large Bowl	White		Porcelin
3-42	Whole	Spoon	Metalic	U.S.N.	Utensil
3-43	Whole	Spoon	Metalic	U.S.N.	Utensil
3-44	Whole	Peeler	Metalic		Utensil
3-45	Whole	Snuff Container	Metalic		
3-46	Whole	Marble	Blue		
3-47	Whole	Sauce	Clear	Anchor Hocking Mark	Post 1938
3-48	Body	Medical	Amber	7 <I> 8	1929-1954
3-49	Whole	Soda	Aqua	Coca-Cola, Honolulu TH	1951-1958
3-50	Whole	Liquor	Amber	Owens-Illinois Glass Mark(I)	Post 1954
3-51	Whole	Dressing	Clear	(B)	1925-1979
3-52-53	Whole	Food/Fruit	Amber	9<I>51, 9<I>52	1929-1954 ('51/'52)
3-54	Whole	Liquor	Clear	3<I>46	1929-1954 ('46)
3-55-57	Whole	Food/Fruit	Amber	<I>42	1929-1954 ('42)
3-58	Base Fragment	Soda	Clear	3<I>46	1929-1954 ('46)
3-59	Body	Soda	Aqua	<I>42	1929-1954 ('42)
3-60	Whole	Unknown	Clear	Mifflin	
3-61	Whole	Liquor	Amber	Ball	1919-1969 ('44)
3-62	Whole	Food/Fruit	Clear	Duraglas, 20<I>	1940
3-63	Rim and Base	Plate	White		Porcelin
3-64	Base Fragment	Cup	White	(SC*)	1901-1991, Porcelin
3-65	Whole	Bowl	White	Illegible Blue Mark	Porcelin
3-66	Whole	Bowl	Milky	Corring T.M. Rey	
3-67	Whole (3 pieces)	Cup	White	(SC*)	1901-1991, Porcelin
3-68	Whole	Plate	White	Anchor, (SC*)	1901-1991, Porcelin
3-69	Whole	Plate	White	Anchor, (SC*)	1901-1991, Porcelin

Acc#	Pieces	Function	Color	Labeling	Comments
3-70	Base and Body	Soda	Clear	Barqs, It's Good, Duraglas 20<I>	1940
3-119	Rim Fragment	Liquor	Amber		Cap on

(SC*): Shenango China

Documentation of Plantation Infrastructure at Kapolei,

Honouliuli Ahupua‘a, District of ‘Ewa, O‘ahu

TMK: (1) 9-1-015:004

by

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June 2004

EXECUTIVE SUMMARY

At the request of Mr. Tom Fee of Helber, Hastert & Fee, Cultural Surveys Hawai‘i (CSH) has prepared this documentation of plantation infrastructure within a 474-acre parcel in the *ahupua‘a* of Honouliuli, District of ‘Ewa, Island of O‘ahu (TMK [1] 9-1-015:004). This study was carried out to address stated State Historic Preservation Division (letter from McEldowney to Shideler dated January 8, 2004; Log No. 2004.0037, Doc No. 0401EJ04) concerns in order to conclude historic preservation requirements within the project area. The scope of work for this project included archival historical background research, fieldwork documentation of sugar plantation infrastructure remains currently on the parcel, and a report on the archival and field results.

According to archival research, this parcel was once part of the Ewa Plantation Company, which was incorporated in 1890 for sugar cane cultivation. Ewa was the first sugar plantation to rely totally on artesian water; the water was pumped to the surface at several pumping stations (Pump Station # 10 was once within the project area) and then transported to the fields through irrigation ditches and flumes. The irrigation system was continually improved during the history of the plantation, which grew sugar cane into the 1970s. Irrigation was first provided by hand-excavated earthen ditches, which were later lined by plaster, stone and mortar, molded concrete, portable pre-cast cement blocks, and asphalt. The dates for these innovations were found in the Annual Reports of the Ewa Plantation, which documented the costs of such innovations each year.

During the field survey of the project, two sites in the parcel related to sugar cane plantation infrastructure were identified. Site 50-80-12-6678 consists of five features related to the irrigation system, a concrete culvert and ditch intersection, a metal flume, two stone-and-mortar lined ditches, and a flume constructed of pre-cast portable concrete blocks. Several of these features have dates inscribed into the concrete; the earliest date is 1935, the latest 1964. The location of several features corresponds to the locations of ditches on early maps. The two stone and mortar ditches are pictured on maps as early as 1919. Site 50-80-12-6679 is a drainage canal excavated into the earth; the location of this canal is pictured on a 1943 map, but not on earlier maps (1919 and 1928), which indicates the canal was built post-1928. It is possible that the origin of this canal had something to do with construction activities during World War II.

The sites were regarded as significant for their information content only and no further work was recommended for this plantation infrastructure. In the acceptance of this study and a companion study on two sinkholes by the State Historic Preservation Division it is anticipated there will be a determination by that agency of no further work required.

TABLE OF CONTENTS

I. INTRODUCTION 1
- A. Background of Project 1
- B. Scope of Work 1
- C. Project Area Description 1
- D. Previous Archaeological Research in the Project Area 4

II. HISTORICAL BACKGROUND 6
- A. Historical Setting 6
- B. Pre-Contact and Early Historic Period 6
- C. Mid 1800s – The Great Mahele 6
- D. Early Ranching in on the ‘Ewa Plain 7
- E. History of the Ewa Sugar Plantation 9

III. DOCUMENTATION OF ‘EWA IRRIGATION SYSTEM 10
- A. Irrigation Systems 10
- B. Lining of Ditches and Flumes 13
- C. Ewa Plantation Annual Reports 13

IV. RESULTS OF FIELD DOCUMENTATION 31
- A. State Site: 50-80-12-6678 Feature A 31
- B. State Site: 50-80-12-6678 Feature B 35
- C. State Site: 50-80-12-6678 Feature C 40
- D. State Site: 50-80-12-6678 Feature D 43
- E. State Site: 50-80-12-6678 Feature E 51
- F. State Site: 50-80-12-6679 55

V. SUMMARY OF ARCHIVAL RESEARCH AND FIELD RESULTS 58
- A. Summary of Irrigation System Improvements at the Ewa Plantation 58
- B. Summary of Plantation Infrastructure Recorded in the Project Area 58
- C. Site Significance and Recommendations 62

VI. REFERENCES CITED 63

LIST OF FIGURES

Figure 1 USGS Topographic Map, Ewa Quad, Showing Project Location 2

Figure 2 Tax Map Key 1-9-1-15, Showing Project Area Location 3

Figure 3 TMK 9-1-15 Showing Haun (1986) Study and Cordy and Hammatt (2003) Study 5

Figure 4 1880s photograph of James Campbell’s residence on the ‘Ewa Plain (Hawaii State Archives) 8

Figure 5 Photo entitled “Drilling artesian well at Ewa ca. 1890” (Wilcox 1996:18) 8

Figure 6 Five types of irrigation lines used in the Hawaiian Furrow System 11

Figure 7 Five Types of Irrigation Lines: Main Ditches (upper left); Straight Ditches (lower left - juncture with main ditch); Level Ditches (upper center); Watercourses (upper right); and, furrows (lower right) (Armstrong 1923) 12

Figure 8 Ditch Lining using Cement Plaster on Chicken Wire (Armstrong 1923:52) 14

Figure 9 Reinforced Concrete Ditch, with Concrete Slabs on the Sides (Ewa Plantation Co. 1934:6) 14

Figure 10 Three types of concrete ditch lining: Field stone and concrete lining for steep grades (left); concrete lining through sandy fields (center); and, standard type of concrete lining (Armstrong 1923:53) 15

Figure 11 1926 Map of Ewa Plantation in Contrast to Size of City of Honolulu (1926 Ewa Plantation Annual Report) 17

Figure 12 1927 Map Showing Numbered Fields (East to West) of the Ewa Plantation (1927 Ewa Plantation Co. Annual Report) 20

Figure 13 Contour Method of Irrigation (Ewa Plantation Co. 1930:6) 21

Figure 14 Ewa Border Method (Ewa Plantation Co. 1930:7) 21

Figure 15 1939 Map Showing Numbered Fields (West to East) of the Ewa Plantation Co. (Conde and Best 1973:285) 24

Figure 16 Waialua Flume Irrigation Method; Portable Cement Sections (Ewa Plantation Co. 1944) made at the Ewa workshop (left); flumes set in field with furrows (Armstrong 1923:41) in a herring bone pattern (right) 25

Figure 17 Pipes placed at the head of each cane row so that the irrigation waster running down the main ditch can be diverted into the single lines of growing cane (Ewa Plantation Co. 195) 27

Figure 18 Level Irrigation Ditch with outlets for irrigation of watercourses and furrows (Armstrong 1923:25) 27

Figure 19 Overhead Irrigator sucks water from an irrigation ditch and spews it out on the cane fields (Ewa Plantation Co. 1964-1965) 29

Figure 20 A timer mechanism semi-automated control of an irrigation gate system (Ewa Plantation Co. 1964-1965) 29
Figure 21 USGS Topographic Map, 'Ewa Quad, Showing the Location of Plantation Infrastructure within the Project Area 32
Figure 22 Aerial Photograph (2000) Showing the Location of Plantation Infrastructure within the Project Area 33
Figure 23 Site 50-80-12-6678 Feature A Ditch Intersection, view to E. Note the use of old railroad rails incorporated into the construction 34
Figure 24 Portion of Site 50-80-12-6678 Feature B: Stone and Mortar Irrigation Ditch with Mortar Lining. View to E 36
Figure 25 Damaged Portion of Site 50-80-12-6678 Feature B: Ditch, Showing Stone and Mortar with Mortar Lining Construction Method 36
Figure 26 Example Ditch Outlet within Site 50-80-12-6678 Feature B: Stone and Mortar Irrigation Ditch. Note the constructed sluice gate slots 37
Figure 27 Example Cement Outlet Pipe within Site 50-80-12-6678 Feature B: Stone and Mortar Irrigation Ditch 37
Figure 28 Water Collection Basin at Southwestern Terminus of Site 50-80-12-6678 Feature B 38
Figure 29 Siphon Inlet Pipe within Site 50-80-12-6678 Feature B Water Collection Basin ... 38
Figure 30 "NOV. 1942" Date Etched into Site 50-80-12-6678 Feature B Water Collection Basin 39
Figure 31 Segment of Site 50-80-12-6678 Feature C: Irrigation Ditch, Constructed of Prefabricated, U-Shaped Concrete Segments 41
Figure 32 Photograph Showing Ditch Outlet within Site 50-80-12-6678 Feature C: Irrigation Ditch. Note the constructed sluice gate slots and wooden gate remnant 41
Figure 33 Photograph Showing Cement Outlet Pipe within Site 50-80-12-6678 Feature C: Irrigation Ditch. Note the metal sluice gate 42
Figure 34 Portion of Site 50-80-12-6678 Feature D: Stone and Mortar Irrigation Ditch 45
Figure 35 Portion of Site 50-80-12-6678 Feature D: Stone and Mortar Irrigation Ditch with Mortar Lining. View to W 45
Figure 36 "APRIL-4-1936" Date Etched into Western Portion of Site 50-80-12-6678 Feature D: Stone and Mortar Irrigation Ditch 46
Figure 37 Site 50-80-12-6678 Feature D: Irrigation Ditch, Transition from Stone and Mortar Construction to Metal Flume Near Natural Drainage Gully. View to NW 46
Figure 38 Faced Mound of Flaked Basalt Boulders and Cobbles Adjacent to the Down slope Edge of Site 50-80-12-6678 Feature D: Irrigation Ditch. View to S 47

Figure 39 Concrete Slab over Site 50-80-12-6678 Feature D: Irrigation Ditch 47
Figure 40 Ditch Outlet within Site 50-80-12-6678 Feature D: Irrigation Ditch, with Additional Ditch Segment and Multiple Outlet Gates. Note the constructed sluice gate slots 48
Figure 41 Sealed Ditch Outlet within Site 50-80-12-6678 Feature D: Irrigation Ditch 48
Figure 42 Site 50-80-12-6678 Feature D: Ditch Intersection Showing Eastern Siphon Outlet Pipe, Western Siphon Inlet Pipe and Flume Outlet. View to S 49
Figure 43 "JAN – 1951" Date Etched into Feature E: Cement Siphon Outlet Structure 49
Figure 44 "NOV. 1935" Date Etched into Feature E: Stone and Mortar Flume Support 50
Figure 45 Site 50-80-12-6678 Feature E: Parallel Siphon Pipes. View to SW 52
Figure 46 "6-`64" Date Etched into Cement Pipe Support of Feature E: Eastern Siphon 52
Figure 47 Site 50-80-12-6678 Feature E: Eastern Siphon Valve and Outlet Pipe into Flume and Metal Bridge Structure 53
Figure 48 Site 50-80-12-6678 Feature E: Western Siphon Valve and Outlet Pipe into Feature D: Ditch Intersection and Metal Bridge Structure 53
Figure 49 Site 50-80-12-6678 Feature E: Elevated Flume Between Parallel Siphon Pipes, View to S 54
Figure 50 Site 50-80-12-6678 Feature E: Parallel siphon Pipes Directed Underground. View to NE 54
Figure 51 Site 50-80-12-6679: Drainage Canal, View to SE 56
Figure 52 Site 50-80-12-6679 Drainage Culvert Running under the H-1 Freeway. View to N 56
Figure 53 Site 50-80-12-6679, Cemented Basalt Boulder Canal Lining 57
Figure 54 1919 Fire Control Map, Showing the Location of the Project Area 59
Figure 55 1928 USGS Map, Showing the Location of the Project Area 59
Figure 56 1943 War Department Map, Showing the Location of the Project Area 61
Figure 57 1967 Map of Ewa Plantation, Showing Infrastructure and Field Boundaries 61

LIST OF TABLES

Table 1 Improvements in Irrigation System at Ewa Plantation 30

I. INTRODUCTION

A. Background of Project

At the request of Mr. Tom Fee of Helber, Hastert & Fee, Cultural Surveys Hawai‘i (CSH) has prepared this documentation of plantation infrastructure within a 474-acre parcel in the *ahupua‘a* of Honouliuli, District of ‘Ewa, Island of O‘ahu (TMK [1] 9-1-015:004) (Figures 1-2). This report documents certain historic flume and plantation ditch infrastructure present along the northern, *mauka* (inland) edge and also in the eastern portion of these lands.

B. Scope of Work

The scope of work for this project includes:

1) Fieldwork to locate, map, photograph, and describe sites as appropriate;

2) Historical research documenting the nature and history of the plantation infrastructure; and,

3) Preparation of a report presenting the results of the fieldwork and the historical research.

C. Project Area Description

The project area of this study consists of an approximately 474-acre parcel located in the *ahupua‘a* of Honouliuli, within the ‘Ewa District of Leeward O‘ahu. 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* 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 Hapapa (or to the top of Ka‘ala Mountain, according to some).

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). Elevations within the project area ranged from approximately 30-100 ft (feet), or 10-30 m (meters) AMSL (above mean sea level). In pre-contact Hawai‘i the project area would have been mostly lowland dry shrub and grassland, but this area has been extensively disturbed and transformed by human activity with a variety of exotic grasses, weeds and shrubs now dominating. These grasses and shrubs, along with pockets of *kiawe* forest, and a few scattered banyan trees are characteristic of the vegetation of the project area. The area today is generally covered with introduced grasses, such as fingergrass (*Chloris* spp.), Bermudagrass (*Cynodon dactylon*), and bristly foxtail (*Setaria verticillata*). Other vegetation includes *kiawe* (*Prosopis pallida*), *koa haole* (*Leucaena leucocephala*), *klu* (*Acacia farnesiana*), and ‘*uhaloa* (*Waltheria americana*).

The project is situated on the ‘Ewa plain, south of the Wai‘anae Mountain Range in the southwest corner of O‘ahu. The terrain is coral outcrop along the lower, southern border. The interior of the project area is covered with thin soils, mainly from the Ewa and Lualualei Series,

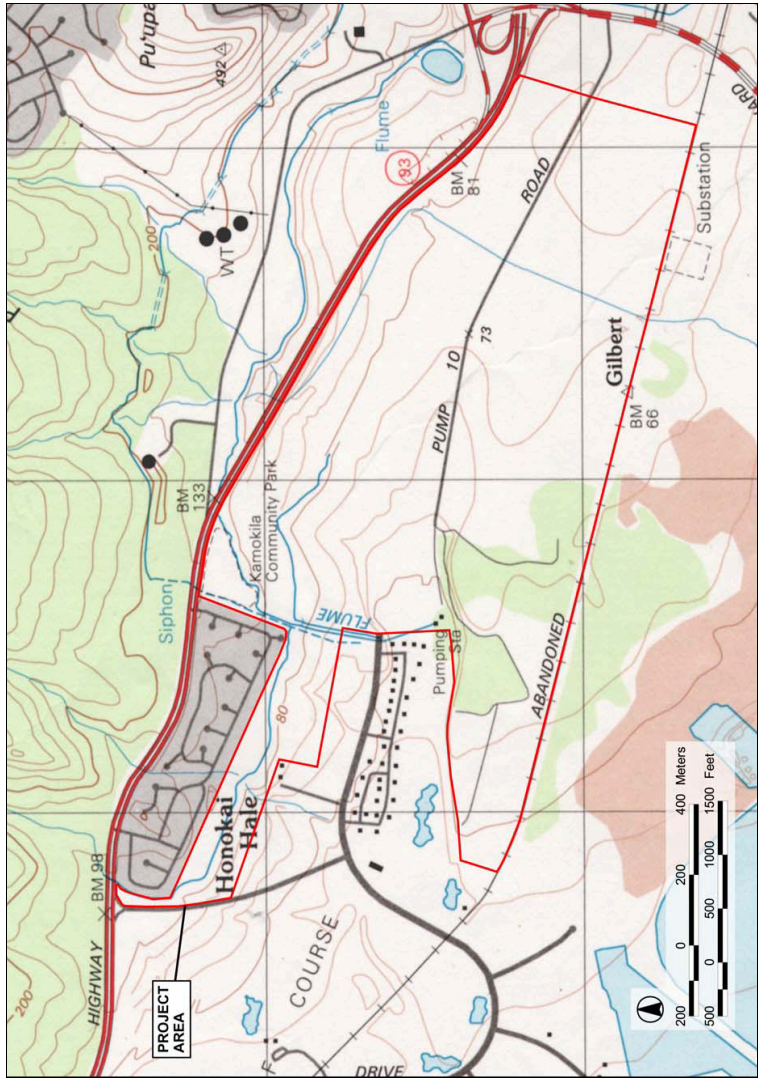

Figure 1 USGS Topographic Map, Ewa Quad, Showing Project Location

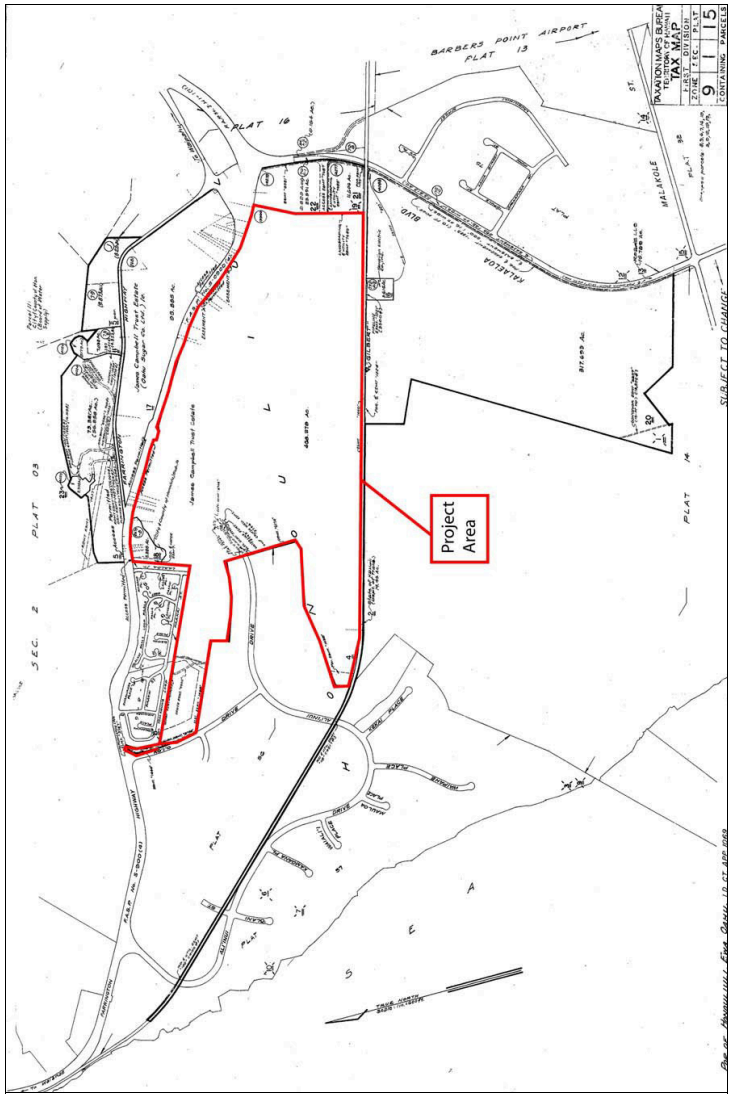

Figure 2 Tax Map Key 1-9-1-15, Showing Project Area Location

which are generally used for sugarcane, truck crops, orchards, and pasture. The Ewa Series (Ewa silty clay loam, moderately shallow, 0 to 2 percent slopes [EmA] and Ewa silty clay loam, moderately shallow, 2 to 6 percent slopes [EmB]) consists of well-drained soils in basins and on alluvial fans that developed in alluvium derived from basic igneous rock. The Lualualei series (Lualualei stony clay, 2 to 6 percent slopes [LvB] and Lualualei extremely stony clay, 3 to 35 percent slopes [LPE]) consists of well-drained soils on the coastal plains, alluvial fans, and on talus slopes that developed in alluvium and colluvium (Foote et al.1972).

There are also scattered areas of a soil of the Mamala Series (Mamala stony silty clay loam, 0 to 12 percent slopes [MnC]), which is a shallow, well-drained soil along the coastal plains formed in alluvium deposited over coral limestone and consolidated calcareous sand. The eastern end of the project area is generally covered with a soil of the Honouliuli series, Honouliuli clay, 0 to 2 percent slopes (HxA), which is a well-drained soil on coastal plains that developed in alluvium derived from basic igneous material. On the western side is one area is Waialua stony silty clay, 3 to 8 percent slopes (WIB), a moderately well drained soils on alluvial fans developed in alluvium weathered from basic igneous rock. In the upper elevations, along the northern border of the project area, the area is Stony steep land (rSY), which consists of a mass of boulders and stones deposited by water and gravity on side slopes of drainage-ways (Foote et al. 1972).

D. Previous Archaeological Research in the Project Area

The eastern portion of the project area was first surveyed by archaeologists from PHRI (Paul H. Rosendahl, PhD., Inc.) in the late 1980s (Haun 1986). No archaeological sites were recorded. This study covered a petition area of approximately 1,400 acres (Figure 3), which includes the northern and eastern sections of the current study area. The Haun study noted the extensive modification for sugarcane cultivation and concluded that only two sites had been previously reported in the vicinity: the OR&L alignment on the southern border of the study area and a *heiau* and large rock shelter on Puʻu Kapolei. The Haun study identified two new sites: an irrigation ditch north of the H–1 and a WWII military structure on Puʻu Palailai. The irrigation system was briefly described as consisting of ditches lined with concrete and stone; in several areas these were replaced by elevated flumes made of timbers and steel bridges. These features were not described in detail and were not given any State Site designation numbers.

A secondary study of particular interest (which may never have been formally reviewed by the State Historic Preservation Division) recounts the results of some 72 backhoe trenches scattered across much of the area of the present study area. A total of 60 trenches were excavated to bedrock, which was typically encountered at depths of 55 to 161 cmbs (centimeters below surface). No archaeologically significant remains of any kind were encountered (Burgett and Rosendahl 1989:4).

Cordy and Hammatt (2003) recently made a study of a land parcel which comprises the southwestern portion of the project area (Figure 3). Several sinkholes were noted as of potential archaeological interest. The study also documented the presence of a historic chicken farm as well as other twentieth century architectural remains, including a Quonset hut of unknown use.

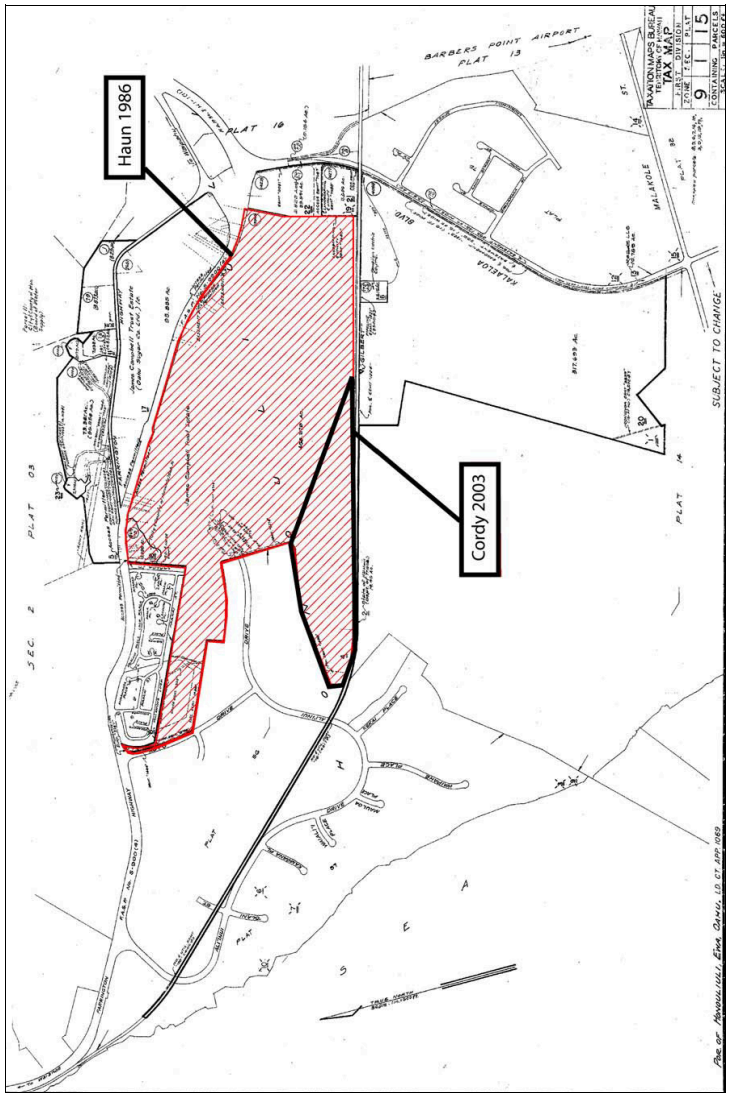

Figure 3 TMK 9-1-15 Showing Haun (1986) Study and Cordy and Hammatt (2003) Study

II. HISTORICAL BACKGROUND

A. Historical Setting

Honouliuli Ahupua‘a, as a traditional land unit, had tremendous and varied resources available for exploitation by early Hawaiians. Not only does Honouliuli Ahupua‘a, include a long coastline fronting the normally calm water of leeward O‘ahu, but there is also four miles of waterfront along the west side of West Loch. The land immediately *mauka* (inland including the project area) 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 illuviation caused by sugar cultivation) by a thin or non-existent soil mantle. Proceeding *mauka* from this limestone plain, this shelf is overlain by alluvium deposited through a series of gulches draining the Wai‘anae Mountains. 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.

B. Pre-Contact and Early Historic Period

A reconstruction of Hawaiian political history (Cordy 1996) indicates that in the early 1300s, ‘Ewa was a dominant political entity that was joined with Wai‘anae and Waialua under a king named Keaunui, son of Māweke and part of the Māweke-Kumuhonua line. O‘ahu unification is understood as having occurred by A.D. 1400 under the King La‘akona, also identified with ‘Ewa (Cordy 1996). Ross Cordy suggests that at least one royal center for ‘Ewa was at Līhu‘e in upland Honouliuli, but this is not well documented. There were several shifts of power from the 1500s until the early 1700s when Kūali‘i achieved control of all of O‘ahu, a process, which included defeating ‘Ewa chiefs in at least two battles. Peleiholani, a son of Kūali‘i, took control of O‘ahu as regent circa 1740, and remained ruler of O‘ahu until after 1778 when Kahahana (from the ‘Ewa line of chiefs but raised in Kahekili’s Maui court) took control of O‘ahu.

After Kamehameha’s O‘ahu victory, he gave the *ahupua‘a* of Honouliuli to Kalanimōkū as part of *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.

C. Mid 1800s – The Great Mahele

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-19th due to population decline and consolidation of the remaining people in town. A detailed discussion of the historic population counts in the ‘Ewa District has been presented by Charvet-Pond and Davis (1992).

During the *Mahele* of 1848, 72 individual land claims in the *ahupua'a* of Honouliuli were registered and awarded by King Kamehameha III (Tuggle and Tuggle 1997:34). 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). The 72 *kuleana* awards were made almost all adjacent to Honouliuli Gulch, which contained fishponds and irrigated taro fields. No awards were located near the project area.

Kekau'ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu'u Kahala'i'a, who was governor of Kaua'i (Hammatt and Shideler 1990:19-20.). Subsequently, Kekau'onohi ran away with Queen Ka'ahumanu's stepson, Keli'i-ahonui, 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. 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'alealea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney (Yoklavich et al 1995:16).

D. 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 the land 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). Campbell set up several enterprises in the *ahupua'a,* including a cattle ranch, a rice farm, a lime quarry, and commercial *kiawe* cutting. Some sugar cane was grown in the area above the main pasturelands and the mountains. 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 4).

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 (Figure 5) to search the 'Ewa plains for water, and the well, drilled to a depth of 240 feet near Campbell's home in 'Ewa, resulting 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.

By 1881, the Campbell property of Honouliuli prospered as a cattle ranch with "abundant pasturage of various kinds" (Briggs 1926:62). Within 10 years of the first drilled well in 'Ewa, the addition of a series of artesian wells throughout the island was supplying most of Honolulu's water needs (Armstrong and Bier 1983).

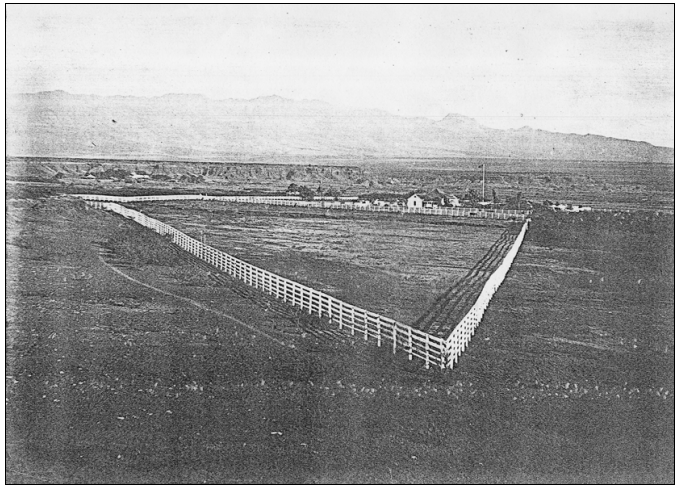

Figure 4 **1880s photograph of James Campbell's residence on the 'Ewa Plain (Hawaii State Archives)**

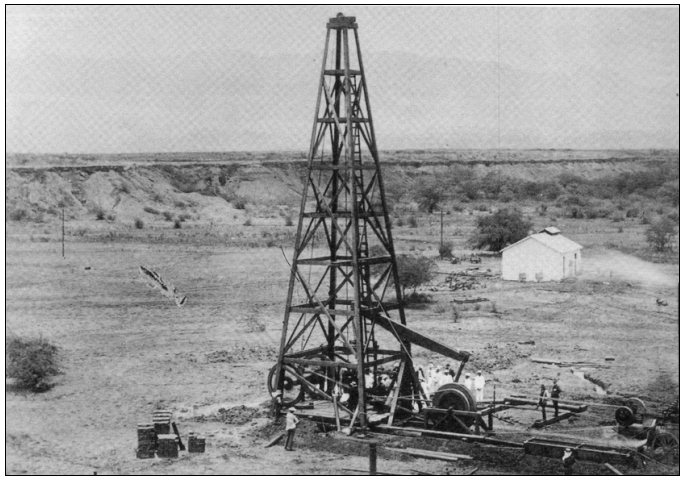

Figure 5 **Photo entitled "Drilling artesian well at Ewa ca. 1890" (Wilcox 1996:18)**

E. History of the Ewa Sugar 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 (*Hawaiian Annual* 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).

In 1889, Campbell leased his property to Benjamin Dillingham, who subsequently formed the Oahu Railway & Land Co. (O.R. & L) in 1890. During the last decade of the nineteenth century, the railroad would reach from Honolulu to Pearl City in 1890, to Waianae 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 elevation to William Castle, who in turn sublet the area to the newly formed Ewa Plantation Company (Frierson 1972:15). Dillingham's Honouliuli lands above the 200 ft elevation that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company.

Ewa Plantation Company 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).

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" (Conde and Best 1973:313). The Oahu Sugar Company took control over the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugar cane production in the combined plantation areas, including the present study area (Dorrance and Morgan 2000:45, 50).

III. DOCUMENTATION OF 'EWA IRRIGATION SYSTEM

A. Irrigation Systems

During the early history of the Ewa Plantation, like the majority of other plantations, the furrow system of irrigation was used. In this system, the fields were plowed into furrows, which ran parallel to the contour lines of the field. The seed cane was planted in the furrows, and then the water was directed into the furrows (Wilcox 1996:6). The irrigation system used at Ewa Plantation in 1923 was described as:

> The cane is either in the furrow or on the ridge between the furrows, i.e., in the first case the water running and around the cane stalks (this is always so of plant cane), and in the second case the water is applied between the cane rows in hilled-up rations). The furrows are about 30 to 35 feet in length, and the distance between rows may vary, but is has been generally assumed that five feet gives the best results for most plantations.
>
> The furrows are made at right angles to the fall of the land, and at right angles, i.e. parallel to the natural water flow, the watercourses are constructed. They are improvised water channels bringing the water from a level or distributing ditch which is on a parallel contour line to the furrows. These level ditches are about 200 to 300 feet apart, and are fed from so-called straight ditches, which in turn receive their water from the main ditch. The character of the field will determine the number and relative position of these distributing laterals from the main ditch [Alexander 1923:10-11].

The elements of the irrigation system (Figures 6 and 7) used up to 1930 (Alexander 1923:10-11) in the Hawaiian Furrow System are:

1) Main ditches, which deliver water to the field;

2) Straight ditches, which run down grade;

3) Level ditches, which take the water off laterally;

4) Watercourses; which are small improvised channels that hold the water applied by one man; and,

5) Furrows, which are at right angles to the watercourses in which the cane grows or which may be adjacent to the cane hill.

Early plantations used a single line irrigation system, where each furrow was irrigated from one side of a watercourse. In 1821, a different system was devised, called a "No-watercourse system". In this system, the field is in a series of parallel furrows at right angles to the contours. The furrows are five feet apart, and about 200 feet long. The water is fed to about 10 furrows at a time, from level ditches following the contours of the field. When the water has time to reach the end of the line, the line is closed (Alexander 1923:21). In 1930, the Ewa system or Renton system was devised, in which the water ran into a U-shape. Every other watercourse was cut out.

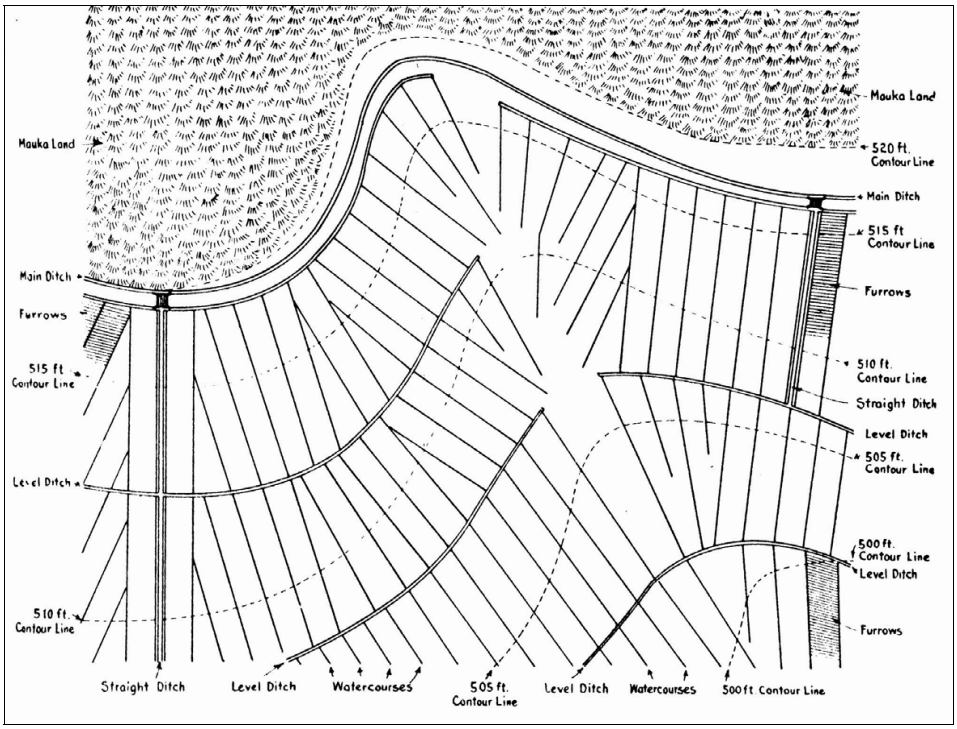

Figure 6 Five types of irrigation lines used in the Hawaiian Furrow System

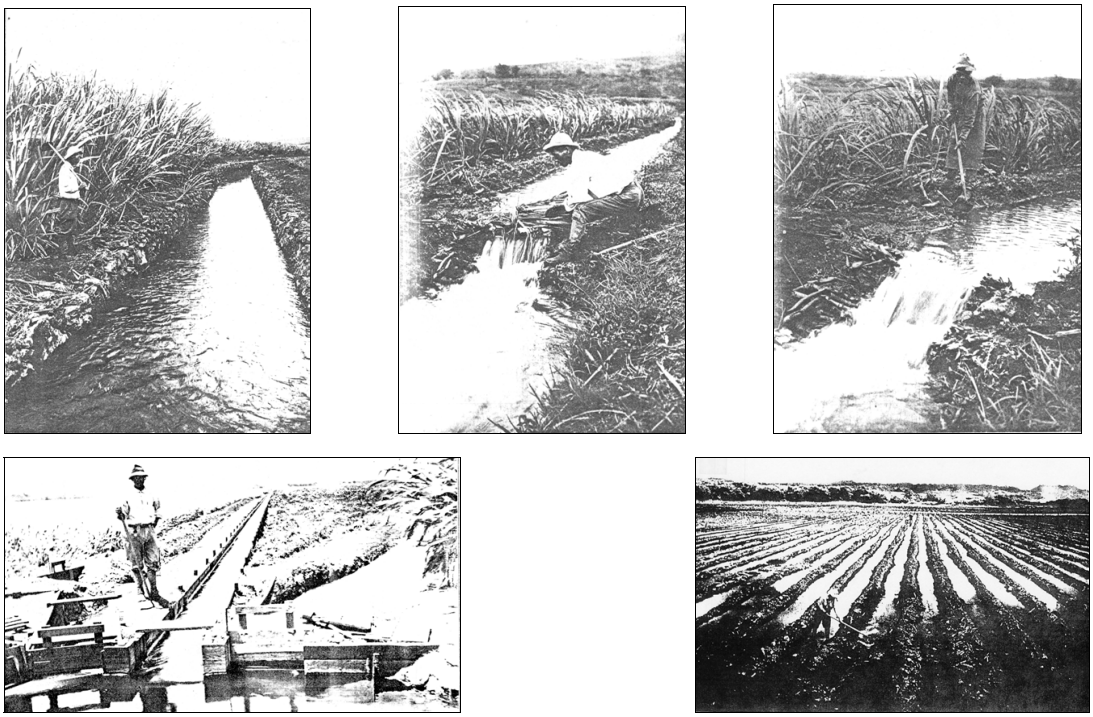

Figure 7 Five Types of Irrigation Lines: Main Ditches (upper left); Straight Ditches (lower left - juncture with main ditch); Level Ditches (upper center); Watercourses (upper right); and, furrows (lower right) (Armstrong 1923)

The remaining alternate watercourses furnished water on each side of the furrows (Alexander 1923:19).

Flume irrigation was first used at the Baldwin Sugar Plantation on Maui. The system consisted of a series of flumes made of one-inch redwood surfaced on the inside (Alexander 1923:40). These flumes had small outlets bored in the sides of the flumes, which were placed opposite to the water rows, so that water automatically flowed into the cane furrows (Alexander 1923:40-41). By 1923, the use of galvanized iron pipes to replace the flumes had been used (Alexander 1923:42). The Waialua Flume System used concrete flumes made in portable sections. The sections were placed in a herring-bone configuration; water was released into the furrows through small tin gates in the sides of the concrete flumes (Wilcox 1996:110).

B. Lining of Ditches and Flumes

A major concern of the sugar planters was the loss, or seepage of water. The first ditches were earthen, which lost up to 60 per cent of their water content, depending on the type of soil (Alexander 1923:51). Eventually, ditches were lined to prevent seepage and prevent bank erosion (Figures 8-10). Ditches lined with rocks or stone blocks set in cement mortar were tried but found to allow large seepage. This method was therefore used only in ditches and chutes over steep grades, where only this type of lining could withstand the great wear caused by scouring. Some ditches were lined with cement plaster reinforced with chicken wire stapled to the side walls. These were also vulnerable to damage by erosion and temperature cracks, and had to be repaired at least once a year. This method was used only for short or temporary ditches. The best but most costly method was to line the ditches with cement, either poured into moulds or laid down without forms. Pre-cast concrete slabs, with a tongue and groove joint, could also be laid down (Wilcox 1996:128). Only main and straight ditches were lined with concrete. Level ditches, watercourses, and furrows were excavated in the earth, and seepage was kept low by avoiding running small heads of water into them.

The task of irrigating the fields was conducted under the contract system. The key role in this task belonged to the men who worked at the reservoir, letting the water out. The task of individual irrigators was mainly to keep the watercourses and furrows clean of trash, so that the water could move freely. An irrigator needed to strip the dead leaves of the cane from the watercourses and put them into bundles called “panis”. These *panis* were then used to make obstructions in the ditches and damn up the water when necessary (Alexander 1923:78).

> In a well regulated field, one man always irrigates the same watercourse. He knows good work once, means an easier time thereafter. His lines are closed tightly, his “panis” are well made, his watercourses are free from trash. He takes care to see that his stream of water is not so large as to deepen watercourses and destroy lines. He soon finds that certain areas require water oftener; and other, known as “wet spots” should get their water by seepage, or only once in two or three rounds. . [Alexander 1923:85]

C. Ewa Plantation Annual Reports

The Ewa Plantation was chartered on January 29, 1890 with W. J. Lowrie as plantation manager (Pagliaro 1987:5). Lowrie reported in his *Annual Report of the Ewa Plantation* for 1890 the first days of the plantation:



Figure 8 Ditch Lining using Cement Plaster on Chicken Wire (Armstrong 1923:52)

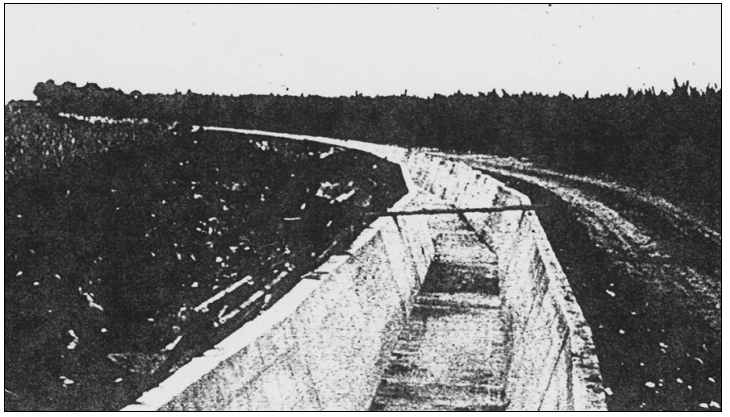

Figure 9 Reinforced Concrete Ditch, with Concrete Slabs on the Sides (Ewa Plantation Co. 1934:6)

Figure 10 **Three types of concrete ditch lining: Field stone and concrete lining for steep grades (left); concrete lining through sandy fields (center); and, standard type of concrete lining (Armstrong 1923:53)**

> . . . at 5:30 a.m. with 5 white men, two kanakas and 8 Chinamen. Cleared a good piece of klue and lantana and started the first plow at one o'clock and plowed the first furrow myself. Had two horses and chains parted we got started, and by 4:30 p.m. we had quite a piece of land plowed. The ground was very dry but plowed easily [from company's charter, cited in Pagliaro 19887:8].

In the first year, Lowrie also reported on the building of flumes for irrigation:

> . . . [W]e commenced by building flumes, plowing, planting, etc. as far as we could during the wet weather of those months and finished the planting of 74 acres on April 15th.
>
> The water for it from Robinson's pump has been very expensive, costing nearly $5,400, or over one-fourth of the total cost of seed cane. But it was the best we could do at the time. We are still using water from this pump, but our own pump has been received and we hope to have it running in about six weeks [Ewa Plantation Co. 1890:4].

By the end of 1890, ten artesian wells had been dug. Lowrie hired the McCandless Brothers to drill more wells over the next five years at a rate of $4.50 per foot (Ewa Plantation Co. 1980:6). When Lowrie resigned his position of manager in 1898, the plantation was making a profit and a total of 35 wells had been drilled (Pagliaro 1987:14). In 1925, the total capacity of the wells was 105 million gallons per day. By 1931, they had 70 artesian wells, four surface wells, and 18 pumps with a total capacity of 118 million gallons per day (Wilcox 1996:18, 107). Eventually the McCandless brothers would dig a total of 71 wells, which were used by both the Ewa Sugar Plantation and the adjacent Oahu Sugar Company Plantation

In 1907, the new manager, George Renton mentions the construction of a new pumping station near "what is known as the Waimanalo section of the Plantation" (Ewa Plantation Co. 1890:6). This is the pumping station (called Pumping Station No. 10) just within the western central boundary of the current project area (Figure 11). The reservoir just north of the pumping station was probably also built at this time (see Figure 1 for present location of pumping station and reservoir). In 1909, the report of the discovery of artesian water at Waimanalo was reported. This led to some rearrangement of the irrigation system, as follows:

> . . . the addition of three reservoirs was found to be necessary, one to receive the night water from the No. 10 station in that locality, and the other two in Field 19 above the hill of Kapolei to store water which was formerly delivered to Waimanalo. . . .
>
> The completion of No. 10 Pumping Station with the construction of necessary flumes and waterways and the clearing of new lands at the extreme western end of the plantation has necessitated during the year past the expenditure of $43,691.80. Owing to its rocky nature, clearing of this new land was very expensive. Nevertheless it is good soil, and is an addition which in time will well repay the investment [Ewa Plantation Co. 1907:4].

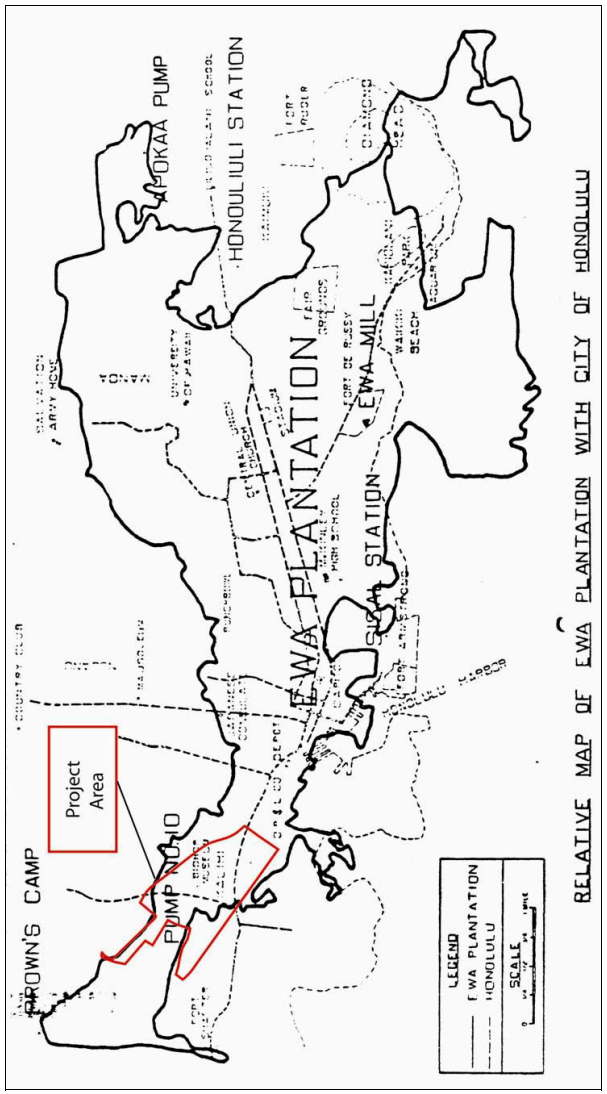

Figure 11 1926 Map of Ewa Plantation in Contrast to Size of City of Honolulu (1926 Ewa Plantation Annual Report)

In 1910, additional changes were made to improve the area around the pumping station and the new agricultural lands added to the western section of the plantation (within and around the present project area). Renton reports on flumes that need to be built to join this new land with the present irrigation system. Renton states:

> During the fiscal period under consideration it was considered expedient to elevate the water from No. 10 Station higher than 125 feet above mean sea level. The Pipe Line from this pumping engine has accordingly been extended to the full height of 200 feet allowed in our lease. On account of this higher pump lift, an increased area can be brought under cultivation. Fifty-five acres at this point were added to our cane lands in 1910; about as much may be added in 1911 [Ewa Plantation Co. 1910:3-4].
>
> Owing to the increase of area in the Waimanalo section of the Plantation, it was found advisable to straighten the railroad tracks near No. 10 Station. Two curves have been eliminated. We have now a straight track at that point and one far more economical on fuel and liable to cause accidents [Ewa Plantation Co. 1910:4].

The history of the irrigation in the Waimanalo area was discussed in the 1912 annual report:

> In order that some understanding may be had of the increase in expenditure already incurred and the project expenditure at this station, which will be referred to later on, a brief statement of its history may be timely.
>
> It was thought at one time that sufficient waster in the Waimanalo region could not profitably be obtained by boring wells. Water was, therefore, carried by ditch and flume from Honouliuli Valley from four to six miles. The increase in area at Waimanalo under cultivation and the strain on the pumping system at Honouliuli to irrigate these lands, together with the loss in seepage from transporting water such a long distance made it imperative to procure water at the western end of the plantation, if it could be obtained. Two experimental wells were drilled with gave evidence of an abundant supply of water. Two more were bored with the same result. A Compound Riedler Pump of Fraser and Chalmers make was then purchased and erected, and a 8,000,000 gallons per twenty-four hours station was under way. . . . Pipes were run to the 200 feet elevation, and, in addition to the new areas incorporated water was carried easterly to the older lands to relieve still further the pumping plants of Honouliuli Valley [Ewa Plantation Co. 1912:6-7].

A low pressure turbine engine at Pump Station 10 was installed in 1913. In 1914, the irrigation system was changed to the Renton system (also called the Ewa system), in which two furrows were watered from one watercourse. Renton recorded:

> When it is understood that a laborer, under the new system, can irrigate about fifty per cent more cane with but little extra effort, the financial result to the plantation may be appreciated [Ewa Plantation Co. 1914:8].

Improvements mentioned in the annual reports include the replacement of old steam pump engines with motor driven pumps, with electricity provided by the Hawaiian Electric Co., Ltd. Pump 10 was not improved, however, as mentioned by the new manager, George Renton, Jr., who had taken over management of the company in 1921:

> The installation of motor driven centrifugal pumps to replace the majority of the old steam driven units was finished early in the year, thus completing the partial electrification of our irrigation pumping system. The only pumps not electrified are Nos. 7 and 10, which will not be changed, as they are efficient steam driven units. With these improvements, we now have a modern pumping system, efficient in every respect [Ewa Plantation Co. 1924:7].

A 1927 map (Figure 12) of the Ewa Plantation shows that the current project area was at that time in the last section of the area to be developed. Field lots were numbered from east to west, with the lower numbers near the mill and the higher numbers near the coast. The present project area was within Fields 25 and 28.

A major change in the irrigation system occurred in 1930, as illustrated (Figures 13 and 14) and described by Renton:

> The most important of these is the new method of laying out our more level fields after plowing, the result of experimentation and developments which have been going on for the past three years. The simplicity of this system-called the Ewa Border Method as compared with the contour system, can be seen by comparing the maps reproduced in this report wherein there is shown field 23-B last crop-contour system-and this same field plowed and laid out the Ewa Border Method for next crop. The layout of this new method is such that the cane lines are 700 to 1,000 feet long, four of them being irrigated simultaneously, whereas in the contour system the lines are 70 feet long and two of them are irrigated at a time.
>
> . . . this new method lends itself more readily to mechanical planting, weeding, cultivating, fertilizing and harvesting than the contour system because the cane is planted in flat beds which are long and straight, rather than in furrows which are short and oftentimes not straight, as in the case in the contour system [Ewa Plantation Co. 1930:4-5].

Lowrie summarized the changes to the Ewa irrigation system up to 1933:

> The Development the Irrigation Methods also played its part. The first marked change at Ewa was in 1914 when the single-line system was converted into the two-way method of irrigation, now commonly called the "U" system. Seven years later (1921) the "no-watercourse" system-known today as the Long Line Method-was installed as an experiment, but this showed a saving in irrigation costs only, with no increase in yields. Furthermore, this system did not lend itself to mechanical weeding and fertilizing as is the case with the Ewa Border Method of today. On poorly drained areas, however, long lines are being installed as these areas are plowed, as it is felt that this system facilitates drainages.
>
> The Ewa Border Method, as it is known today, has been a gradual development over a number of years beginning in 1927. By 1930 as standard layout had been adopted and since that period this system has been spread as rapidly as possible [Ewa Plantation Co. 1933:6].

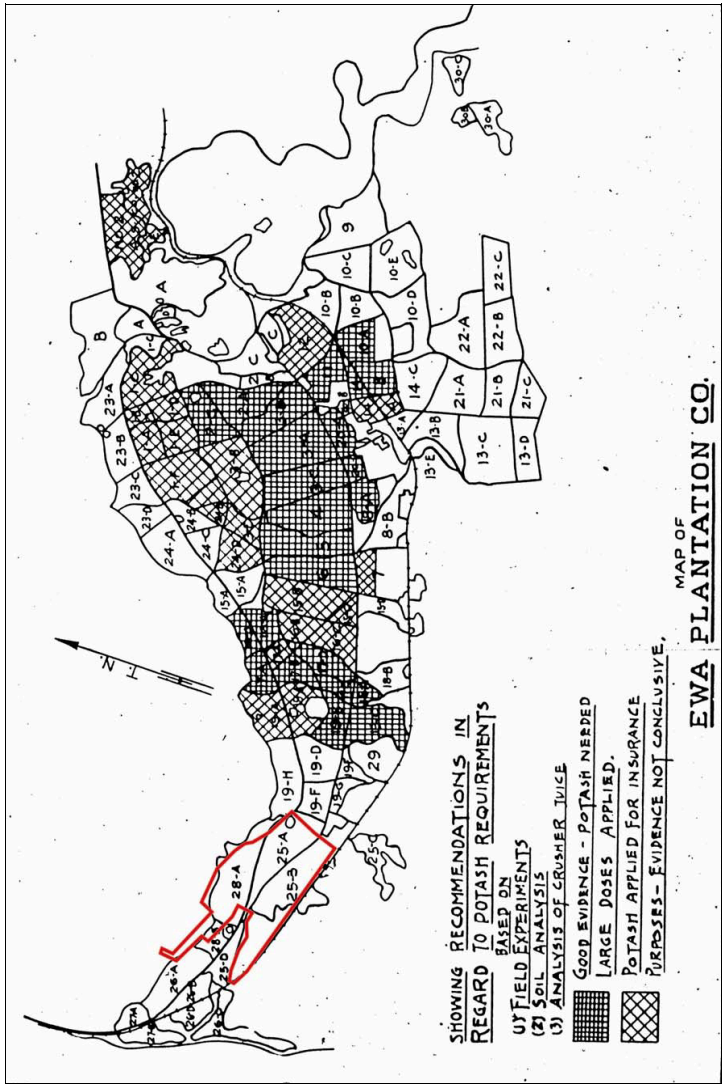

Figure 12 1927 Map Showing Numbered Fields (East to West) of the Ewa Plantation (1927 Ewa Plantation Co. Annual Report)

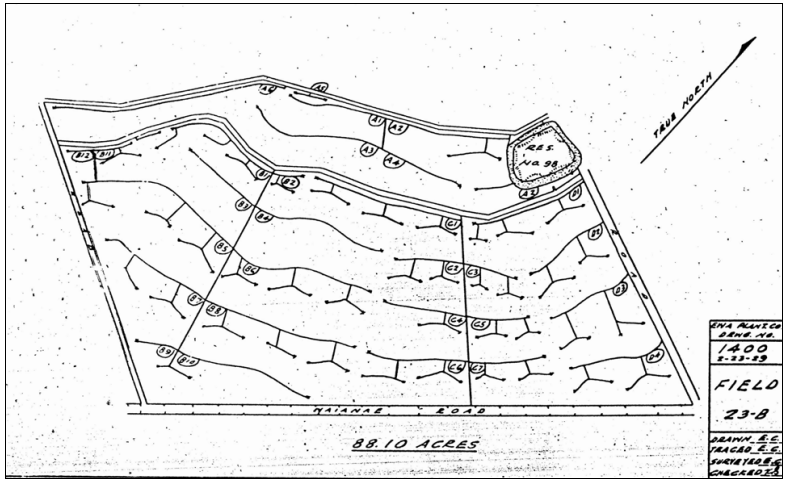

Figure 13 Contour Method of Irrigation (Ewa Plantation Co. 1930:6)

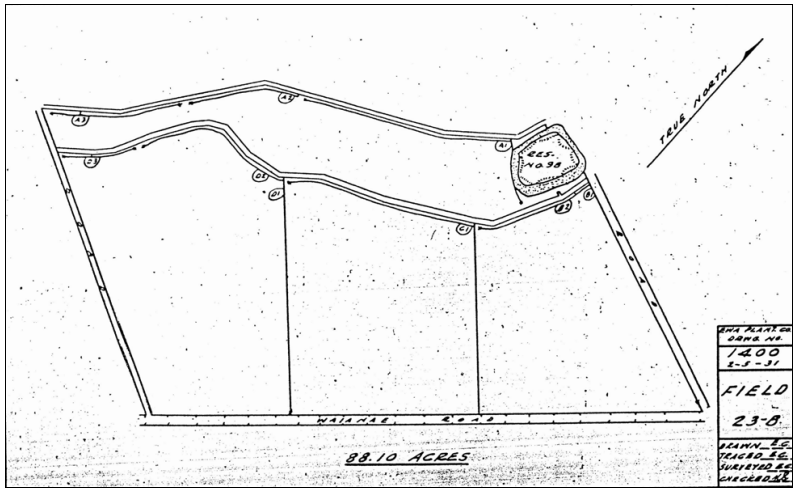

Figure 14 Ewa Border Method (Ewa Plantation Co. 1930:7)

A new pump of higher efficiency was installed at Station No. 10 in 1934 (Ewa Plantation Co. 1934:4). In addition, improvements were made to the flumes and ditches:

> It was thought advisable this past year to start the concrete lining of our large irrigation ditches where examination indicated the need for this improvement, no work of this nature having been done prior to final execution of our new lease. Accordingly a five-year program was planned and the work done in the year 1934 was as follows:
>
> Reinforced Concrete Ditches……6,071 feet
> Cement Plaster Ditches…….....2,943 “.
>
> The program for the replacement of our oldest iron flumes, some of which were installed when the plantation was first established, was distributed over a three-year period, and 7,072 feet of new flumes of No. 10 gauge material were put in place during this past year [Ewa Plantation Co. 1934:8].

Armco Iron for flumes is first mentioned in 1935. Armco Iron is iron of a comparatively high purity produced in open-hearth furnace under conditions that keep down the carbon, manganese, and silicon content. An update of improvements in 1935 follows:

> The improvement of our main irrigation waterways, commenced as a project in 1933, has continued with the following installations for 1935:
>
> Reinforced Concrete Ditches……...6,725 feet
> Cement Plaster Ditches……..…..2,261 feet
> Armco Iron Flumes (Various Sizes)……4,312 feet
> Concrete Culverts…….....255 feet
>
> These improvements have increased our operating efficiency in the delivery of wear and reduced water losses from seepage [Ewa Plantation Co. 1935:6].

An update in 1936 showed the progress of these improvements to the irrigation ditches and flumes:

The improvement and lining of our irrigation arteries has progressed from year to year since 1933. In 1936 the following construction work was completed:

> Rubble-lined Main Ditches……..…...4,917 Feet
> Reinforced Concrete Ditches……915 Feet
> Armco Iron Flumes……...4,631 Feet
> Cement Culverts, Boxes and Field Ditches……3,139 Feet
>
> Heretofore reinforced concrete has been used for the most part in lining our main waterways. The high cost of this type of lining prompted the trial of rubble masonry for this work, using field rock. This has proven considerable less costly and found to be satisfactory for this purpose. The greater portion of our program in 1936 was of this type of construction and we lined over a mile more of ditch than in either of the previous two years, at an appreciably lower total expenditure [Ewa Plantation Co. 1936:7].

In March of 1937, George Renton, Jr. resigned and his assistant Manager, J. D. Bond became the manager (Pagliaro 1987:33). Changes in the water system in that year included an additional well drilled along the *mauka* border of the plantation and continued improvements to flumes and ditches:

> During the year 2,576 lineal feet of galvanized iron flume were constructed and 11,082 lineal feet of ditch were lined with rubble masonry and concrete [Ewa Plantation Co. 1937:14].

A 1939 map of the Ewa Plantation indicates the increase in acerage. In 1927 (Figure 15), the fields were numbered 1-27 from east to west. In 1939, they are numbered 1-83 from west to east. The fields within the project area are now numbered 2, 5, 7, and 8. In 1939, some of the ditches were being replaced by pipes:

> Continuing the improvement our main irrigation arteries, about 7,300 feet of ditch were lined with rubble masonry. As a means of avoiding serious erosion and of increasing irrigation efficiency, about 23,000 feet of Ames pipe of various sizes were installed in those fields with steep slopes, planted during the year [Ewa Plantation Co. 1939:11].

In 1940, improvements consisted of an additional 8,448 feet of rubble masonry for the lining of ditches, mainly in areas above the 200-foot elevation. The reservoir near Pump 10 had to be repaired and the concrete lining was extended to prevent seepage. A new type of ditch lining was used in 1940 for adobe (heavy clay) soils, thus:

> Following our successful experience with tile drains in some of our heavy adobe fields, we installed a similar system in one of our other large fields of the same soil types. In this instance, however, coral, graded according to size, rather than expensive tile, was placed in open ditches and then covered over. Our experience thus far with this installation has been gratifying [Ewa Plantation Co. 1940:7].

In 1941, the company suffered labor shortages and other problems associated with the beginning of World War II. A new 56-inch pipeline was installed for more efficient water distribution (Ewa Plantation Co. 1941]. In 1942, $6,972 was spent on masonry irrigation ditch lining and $5,628 was spent on concrete flumes, pipes, and culverts. This is the first mention of concrete flumes and pipes (Ewa Plantation Co. 1942). In 1943, the casings of some of the mill artesian wells failed; these had to be recased. Demands for water stressed the system, since the plantation not only provided water to the fields but also to the military (Ewa Plantation Co. 1943). In 1944, Waialua type flumes (Figure 16) were used in sloping areas. These were flumes made of separate concrete sections, made at the plantation workshop. The flumes fed cane lines placed in a herring-bone pattern.

> We have completed the installation of 11.5 miles of Waialua flume. This serves 588 acres of cane. On lands with sufficient slope, the pre-cast concrete flumes make for greatly improved irrigation performance and more efficient use of water. These flumes are produced in our own concrete products yard [Ewa Plantation Co. 1944 – note: after 1943 the annual reports are not paginated].

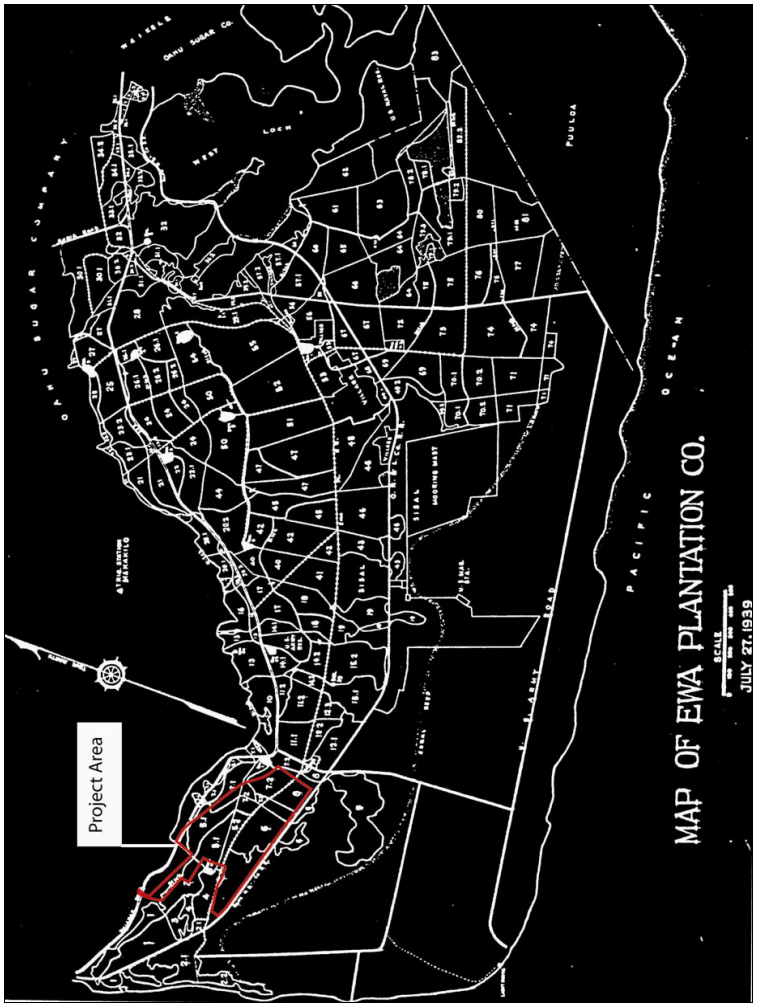

Figure 15 1939 Map Showing Numbered Fields (West to East) of the Ewa Plantation Co. (Conde and Best 1973:285)

Figure 16 Waialua Flume Irrigation Method; Portable Cement Sections (Ewa Plantation Co. 1944) made at the Ewa workshop (left); flumes set in field with furrows (Armstrong 1923:41) in a herring bone pattern (right)

In 1947, transportation switched fully from railroad cars to trucks. All of the old OR&L rail, locomotives and rolling stock were sold for scrap. The old road bed of the railroad was converted to a road system for the new trucks, called "Tounahaulers". The irrigation system changed from the long border system to a 200-foot line method of irrigation in this year. Irrigation flumes continued to be built and installed on the plantation:

> Our large planting program necessitated the use of two crews throughout the year for making concrete flumes. Even then, we were just able to keep up with the planting, and at times, found it necessary to send flumes to the field with only two days curing time. With careful handling, however, there was very little breakage.
>
> A total of 93,420 pieces or approximately 45 miles of flume section were manufactured. This is about three times the record output of 1946 [Ewa Plantation Co. 1947].

In 1948, it is evident that the straight ditches were still earthen and not lined with other material, as follows:

> We have, however, continued to experience trouble with serious erosion of the straight ditches in some fields, with the consequent silting up of the level ditches. It has been necessary to use a considerable amount of labor to dig out these silted ditches to maintain adequate capacity for efficient irrigation.
>
> The split-flume straight ditches, with concrete poured down the center strip, appear to be the answer to this problem. While this type of installation is rather costly, it should last through several crops, and the cost per crop should be low [Ewa Plantation Co. 1948].

In 1949, a new method of lining was tried in the main irrigation ditches. One ditch was lined with the "Gunite" process, having first been deepened in certain sections. In the Gunite Cement method a wire frame is made, and a special gun is used to spray plaster onto the frame by means of compressed air. A supply of dry material is held in the gun, conveyed to the nozzle with compressed air, and wet with the proper amount of water as it is then blown onto the frame. This resulted in strong, thin coatings that would not slump off the frame and eliminated the problem of the plaster setting up before it was fully placed. The equipment is used to patch deteriorated concrete with a sand and cement mix (http://www.allentownequipment.com/Allentown/history.htm, June 4, 2004). Two other ditches were lined with concrete slabs and a cement fill (Ewa Plantation Co. 1949).

By 1955, main ditches are illustrated with a concrete lining. Pipes were used at the head of each cane row (Figures 17 and 18) so that irrigation water ran down from the main ditches into the single lines of growing cane (Ewa Plantation Co. 1955).

In 1960, tests were first made to use overhead irrigation, using a mobile sprinkler that pumped water from the existing ditches (Figure 19). The system showed "promise, although additional experience is necessary before it can be fully evaluated" (Ewa Plantation Co. 1960). In 1961/1962, the overhead irrigation system was expanded to 81 acres. The older method was still maintained:



Figure 17 **Pipes placed at the head of each cane row so that the irrigation waster running down the main ditch can be diverted into the single lines of growing cane (Ewa Plantation Co. 195)**

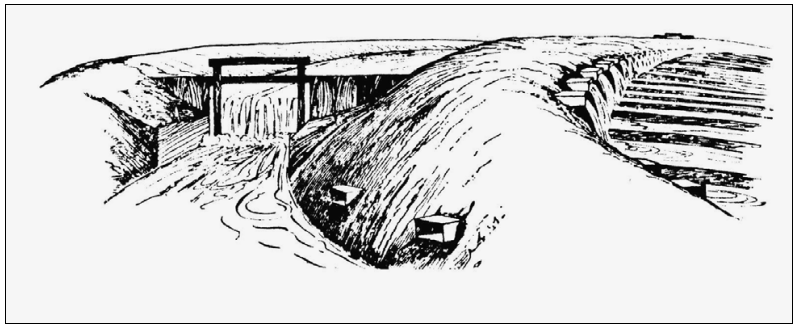

Figure 18 **Level Irrigation Ditch with outlets for irrigation of watercourses and furrows (Armstrong 1923:25)**

> Finding the most economical means to maintaining the distribution system for Ewa‘s irrigation water presents a continuing challenge. This past year some 1,000 feet of large flume was treated with a mixture of bitumuls [asphalt] and plastic which may prove applicable to many miles of our older flume. Nearly a mile of large diameter pipe, with years of service behind it, was lined with cement mortar at a fraction of the coast of new pipe. It was also necessary to replace a 1,500-foot section of elevated flume and its supporting structure with a welded steel, inverted siphon at a cost of $40.00 per foot [Ewa Plantation Co. 1961/1962].

In 1963/1964, a second high-volume overhead irrigation unit went into operation; the two units were used to irrigate 854 acres. Additional overhead machines were being made in the company shops. The fields irrigated by this method were fertilized by aircraft. In this year, it was also mentioned that over the next two years the plantation would lose as much as 200 acres for new highway construction (Ewa Plantation Co. 1963/1964).

In 1964/1965, the acreage irrigated by the mobile units increased to a thousand acres. A new pipeline was under construction to provide additional water from caprock sources to the Waimanalo section of the plantation. The annual report also noted that construction started under the H-1 and Farrington Highway Improvement Program, and the first acre of cane land was lost for this project (Ewa Plantation Co. 1964/1965).

In 1966/1967 the irrigation flume trestle across Makalapa Gulch, first built in 1895, was replaced by a 30-inch welded steel siphon. The report adds that at least one more trestle will need to be replaced in the next few years (Ewa Plantation Co. 1966/1967).

In 1967/1968 the plantation started to switch to a semi-automatic furrow (surface) irrigation system (Figure 20):

> . . . We now have 548 acres where irrigation is completely controlled by clock-actuated gates, and another 132 acres where parts of the fields are using this system. Expansion of semi-automated surface irrigation is being stressed. Priority is being given to straight-line, level-ditch layouts, which can be most readily and economically converted. Largely as a result of this program, acres irrigated per man-day reached a new high-10.92-for the second consecutive year [Ewa Plantation Co. 1967/1968].

The annual reports for the Ewa Plantation Co. end in this year. In 1970, the Oahu Sugar Company took over the remaining acreage of the Ewa Plantation Co. and continued to grow sugar until 1995.

The annual reports of the Ewa Plantation Co. show a steady interest in the improvement of the efficiency of the irrigation system. Table 1 presents a summary of the information on the first mention of these improvements.

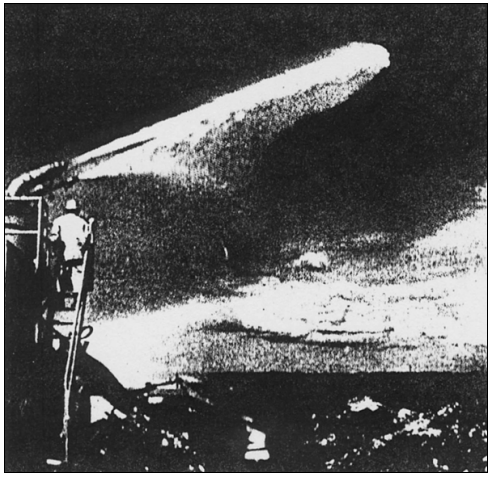

Figure 19 **Overhead Irrigator sucks water from an irrigation ditch and spews it out on the cane fields (Ewa Plantation Co. 1964-1965)**

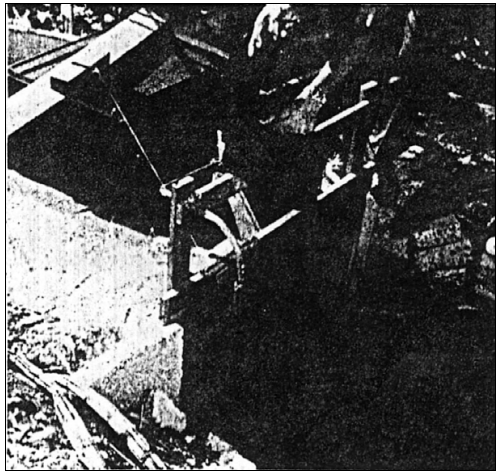

Figure 20 **A timer mechanism semi-automated control of an irrigation gate system (Ewa Plantation Co. 1964-1965)**

Table 1 **Improvements in Irrigation System at Ewa Plantation**

Year	Improvement
1890-1931	Use of Robinson’s Pump in 1890. Ten wells drilled by 1891; By 1898 had 35 wells; By 1931 had 70 wells and 18 pumps
1890	Contour System with single-row irrigation used; each furrow irrigated by one watercourse
1907	Pumping Station 10 in Waimanalo section (within project area) and reservoir (adjacent to project area) constructed; flumes and ditches associated with Pump 10 also constructed
1909	Artesian water found in Waimanalo
1913	Contour System with two-line irrigation used (called Renton, Ewa or “U” system); cane lines are 70 feet long and are irrigated by one watercourse
1921	No Watercourse System (Long Line Method) of Irrigation used as an experiment; eventually used only on poorly drained areas
1932	Main ditches were lined with reinforced concrete or cement plaster
1932	Old iron flumes replaced with No. 10 gauge iron
1935	First mention of Armco Iron Flumes and concrete culverts
1936	Ditches were lined with rubble masonry and reinforced concrete
1937	Galvanized iron used for flumes; ditches lined with concrete or rubble masonry
1939	Pipes (Ames) sometimes used instead of ditches on steep slopes
1940	Ditches first lined with tile drains in adobe (heavy clay) fields; others lined in graded coral; ditches above the 200 foot elevation continued to be lined with rubble masonry
1941	Large 56-inch pipeline installed; Waialua concrete flumes (made in sections at the Ewa plantation workshop) are first installed; first mention of concrete pipes
1947	200-foot Line method of irrigation used
1948	Straight ditches replaced with split flume straight ditches, with concrete poured down the center strip
1949	Gunite Cement used to line ditches; plaster sprayed on with a gun over a wire frame; ditches also lined with concrete slabs and cement
1955	Small pipes used at the head of each cane row
1960	First tests with overhead high volume irrigation with a mobile sprinkler
1961/2	Some flumes lined with bitumuls (asphalt) and plastic; older pipes lined with cement mortar; trestles for elevated flumes replaced with welded steel trestles
1966/7	Switch to semi-automatic furrow system with clock-actuated gates

IV. RESULTS OF FIELD DOCUMENTATION

by Todd Tulchin

Fieldwork within the project area (Figures 21 and 22) was conducted on May 26, 2004 by two CSH archaeologists, Todd Tulchin, B.S. and Jon Tulchin, A.A., under the general direction of Hallett H. Hammatt, Ph.D. As the project area was previously subject to an inventory survey level study, the current study was specific to the documentation of historic plantation infrastructure within the project area. Documentation of the plantation infrastructure was initiated in the vicinity of the Kamokila Community Park. Extensive ditch and siphon infrastructure were observed to be concentrated in this area. All plantation infrastructure observed in this area, as well as located throughout the project area with the use of historic maps, were inspected. All observed ditches and other infrastructure were traversed throughout their length within the project area. Documentation consisted of written descriptions, photographs, and location of the features with GPS survey technology. Two historic properties were located within the project area. Site 50-80-12-6678 consisted of various ditches, siphons, and flumes associated with sugar plantation irrigation. Site 50-80-12-6679 consisted of a drainage canal associated with flood control measures of the plantation. Detailed descriptions of the plantation infrastructure features are as follows:

A. State Site: 50-80-12-6678 Feature A

Site Type: Culvert
Function: Agricultural (Plantation Irrigation)
Age: Modern

Site 50-80-12-6678 Feature A (Figure 23) consists of a modern ditch intersection and associated culvert. The intersection was roughly rectangular, measuring 4.3 m by 3.2 m wide and 1.5 m deep. The structure was primarily constructed of concrete, with additional metal gratings over the top of the intersection and the western ditch outlet. The metal gratings were observed to be resting on two old railroad rails anchored into the top of the concrete structure. Two parallel 75 cm diameter iron pipes, observed to run northeast under the H-1 Freeway, channel water entering from an irrigation ditch *mauka* (north) of the H-1 Freeway into the northeast corner of the ditch intersection. The water could then be diverted to the east or west through two ditch outlets located in the southern portion of the ditch intersection. The ditch outlets were each approximately 1 m wide with two vertical sluice gate slots molded into the concrete. The ditch outlets allowed water to be diverted into either of two historic irrigation ditches, Features B and C (see Figures 21 and 22).

Site 50-80-12-6678 Feature A served the function of channeling and diverting water into associated irrigation ditches. It was likely initially constructed concurrently with the construction of the H-1 Freeway in the late 1960s. However, later expansion of the H-1 Freeway may have required modification or reconstruction of the ditch intersection. Feature A is in good condition, with no damage observed.

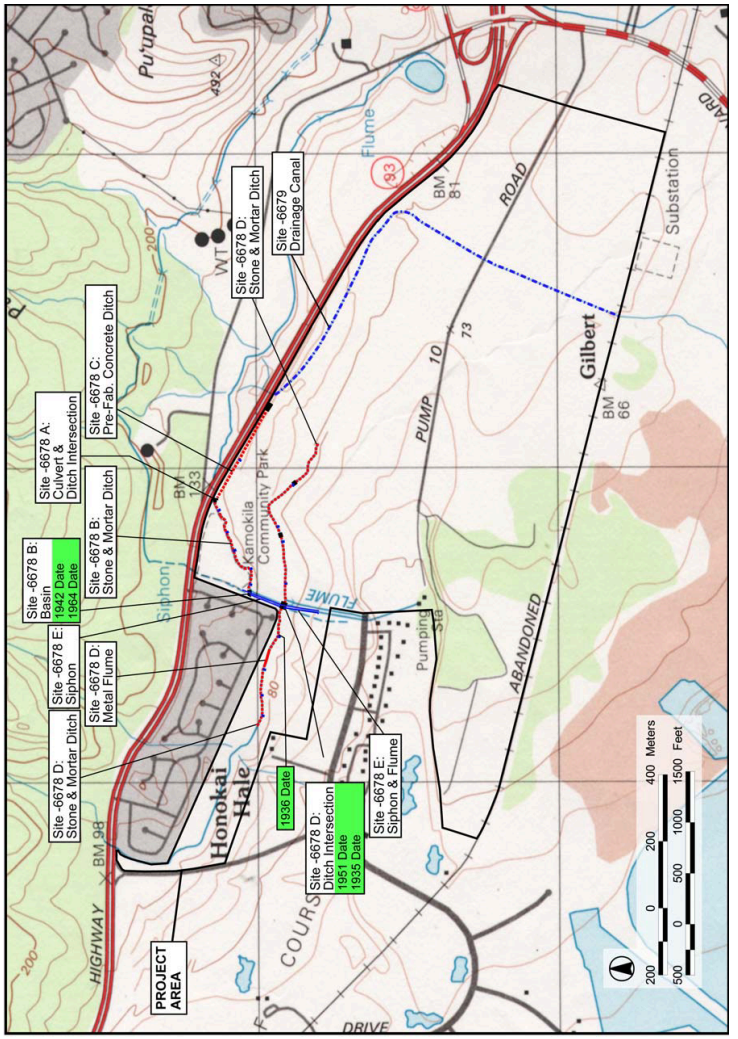

Figure 21 USGS Topographic Map, Ewa Quad, Showing the Location of Plantation Infrastructure within the Project Area

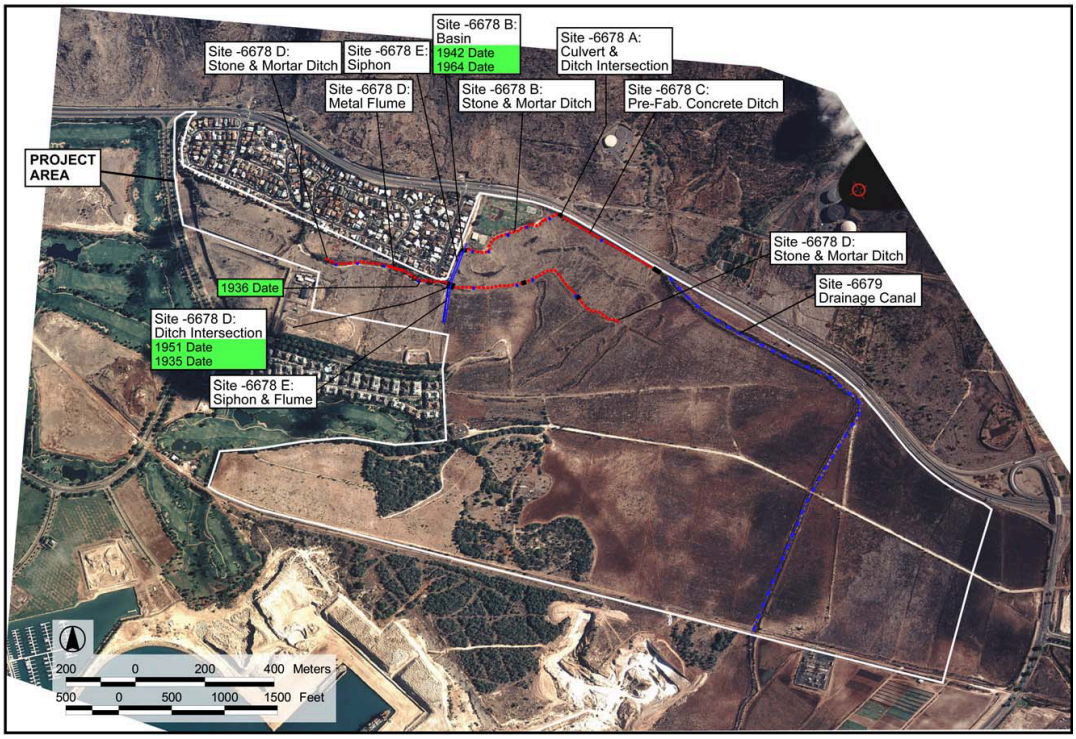

Figure 22 **Aerial Photograph (2000) Showing the Location of Plantation Infrastructure within the Project Area**



Figure 23 **Site 50-80-12-6678 Feature A Ditch Intersection, view to E. Note the use of old railroad rails incorporated into the construction**

B. State Site: 50-80-12-6678 Feature B

Site Type: Improved Ditch
Function: Agricultural (Plantation Irrigation)
Age: Historic

Site 50-80-12-6678 Feature B consisted of an improved irrigation ditch and associated water collection basin located in the northern portion of the project area (see Figures 21 and 22). The ditch originated at the Feature A: ditch intersection and terminated at a water collection basin, approximately 300 m to the southwest. The ditch followed the contour of a low bluff, upon which Kamokila Park is presently located. The irrigation ditch was of basalt stone and mortar construction, with an additional layer of rough mortar lining the interior of the ditch (Figures 24 and 25). It was constructed in a U-shaped configuration, with a flat bottom and nearly vertical sidewalls. The ditch measured 1.5 m wide and an average of 0.8 m deep. The downslope portion of the ditch was supported by mounded earth, including basalt boulders and cement fragments.

Located along the downslope side of the ditch, spaced 60-90 m apart, were constructed ditch outlets (Figure 26). The outlets were U-shaped constructions, designed to channel water out of the ditch and on to the plantation fields as needed (Figure 27). Two vertical sluice gate slots were observed molded into the ditch outlet, as well as in the main ditch, allowing the water to be directed to the desired location. Also located spaced along the length of the ditch were cement outlet pipes. The pipes were 15 cm in diameter and were set in the *makai* (seaward) wall of the ditch with the use of plaster, approximately 40 cm above the base of the ditch. While some of the ditch and pipe outlets appeared to be contemporaneous with the initial construction of the ditch, others were clearly later additions. Portions of the *makai* wall of the ditch were likely demolished and replaced with outlets as necessary.

The southwestern terminus of the Feature B irrigation ditch was at a water collection basin (Figure 28). The basin was primarily constructed of concrete, with a thin layer of rough mortar lining the interior cavity. The basin was roughly rectangular, measuring approximately 7.2 m by 4.0 m wide and 0.9 m deep. The water collection basin fed a siphon (Feature E), which carried the water to the south (Figure 29). A second siphon pipe was observed to cross over the basin. A "NOV. 1942" date was observed to be etched into the top of the concrete water collection basin (Figure 30).

Site 50-80-12-6678 Feature B served the function of channeling water from the Feature A ditch intersection to a water collection basin and siphon to the southwest, with ditch and pipe outlets used to irrigate adjacent plantation fields. Feature B is a historic construction, with the water collection basin being built in 1942. It is in good condition with relatively little damage.



Figure 24 **Portion of Site 50-80-12-6678 Feature B: Stone and Mortar Irrigation Ditch with Mortar Lining. View to E**



Figure 25 **Damaged Portion of Site 50-80-12-6678 Feature B: Ditch, Showing Stone and Mortar with Mortar Lining Construction Method**



Figure 26 **Example Ditch Outlet within Site 50-80-12-6678 Feature B: Stone and Mortar Irrigation Ditch. Note the constructed sluice gate slots**



Figure 27 **Example Cement Outlet Pipe within Site 50-80-12-6678 Feature B: Stone and Mortar Irrigation Ditch**



Figure 28 **Water Collection Basin at Southwestern Terminus of Site 50-80-12-6678 Feature B**



Figure 29 **Siphon Inlet Pipe within Site 50-80-12-6678 Feature B Water Collection Basin**



Figure 30 **"NOV. 1942" Date Etched into Site 50-80-12-6678 Feature B Water Collection Basin**

C. State Site: 50-80-12-6678 Feature C

Site Type: Improved Ditch
Function: Agricultural (Plantation Irrigation)
Age: Historic

Site 50-80-12-6678 Feature C consists of an irrigation ditch which runs roughly parallel to the H-1 Freeway, in the northern portion of the project area (see Figures 21 and 22). The ditch originates at the Feature A ditch intersection and terminates near a modern flood control canal, approximately 350 m to the southeast. The ditch is constructed of 1 inch thick, pre-fabricated concrete segments joined together with plaster seals (Figure 31). The concrete segments are U-shaped, with a flat bottom and vertical sidewalls. Each segment measures 0.8 m long, creating a ditch 1.0 m wide and 0.6 m deep. At the southeastern end of the ditch, a 75 cm diameter pipe runs approximately 10 m under an earthen embankment. The ditch then appeared to be truncated by the construction of a modern flood control canal.

Located along the downslope side of the ditch was a single ditch outlet (Figure 32). The outlet was a U-shaped construction, designed to channel water out of the ditch and on to the plantation fields as needed. Two vertical sluice gate slots were observed molded into the ditch outlet, as well as in the main ditch, allowing the water to be directed to the desired location. A wooden remnant sluice gate was observed. The gate was constructed of two vertical posts supporting two horizontal planks. Also located spaced along the length of the ditch were cement outlet pipes. The pipes were 15 cm in diameter and were set in the base of the *makai* wall of the ditch with the use of plaster (Figure 33). A metal shutter was observed within one of the pipe outlets.

Site 50-80-12-6678 Feature C serves the function of channeling water from the Feature A: ditch intersection to the east, parallel to the H-1 Freeway, with ditch and pipe outlets used to irrigate adjacent plantation fields. Feature C, in its present location, is likely a modern construction post-dating the construction of the H-1 Freeway. However, the pre-fabricated segmented construction may have allowed for the ditch to have been relocated from a previous position. Feature C is in fair condition with both intact as well as collapsed portions.



Figure 31 **Segment of Site 50-80-12-6678 Feature C: Irrigation Ditch, Constructed of Prefabricated, U-Shaped Concrete Segments**



Figure 32 **Photograph Showing Ditch Outlet within Site 50-80-12-6678 Feature C: Irrigation Ditch. Note the constructed sluice gate slots and wooden gate remnant**



Figure 33 **Photograph Showing Cement Outlet Pipe within Site 50-80-12-6678 Feature C: Irrigation Ditch. Note the metal sluice gate**

D. State Site: 50-80-12-6678 Feature D

Site Type: Improved Ditch
Function: Agricultural (Plantation Irrigation)
Age: Historic

Site 50-80-12-6678 Feature D consists of an irrigation ditch and associated ditch intersection located in the northern portion of the project area (see Figures 21 and 22). The ditch runs roughly east-west for approximately 900 m. Each end of the ditch appeared to have been truncated by land clearing (bulldozing) activities in the area. The majority of the ditch is of basalt stone and mortar construction (Figure 34). A portion of the ditch was also observed to have an additional layer of rough mortar lining the interior of the ditch (Figure 35). An "APRIL-4-1936" date was observed etched into the top edge of the western portion of the Feature D: stone and mortar ditch (Figure 36). The ditch is constructed in a U-shaped configuration, with a flat bottom and nearly vertical sidewalls. The ditch measures 1.2 m wide, with a maximum depth of approximately 1.0 m. An approximately 60 m section of the ditch was an elevated metal flume (Figure 37). The flume consisted of a 115 cm diameter half-pipe supported by 4 by 8 in wooded beams and posts.

Portions of the downslope side of the ditch were supported by mounded earth, including basalt boulders and cement fragments 1 m in height. A faced mound of flaked basalt boulders and cobbles was observed adjacent to the downslope edge of the ditch (Figure 38). The mound was located in the central portion of the ditch immediately east of the ditch intersection and measured 15 m by 5 m wide and extended 50 cm above the top edge of the ditch (see Figures 21 and 22). Two concrete slabs were also observed to be placed over the ditch, possibly serving as bridges for pedestrian or vehicular traffic over the ditch (Figure 39). Each slab measured approximately 7 m by 2.5 m wide and 10 cm thick.

Several constructed ditch outlets were located along the downslope portion of the irrigation ditch, spaced 50-170 m apart. The outlets were U-shaped constructions, designed to channel water out of the ditch and on to the plantation fields as needed (Figure 40). Two vertical sluice gate slots were observed molded into the ditch outlet, as well as in the main ditch, allowing the water to be directed to the desired location. Two ditch outlets were observed to have an additional short ditch section. This secondary ditch ran parallel to the main ditch for approximately 10-12 m and had multiple sluice gates, allowing for further direction of water flow. The secondary ditches were constructed with stone and mortar, as well as pre-fabricated concrete segments. One former ditch outlet was also observed to be permanently sealed with a basalt stone and mortar wall (Figure 41).

A ditch intersection was located where the Feature E: siphon pipes cross over the Feature D irrigation ditch (see Figures 21 and 22). The ditch intersection consisted of concrete appurtenances allowing water to be directed both in and out of the ditch from intersecting siphon pipes and also for water from the ditch and siphon to be directed into a metal flume (Figure 42). Concrete constructions included a rectangular structure measuring 1.2 m by 1.1 m wide and 2.1 m deep. The structure received the Feature E: western siphon outlet water and channeled it into the Feature D: ditch. A "JAN – 1951" date was observed etched into the top edge of the concrete structure (Figure 43). An additional cement flume outlet was constructed into the ditch intersection. The outlet measured 115 cm in diameter and 65 cm deep and allowed water from

the Feature D: ditch and the Feature E: eastern siphon to be directed into a metal flume running between the parallel Feature E: siphon pipes (seed Figures 21 and 22). A "NOV. 1935" date was observed etched into top the top edge of the concrete flume outlet (Figure 44).

Site 50-80-12-6678 Feature D: irrigation ditch serves the function of channeling irrigation water, with ditch and pipe outlets used to irrigate adjacent plantation fields. The Feature D: ditch intersection serves the function of directing water from the Feature E: siphon pipes and Feature D: irrigation ditch into the Feature E: siphon and flume as needed. Feature D is a historic construction with observed dates as early as 1935. It is in good condition with very little observed damage.



Figure 34 **Portion of Site 50-80-12-6678 Feature D: Stone and Mortar Irrigation Ditch**



Figure 35 **Portion of Site 50-80-12-6678 Feature D: Stone and Mortar Irrigation Ditch with Mortar Lining. View to W**



Figure 36 **"APRIL-4-1936" Date Etched into Western Portion of Site 50-80-12-6678 Feature D: Stone and Mortar Irrigation Ditch**



Figure 37 **Site 50-80-12-6678 Feature D: Irrigation Ditch, Transition from Stone and Mortar Construction to Metal Flume Near Natural Drainage Gully. View to NW**



Figure 38 **Faced Mound of Flaked Basalt Boulders and Cobbles Adjacent to the Down slope Edge of Site 50-80-12-6678 Feature D: Irrigation Ditch. View to S**



Figure 39 **Concrete Slab over Site 50-80-12-6678 Feature D: Irrigation Ditch**



Figure 40 **Ditch Outlet within Site 50-80-12-6678 Feature D: Irrigation Ditch, with Additional Ditch Segment and Multiple Outlet Gates. Note the constructed sluice gate slots**



Figure 41 **Sealed Ditch Outlet within Site 50-80-12-6678 Feature D: Irrigation Ditch**



Figure 42 **Site 50-80-12-6678 Feature D: Ditch Intersection Showing Eastern Siphon Outlet Pipe, Western Siphon Inlet Pipe and Flume Outlet. View to S**

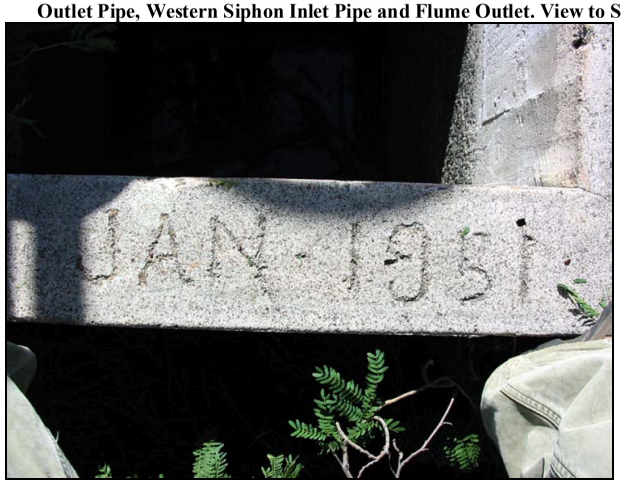

Figure 43 **"JAN – 1951" Date Etched into Feature E: Cement Siphon Outlet Structure**



Figure 44 **"NOV. 1935" Date Etched into Feature E: Stone and Mortar Flume Support**

E. State Site: 50-80-12-6678 Feature E

Site Type: Siphon / Flume
Function: Agricultural (Plantation Irrigation)
Age: Historic

Site 50-80-12-6678 Feature E consisted of two siphon pipes, an elevated metal flume, and associated appurtenances. The siphon was constructed of two parallel iron pipes, 60 cm in diameter and spaced 120 cm apart, extending approximately 300 m south from the southern end of Kamokila Park to the vicinity of a former reservoir (Figure 45). The eastern siphon pipe originated from a subsurface path beneath the Kamokila Park, and continued south, crossing over the Feature B: basin. A "6-'64" (1964) date was observed in the cement pipe support where the eastern pipe crossed over the Feature B: basin (Figure 46). The western siphon pipe originated at the Feature B: water collection basin, where water in the basin could be taken up by the siphon (see Figures 21 and 22).

At the intersection of the eastern siphon pipe and the Feature D: irrigation ditch, a valve and outlet pipe allowed water from the siphon to be emptied into an elevated metal flume (Figure 47). Also at the ditch intersection, the western pipe terminated with a valve and outlet pipe allowing water from the siphon to be emptied into the Feature D: irrigation ditch. A second segment of the western siphon pipe originated at the south end of the Feature D: ditch intersection, siphoning water from the Feature D ditch and continuing to the south (see Figures 21 and 22). A metal Bridge structure was also constructed over the ditch intersection, allowing pedestrian access to the siphon valves. The 90 cm wide bridge was constructed of iron beams with a grated floor (Figure 48).

The Feature E: flume originated at the Feature D: ditch intersection. The flume was constructed of a 115 cm diameter iron half-pipe supported by wooded beams and posts up to 4 by 8 in. in size (Figure 49). The top of the flume was elevated 1.8 m above the ground surface. The two parallel siphon pipes and elevated flume continued to the south, terminating between the Honokai Hale and Ko'Olina Golf Course Homes. The flume appeared to have been deliberately demolished. The two siphon pipes went underground in the vicinity of a reservoir, possibly filling the reservoir from below (Figure 50).

Site 50-80-12-6678 Feature E: siphon and flume serve the function of transporting water *mauka/makai* between plantation irrigation ditches and reservoirs. Feature E is a historic construction, with observed dates as early as 1935. The siphon pipes are in fair condition, with some areas of damage. The flume is in poor condition, with the majority of the wooded support structure damaged by fire.



Figure 45 Site 50-80-12-6678 Feature E: Parallel Siphon Pipes. View to SW



Figure 46 "6-`64" Date Etched into Cement Pipe Support of Feature E: Eastern Siphon



Figure 47 **Site 50-80-12-6678 Feature E: Eastern Siphon Valve and Outlet Pipe into Flume and Metal Bridge Structure**



Figure 48 **Site 50-80-12-6678 Feature E: Western Siphon Valve and Outlet Pipe into Feature D: Ditch Intersection and Metal Bridge Structure**



Figure 49 **Site 50-80-12-6678 Feature E: Elevated Flume Between Parallel Siphon Pipes, View to S**



Figure 50 **Site 50-80-12-6678 Feature E: Parallel siphon Pipes Directed Underground. View to NE**

F. State Site: 50-80-12-6679

Site Type: Drainage Canal
Function: Plantation Flood Control
Age: Historic

Site 50-80-12-6679 consists of a single drainage canal. The canal parallels the H-1 Freeway in the northern portion of the project area for approximately 700 m, then curves and heads southwest through the project area (see Figures 21 and 22). The drainage canal was observed to be mechanically excavated, with the excavated material mounded approximately 3 m above the ground surface along each edge of the canal (Figure 51). The interior of the canal measured approximately 7.5-9.0 m wide and 4.5-6.0 m deep. The canal was generally earth-lined and exhibited significant erosion of the sidewalls.

Drainage water enters the canal from Pālailai and Awanui gulches by passing under the H-1 Freeway through modern drainage culverts (Figure 52). The two water flow channels are then funneled into a single canal. The initial portion of the canal, in the vicinity of the H-1 culvert, was observed to have sidewalls reinforced with a cemented basalt boulder lining (Figure 53). The lining extended approximately 2 m above the base of the canal. The base of the canal, throughout its observed length, appeared to be earth-lined, though heavy sedimentation may have covered any evidence of improvements.

Site 50-80-12-6679 appears to serve the function of channeling storm water from gulches upslope, as to prevent flooding of the lowland plantation fields. The canal may also be related to efforts by the Ewa Plantation to induce erosion and sedimentation of the lowlands. Site-50-80-12-6679 is in good condition and appears to continue to function as a flood control measure.



Figure 51 Site 50-80-12-6679: Drainage Canal, View to SE



Figure 52 Site 50-80-12-6679 Drainage Culvert Running under the H-1 Freeway. View to N



Figure 53 Site 50-80-12-6679, Cemented Basalt Boulder Canal Lining

V. SUMMARY OF ARCHIVAL RESEARCH AND FIELD RESULTS

A. Summary of Irrigation System Improvements at the Ewa Plantation

According to the Annual Reports for the Ewa Plantation Company, the pumping station (Pump No. 10, located inside the project area), the reservoir (just outside the project area), and the ditches and flumes associated with these structures were first constructed in 1907. The area of irrigation was greatly expanded in 1909, when artesian wells were first drilled successfully on the lower ‘Ewa coastal plain. The first irrigation system used in this area had five different types of irrigation lines, main lines that ran from the pumping stations or reservoirs and then ran parallel to the ground contours, straight lines that ran perpendicular to these, level lines, again along contours, watercourses running perpendicular to the slope, and furrows again oriented parallel to the slope. Elevated flumes were used to cross gullies and steep areas. During Alexander’s 1923 survey of the irrigation systems of the Hawaiian Islands, only main and straight lines were sometimes lined with rock, masonry rubble covered with mortar, concrete, or plaster, thus it is likely that only these types of ditches, and elevated flumes, would survive from this early period of the plantation.

The first mention of lining ditches with concrete specifically at the Ewa Plantation was found in the 1932 Annual Report. However, a cheaper method, using rubble masonry cemented with mortar, was still used in most ditches up to the 1940s. In 1941, a new method of irrigation was adopted in some area of the plantation. The cane was irrigated though concrete flumes (Waialua flumes), made in pre-cast sections and then placed in the field. Holes bored in the side of the flumes released water to the cane fields directly. By 1955, other areas of the plantation were irrigated from ditches with small pipes place perpendicular to the ditch length. Improvements continued in 1961/1962 with the adoption of asphalt (bitumals) and plastic ditch lining and clocked semi-automatic irrigation in 1966/1967. In 1960, the first test of a mobile overhead irrigation system was successfully made; over the next few years an increased amount of acerage was irrigated in this manner. This must have led to the abandonment of many of the former ditch systems, especially the smaller ones.

B. Summary of Plantation Infrastructure Recorded in the Project Area

Site 50-80-12-6678 consists of a flume (Feature E), oriented north/south, which runs from Pumping Station No. 10 upslope to the northern boundary of the project area and beyond. It connects to three structures that are oriented parallel to the slope (east-west): a stone and mortar ditch that crosses the flume and extends both to the east and west (Feature D), which also has a metal flume section; a stone and mortar ditch that extends to the east (Feature B) and terminates at a culvert and ditch intersection (Feature A); and, a concrete flume section (Waialua type concrete sections), that extends from Feature A to the east.

All of these features would be classified as main ditches. They are either connected with the pumping station or they are large, lined ditches or flumes oriented parallel to the slope. The present positions of Feature B, the stone and mortar ditch at the northern boundary of the project area and Feature D, the ditch/flume downslope of Feature B, correspond to the locations to two ditches pictured on several early maps of O‘ahu, including a 1919 Fire Control Map (Figure 54) and a 1928 USGS map (Figure 55). In the 1919 map, there also seems to be a ditch extending

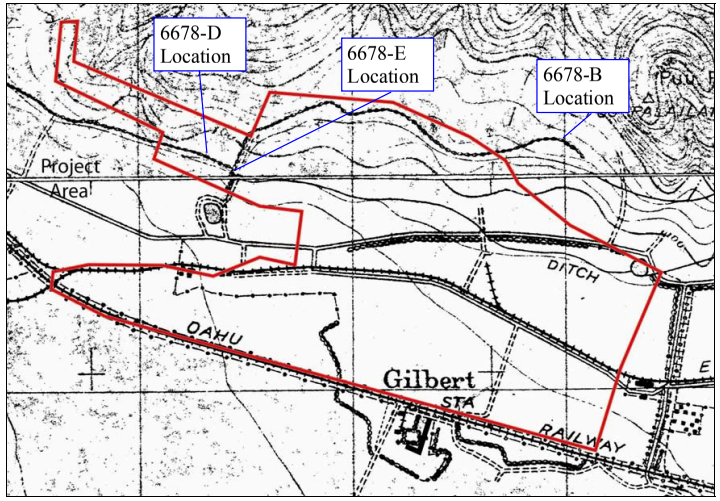

Figure 54 1919 Fire Control Map, Showing the Location of the Project Area

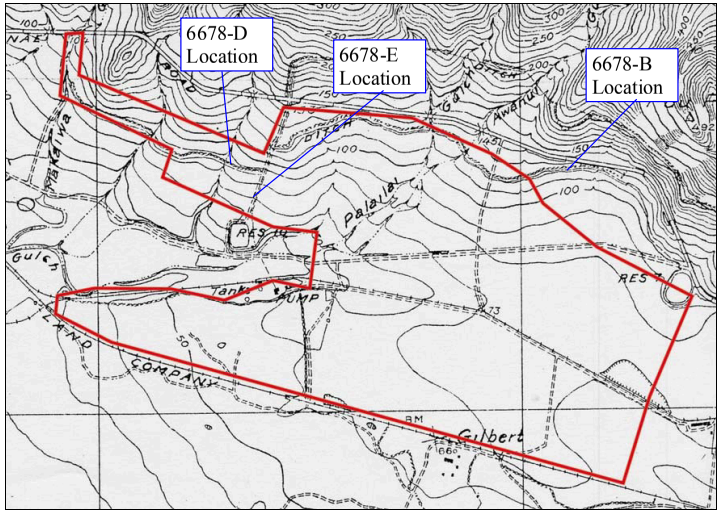

Figure 55 1928 USGS Map, Showing the Location of the Project Area

upslope (north) from the reservoir that intersects with both east/west ditches. This is the present location of Feature E, which consists of an elevated metal flume, two concrete pipes, and a siphon. A date of 1964 is etched on a concrete support of one of the pipes. Three sections of concrete were found with dates at the intersection of Features D and E, 1935, 1936, and 1951. The 1930s date may indicate the first time that these ditches were lined with mortared rubble; the 1951 date attests to the continuing maintenance and improvements to the irrigation system.

A water collection basin at the intersection of Features B and E has two dates etched in concrete, 1942 and 1964. Feature B also contains a section with cement outlet pipes built within the walls. This type of pipe is first mentioned in the 1955 annual report of the Ewa Plantation.

The feature B ditch intersects with a concrete culvert (Feature A) constructed of concrete with a metal grate resting on old railroad ties. The annual report of the Ewa Plantation for 1947 mentions the switch of hauling cane from railroad cars to trucks. The railroad equipment, including the ties, were sold or reused for other purposes. This suggests a date of post 1947 for this culvert section. The culvert also connects to pipes that run beneath the H-1 freeway. The 1963/1964 annual report mentions that 200 acres of Ewa sugar land would be lost in the future for highway construction, thus the construction of the pipes probably dates to the 1960s.

Feature A also connects to a feature (Feature C) that runs parallel to the H-1 freeway, and thus probably post-dates the highway construction in the 1960s. No road is shown in this exact position on any early maps, including the 1919 and 1928 maps (see Figures 54 and 55), 1943 War Department map (Figure 56), or a 1967 map of the plantation (Figure 57). This ditch is lined with U-shaped concrete section, joined together with plastic seals. These seem to be the concrete Waialua flume sections made at the Ewa Plantation Co. workshop beginning in 1941 (compare concrete blocks in Figures 16 and 31). Since these concrete sections are portable, they may have been moved to their present location after cane land was lost in the 1960s for construction of the H-1 freeway.

Site 50-80-12-6679 is a drainage canal excavated into the earth, with the excavated mounded 3 meters above the ground surface on each side of the canal. Water drains from the Pālailai and Awanui Gulches into a concrete culvert beneath the H-1 Highway and into this drainage canal, which then parallels the H-1 to the east for 700 m, then turns south and extends past the southern boundary of the project area. The construction of the east-west portion of this canal probably post-dates the construction of the H-1, since the canal parallels the roadway, but the north/south section may be older. A 1943 War Department map (see Figure 56) shows a line in this same location that may symbolize some type of ditch or canal. This ditch is not shown on the 1912 or 1928 maps. It is possible that the origin of this canal had something to do with construction during activities during World War II.

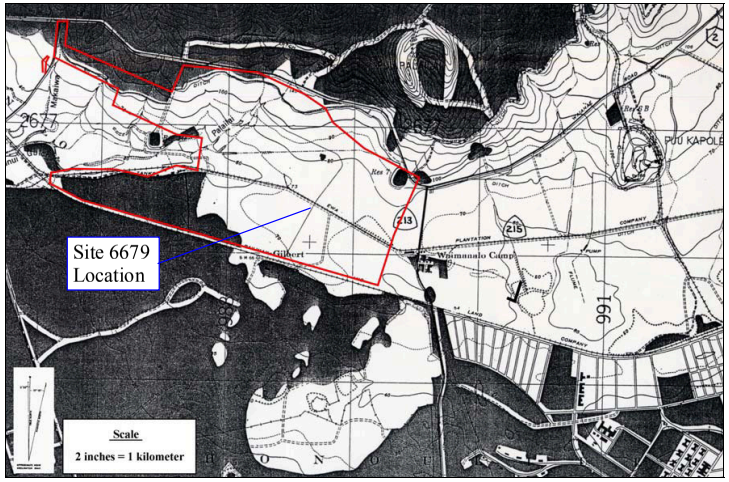

Figure 56 1943 War Department Map, Showing the Location of the Project Area

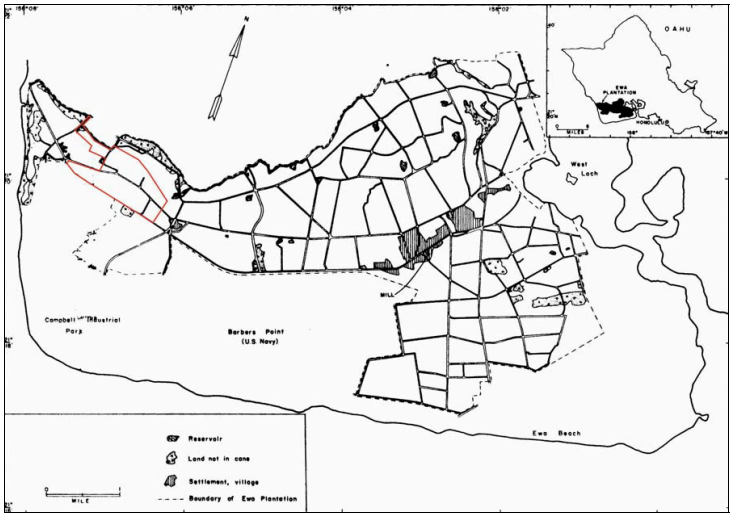

Figure 57 1967 Map of Ewa Plantation, Showing Infrastructure and Field Boundaries

C. Site Significance and Recommendations

State Sites 50-80-12-6678 and -6679 are significant under Criteria D of the Hawai'i State and National Registers of Historic places (HRS 6E-10 and ^6-5.5), which defines five broad criteria for defining a cultural site as significant, as follow:

A. Site reflects major trends or events in the prehistory or 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 has yielded or is likely to yield information important to prehistory or history.

E. Site has traditional cultural significance to an ethnic group.

Criterion D refers to information that has or can be obtained from Sites –6678 and -6638. During the recent field project, the features of the two sites were mapped with a GPS unit, described in detail, and photographed. Background historical research has indicated the probable use and age of the features at the two sites, and their appearance on early to mid 19th century maps has been documented. No further work is recommended for these two sites, nor are they recommended for preservation.

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Field Inspection of Approximately 124 Acres at

Kapolei, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu

TMK: 9-1-14:33 and 9-1-15:20

by

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by

Cultural Surveys Hawai‘i, Inc.
February 2004

EXECUTIVE SUMMARY

Cultural Surveys Hawai‘i completed an archaeological field inspection of approximately 124 acres within parcels designated TMK 9-1-14:33 and –15:20 in the west Kapolei area of the Honouliuli Ahupua‘a.. The inspection focused on the determination of the nature, distribution and density of archaeological sites present.

Large portions of the project area were closely examined and found to be clear, or relatively clear, of archaeological concerns. As a generalization, the southwestern and northeastern thirds of the project area are relatively free of sites and the central third is relatively site-rich (see Figure i). More specifically, in the southwestern portion of the project area, all of designated area A and the western third of designated area B are free of sites. In the eastern portion of the project area, the eastern two-thirds of designated areas C1 and C2 are free of sites with three discrete exceptions: an agricultural irrigation canal with a built-up eastern bank, the Gilbert Trig Station, and a forested area where sites CSH 12 and 13 were identified. No further work is recommended for the areas designated herein as free of archeological concerns.

Within the central portion of the project area (eastern portion of designated area B and western portion of designated areas C1 and C2) a number of historic properties were identified, including stone pavements, sinkholes and modified sinkholes, stone walls, stone mounds. Based on the properties observed and background research on the area, further archaeological study of specific portions of the project area is likely to be required by the State Historic Preservation Division (SHPD) to inventory archaeological remains present. In addition, background research indicates the importance of sinkholes as potential locations for subsurface historic deposits. Based on previous archaeological studies in the project area (Hammatt et al. 1994) that have yielded historic deposits from sinkhole excavations, the potential to encounter subsurface deposits, possibly including human burials, in sinks is evaluated as fairly high.

Also of concern in this area is the historic O.R.&L. railway alignment, which runs along the north side of the project area. In December of 1975, the O.R.&L. right-of-way was added to the National Register of Historic Places. Typically, in the past, the SHPD has asked that any plans for proposed crossings of the railroad be discussed with and approved by the Hawaiian Railway Society.

If development of some portion of the “cleared areas” is desired, we recommend submitting this Field Inspection Report to SHPD with a cover letter explaining the nature of the proposed action for their concurrence.

If development of some portion of the areas where archaeological concerns are likely to be encountered is desired, we recommend that archaeological inventory survey of these areas be conducted. In all probability, there would be some additional combination of data recovery work (plan, work, report), preservation work (plans and institution of preservation measures), and/or burial treatment required. The presence of an adjacent burial preserve should facilitate the chances for burial relocation if burials are found and relocation is desired. If plans allow for park-like preservation of some features, data recovery and burial treatment costs might be kept to a minimum. SHPD’s concurrence with the findings of this report, including recommendations for follow-on work, should be sought prior to initiating any further work on the site.

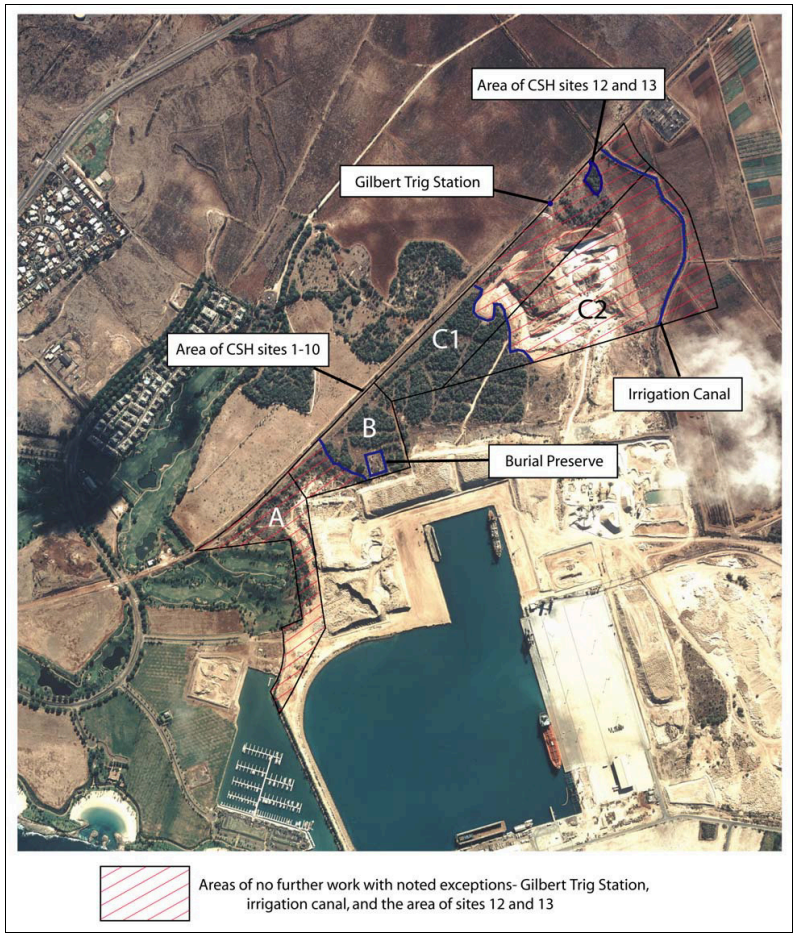

Figure i. Aerial photo of the project area showing recommendations for further work

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

LIST OF FIGURES v

LIST OF TABLES vi

I. INTRODUCTION 1
- A. Project Background 1
- B. Scope of Work 1
- C. Methods 5
  - 1. Background Research 5
  - 2. Field Methods 5
- D. Project Area Description 5

II. HISTORICAL BACKGROUND 7
- A. Precontact and Early History 7
- B. Mid to late 19th Century 8
- C. Twentieth Century 9
- D. Modern Land Use 9

III. HONOULIULI SETTLEMENT PATTERNS 13
- A. The Physical Layout 13
- B. The Coastal Zone 14
  - 1. Kalaeloa (Barber's Point) 14
  - 2. Koʻolina (West Beach) 14
- C. Honouliuli Taro Lands 15
- D. Puʻu Kuʻua: Inland Settlement 15
- E. Summary of Settlement Patterns in Honouliuli 16
- F. Summary of Settlement Patterns in Project Area 17

IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES 18
- A. Overview of Archaeological Studies in Western Honouliuli 18
- B. Predictive Model 29

V. FIELD INVESTIGATION 30
- A. Field Inspection Methods 30

B. Field Inspection Findings 30

VI. SUMMARY AND RECOMMENDATIONS 45

VII. REFERENCES CITED 47

LIST OF FIGURES

Figure 1. Portion of U.S. Geological Survey Map, ‘Ewa Quad (2002), showing project area 2

Figure 2. Portion of TMK 9-1-14 showing the location of the project area.....3

Figure 3. Aerial photograph (2000) showing the location of the project area 4

Figure 4. Map showing location of Honouliuli Ahupua‘a in west O‘ahu (adapted from Sterling and Summers 1978).....6

Figure 5. Portion of 1922 War Department Fire Control Map, Barber’s Point Quad, showing project area.....10

Figure 6. Portion of 1928 U.S. Geological Survey Map, Barbers Point Quad, showing project area.....11

Figure 7. Portion of 1943 War Department Map, Barbers Point Quad, showing project area.....12

Figure 8. Map showing general areas of archaeological study near the project area.....22

Figure 9. Site map from Lewis 1970 showing the current project area.....26

Figure 10. Site map from Barrera 1975 showing the current project area 27

Figure 11. Site map from Sinoto 1976 showing the current project area.....28

Figure 12. Map identifying historic properties within the project area 33

Figure 13. Photograph of CSH 1, view to the west.....34

Figure 14. Photograph of CHS 2 surrounded by *kiawe* debris 34

Figure 15. Photograph of CSH 3, view to the southeast.....35

Figure 16. Photograph of CSH 5, filled sinkhole.....35

Figure 17. Photograph of CSH 6, possible enclosure 36

Figure 18. Photograph of CSH 7 Feature A.....37

Figure 19. Photograph of CSH 7, Feature B 38

Figure 20. Photograph of CSH 8 showing wall and upright.....39

Figure 21. Photograph of CSH 9, "Long wall" 40

Figure 22. Photograph of CHS 10, cist mound.....40

Figure 23. Photograph of CSH 11, the Gilbert Trig Station 41

Figure 24. Photograph of CSH 12, sinkhole with historic debris.....42

Figure 25. Photograph of CSH 13, cement flume.....43

Figure 26. Photograph of CSH 13, engraved date.....44

Figure 27. Photograph of CSH 14, long irrigation canal 44

Figure 28. Aerial photo of the project area showing recommendations for further work 46

LIST OF TABLES

Table 1. Archaeological and related studies in western Honouliuli Ahupua‘a 18

Table 2. Sites near the project area 24

I. INTRODUCTION

A. Project Background

At the request of Helber Hastert and Fee, Cultural Surveys Hawai‘i, Inc. (CSH) completed an archaeological field inspection of approximately 124 acres within the parcels designated TMK 9-1-14:33 and -15:20, lying south of the O.R.&L. alignment, west of Kalaeloa Blvd., and north and east of the Barber's Point Harbor in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southwestern O‘ahu. The project area lies mostly in the northwest section of the TMK 9-1-14:33 parcel, and includes a large wooded area, portions of which have not undergone previous archaeological survey.

B. Scope of Work

The purpose of this field inspection was to determine whether significant historic properties are present within the project parcel. A particular concern here involves filled limestone sinkholes that may contain burials, other cultural finds, or extinct species as have been found in immediately adjacent areas. Previous archaeological surveys in the area have also identified traditional Hawaiian constructions including enclosures and possible burial mounds. WWII and plantation era infrastructure that would now be regarded as of historic significance were also investigated. The field inspection does not meet the SHPD/DLNR requirements for a more intensive inventory-level survey, but does provide sufficient data to make recommendations for future work.

The scope of work includes:

1) Historical research including 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.

2) Field inspection of the project area to identify any surface archaeological features and to investigate the potential for impacts to such sites. This inspection identifies sensitive areas that may require further investigation or mitigation before future development projects proceed.

3) Preparation of a report including the results of the historical research and the fieldwork with an assessment of archaeological potential and including recommendations for further archaeological work, if appropriate. The report includes mitigation recommendations for any archaeologically sensitive areas that need to be considered.

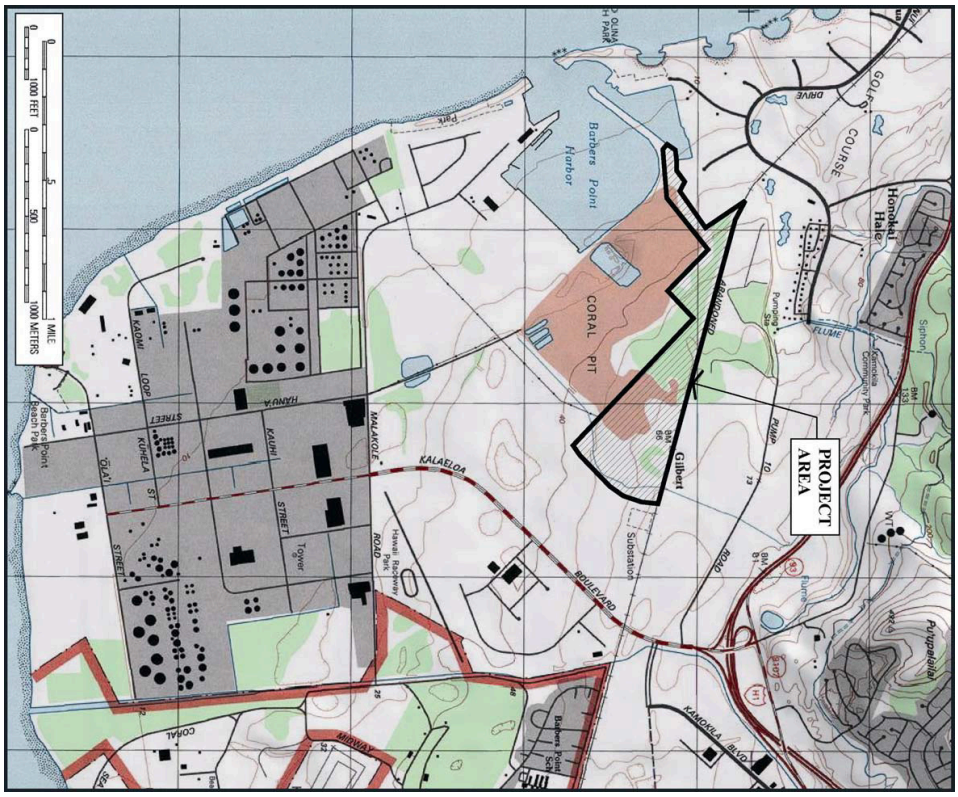

Figure 1. Portion of U.S. Geological Survey Map, 'Ewa Quad (2002), showing project area

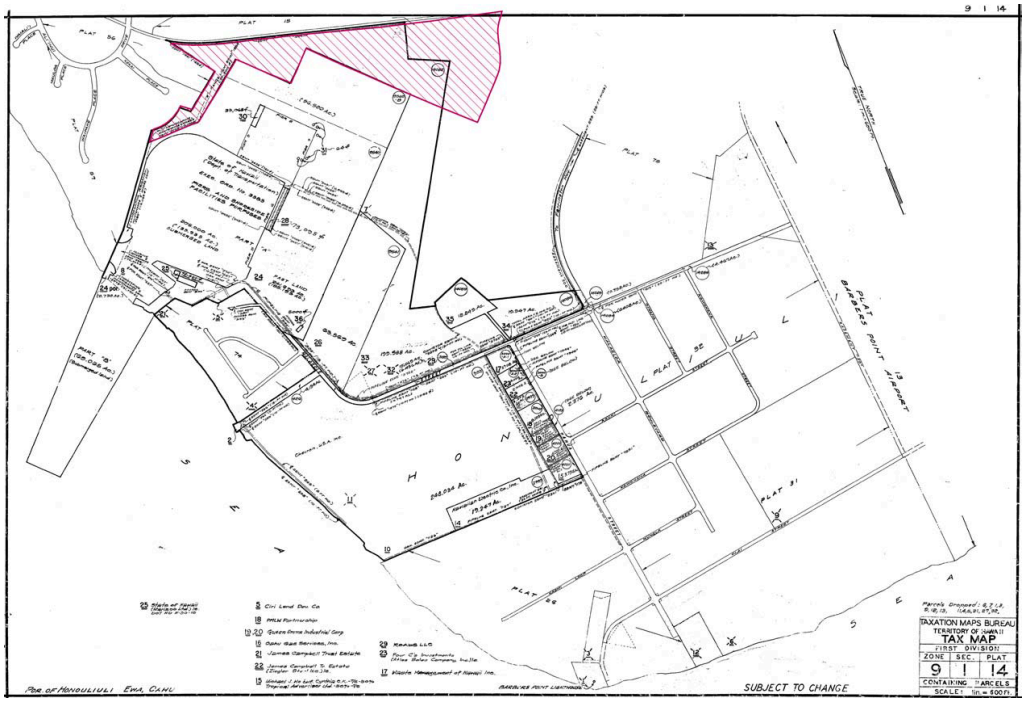

Figure 2. Portion of TMK 9-1-14 showing the location of the project area



Figure 3. Aerial photograph (2000) showing the location of the project area

C. Methods

1. Background Research

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division of the Department of Land and Natural Resources and a review of documents and maps at the Cultural Surveys Hawai‘i library.

2. Field Methods

Field inspection of the project area was conducted on January 23, 2004 by CSH archaeologists David Shideler and Tracy Hoffman. The entire project area was inspected on foot by two archaeologists to determine areas where archaeological features remain intact, and to specify these areas for further archaeological study prior to development of those lands.

D. Project Area Description

The project area consists of approximately 124 acres lying south of the O.R.&L. alignment, west of Kalaeloa Blvd., and north and east of the Barber’s Point Harbor in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southwestern O‘ahu. The project area lies mostly in the northwest section of the 227-acre TMK 9-1-14:33 parcel, and includes a large wooded area, portions of which have not undergone previous archaeological survey. Within the western half of the project area are two archaeological preserves delineated with chain-link fencing and marked as restricted. The larger of the two marks off a burial cave designated State Inventory of Historic Properties (SIHP) site 50-80-12-9633. The second preserve protects a very large sinkhole with cultural remains that was designated SIHP site 50-80-12-9548.

The project area is located on the ‘Ewa plain, south of the Wai‘anae Mountain Range in the southwest corner of O‘ahu. The terrain is limestone and alluvial deposits, overlying flows of the Wai‘anae volcanic series (Macdonald et al. 1983:423). The project area is generally quite level varying between sea level at the western end of the project area and 70 feet elevation above sea level at the project area’s eastern (*mauka*) end.

The project area is largely covered with thin clay soils including a moderately shallow ‘Ewa silty clay loam, and Mamala stony silty clay loam overlying coral (limestone) outcrop (Foote et al. 1972). Some of these clay and silty clay loam deposits are most likely of historic deposition owing to increased erosion from introduced grazing animals and deliberately induced erosion to improve agricultural fields. In traditional Hawaiian times, the areas of coral outcrop were probably more extensive.

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). In pre-contact Hawai‘i the project area would have been mostly lowland dry shrub and grassland, but this area has been extensively disturbed and transformed by human activity with a variety of exotic grasses, weeds and shrubs now dominating. These grasses and shrubs, along with pockets of *kiawe* forest, and a few scattered banyan trees are characteristic of the vegetation of the project area.

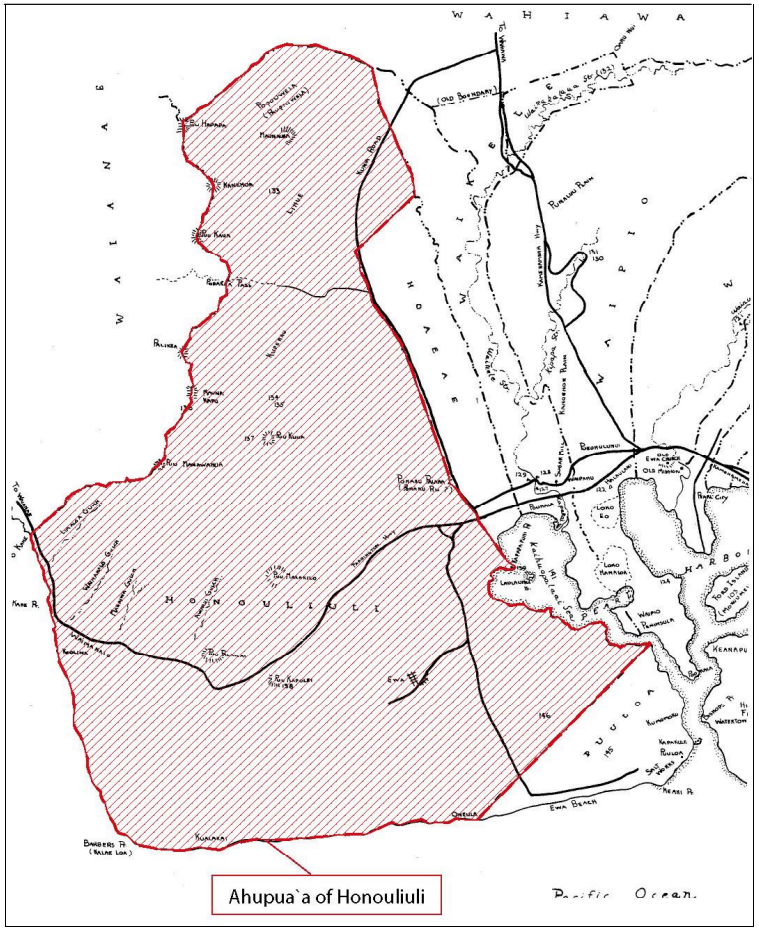

Figure 4. Map showing location of Honouliuli Ahupua‘a in west O‘ahu (adapted from Sterling and Summers 1978)

II. HISTORICAL BACKGROUND

A. Precontact and Early History

Various legends and early historical accounts indicate that the *ahupua‘a* of Honouliuli (shown in Figure 4) was once heavily populated by pre-contact Hawaiians. This substantial settlement is attributable for the most part to the plentiful marine and estuarine resources available at the coast, and lowlands suitable for wetland taro cultivation. In addition, forest resources along the slopes of the Wai‘anae Range, as suggested by E.S. and E.G. Handy, probably acted as a viable subsistence alternative during times of famine and/or low rainfall.

> The length or depth of the valleys and the gradual slope of the ridges made the inhabited lowlands much more distant from the ‘wao, or upland jungle, than was the case on the windward coast. Yet the ‘wao here was more extensive, giving greater opportunity to forage for wild foods during famine time [Handy and Handy 1972:469-470].

The upper valley slopes may have also been a resource for sporadic quarrying of basalt for 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. 1991).

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‘u Kapolei and Waimānalo Gulch to the Wai‘anae coast and onward, circumscribing the shoreline of O‘ahu (‘I‘ī 1959:96-98). Following ‘I‘ī‘s description, a portion of this trail network would have passed close to the presently existing Farrington Highway.

The Hawaiian *ali‘i* were attracted to this region. One historical account of particular interest refers to an *ali‘i* residing in Ko‘olina, just west of the project area:

> Ko‘olina 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‘olina 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 in Sterling and Summers 1978:41].

Other 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 pre-contact and early post-contact populations also adapted to less inviting areas, despite the environmental hardships.

Barber's Point is named after Captain Henry Barber whose ship ran aground on October 31, 1796. Subsequent to western contact in the area, the landscape of the ‘Ewa plains and Wai‘anae slopes was adversely affected by the overharvesting of the sandalwood forest, and the introduction of domesticated animals and exotic plant species. Domesticated animals including goats, sheep and cattle were brought to the Hawaiian Islands by Capt. George Vancouver in the

early 1790s, and allowed to graze freely about the land for some time after. L.A. Henke reports the existence of a longhorn cattle ranch in Waiʻanae by at least 1840 (in Frierson 1972:10).

During this same time, perhaps as early as 1790, exotic vegetation species were introduced to and flourished in the area. The following dates of specific vegetation introduced to Hawaiʻi, given by R. Smith and outlined by Frierson (1972:10-11), are relevant when identifying and selecting charcoal samples used for radiocarbon dating:

> 1) "early", c. 1790: Prickly pear cactus, *Opuntia tuna*; *Haole koa*, *Leucaena glauca*; Guava, *Psidium guajava*
>
> 2) 1835-1840: Burmuda [sic] grass, *Cynodon dactylon;* Wire grass, *Eleusine indica*
>
> 3) 1858: Lantana, *Lantana camara*
>
> The *kiawe* tree was also introduced during this period, either in 1828 or 1837 [Frierson 1972:11].

B. Mid to late 19th Century

Following the Mahele of 1848, 99 individual land claims in the *ahupuaʻa* of Honouliuli were registered and awarded by King Kamehameha III. The present study area appears to have been included in the largest award (Royal Patent 6071, LCA 11216, ʻĀpana 8) granted in Honouliuli Ahupuaʻa to Miriam Keʻahi-Kuni Kekauʻonohi on January 1848 (Native Register). Kekauʻonohi acquired a deed to all unclaimed land within the *ahupuaʻa*, totaling 43,250 acres.

Kekauʻonohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanuʻu Kahalaʻiʻa, who was governor of Kauaʻi. Subsequently, Kekauʻonohi ran away with Queen Kaʻahumanu's stepson, Keliʻi-ahonui, and then became the wife of Chief Levi Haʻalelea. Upon her death on June 2, 1851, all her property was passed on to her husband and his heirs. When Levi Haʻalelea, died the property went to his surviving wife, who in turn leased it to James Dowsett and John Meek in 1871 for stock running and grazing.

In 1877 James Campbell purchased most of Honouliuli Ahupuaʻa -including the present study area- for a total of $95,000. He then drove off 32,347 head of cattle belonging to Dowsett, Meek and James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). By 1881 the Campbell property of Honouliuli prospered as a cattle ranch with "abundant pasturage of various kinds" (Briggs in Haun and Kelly 1984:45).

In 1889, Campbell leased his property to Benjamin Dillingham, who subsequently formed the Oʻahu Railway and Land Company (O.R. & L.) as the result of a franchise granted by King Kalākaua in 1886. In 1889, Dillingham opened the first nine miles of narrow gauge track on the King's birthday. To attract business to his new railroad system, Dillingham subleased all land below 200 feet to William Castle who in turn sublet the area to the ʻEwa Plantation Company for sugar cane cultivation (Frierson 1972:15).

ʻEwa Plantation Co. grew quickly and continued in full operation up into modern times. As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the ʻEwa Plantation Co. installed ditches running from the lower slopes of the mountain range to the

lowlands and then plowed the slopes vertically just before the rainy season to induce erosion (Frierson 1972:17).

C. Twentieth Century

Twentieth century land use of the project area has been for transportation along the former O.R.& L. alignment. The 1922 War Department Fire Control Map (Figure 5) shows a road and architectural features in the area of the Gilbert Station (likely associated with the railway). These features also appear, though less extensive, in the 1928 U.S. Geological Survey map (Figure 6). A 1943 war department map (Figure 7) shows the same features and indicates that only a small part of the northeast portion of the project area (light shading) may have been under cultivation at that time. None of these three maps shows any further development within the area of present concern.

D. Modern Land Use

Today the project area borders the Koʻolina resort complex on the northwest, the O.R.&L. alignment to the north and old cane land to the east. Much of the current project area appears to have had no formal use for quite some time, though portions of the area are currently part of a quarry for coral limestone, and adjacent to areas of active development including the Barber's Point Deep Draft Harbor and Koʻolina resort areas.

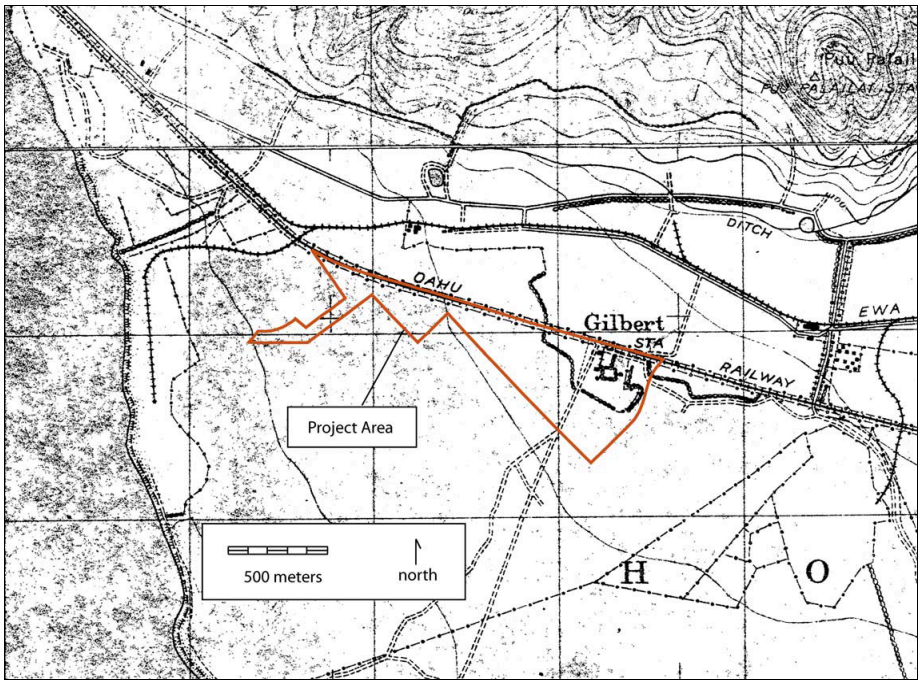

Figure 5. Portion of 1922 War Department Fire Control Map, Barber's Point Quad, showing project area

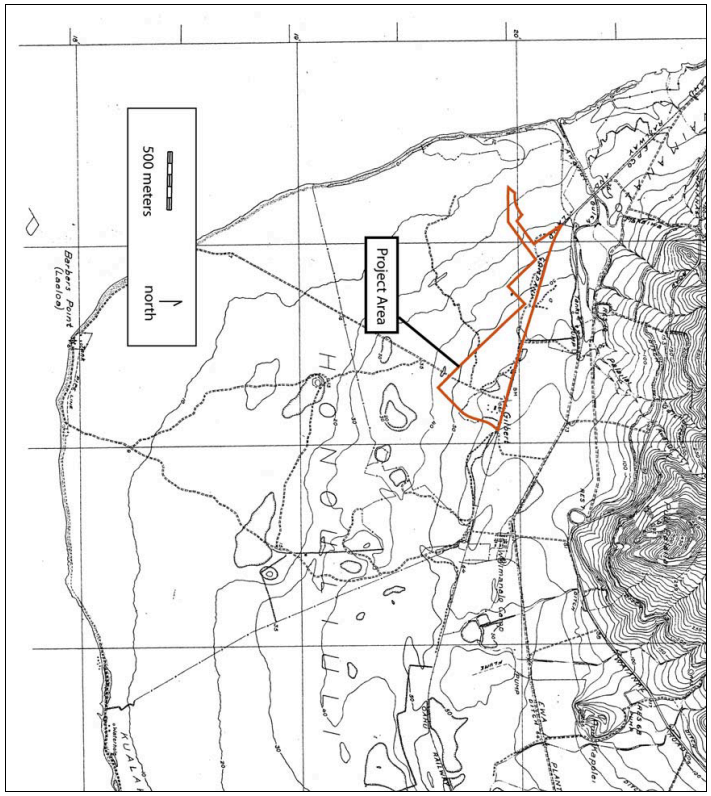

Figure 6. Portion of 1928 U.S. Geological Survey Map, Barbers Point Quad, showing project area

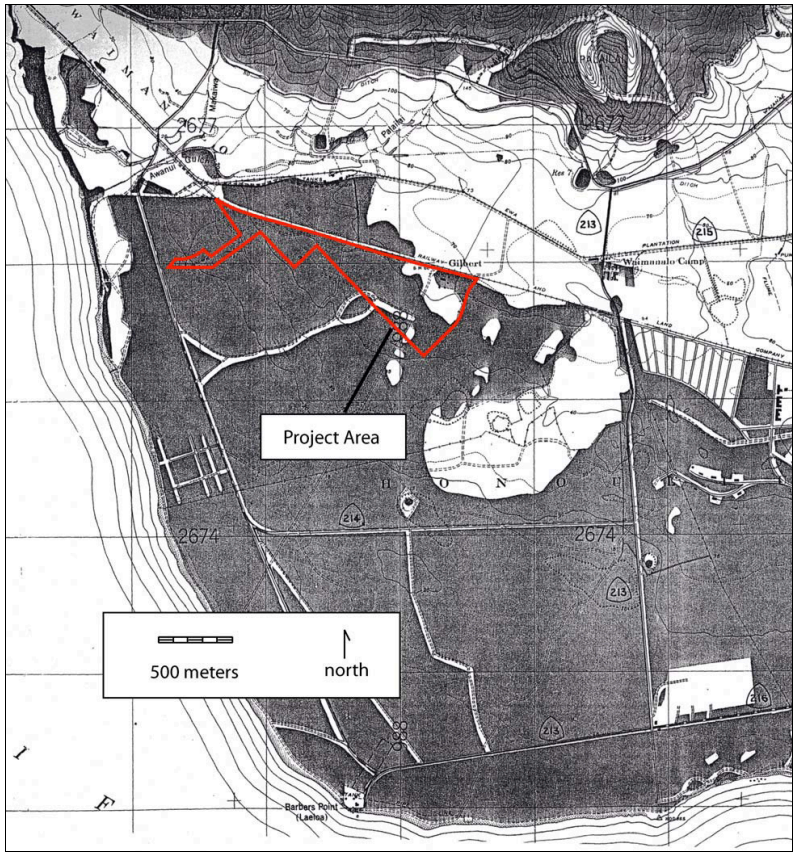

Figure 7. Portion of 1943 War Department Map, Barbers Point Quad, showing project area

III. HONOULIULI SETTLEMENT PATTERNS

A. The Physical Layout

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* 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 does Honouliuli boast a long coastline along the normally calm waters of leeward O'ahu, but there are four miles of waterfront running along the west side of West Loch. The land immediately inland of the sea coast consists of a flat karstic raised limestone reef forming a level, nearly featureless "desert" plain covered in pre-contact times by a sparse soil mantle. The microtopography is notable in containing countless sinkholes in some areas, created by chemical weathering (dissolution) of the limestone shelf. Proceeding inland, this plain is overlain by alluvium deposited through a series of gulches draining the Wai'anae Mountains, the largest of which, Honouliuli gulch, is on the east side of the plain draining into West Loch. To the west are fairly steep gradient gulches forming a more linear than dendritic drainage pattern. The major gulches are (from east to west) Awanui, Palailai, Makaīwa, Waimānalo and Lumaloa. These gulches are 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 inland portions of the plain. These gulches are generally dry, but during seasonal Kona storms they 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 in their upper reaches. These gulches do not have valleys suitable for extensive irrigated agriculture. However, this lack is more than compensated for by the rich, watered lowlands at the base of Honouliuli Gulch (the '*ili* of Honouliuli).

Honouliuli Ahupua'a, as a traditional land unit, had tremendous and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain (which is the most readably visible terrain) does not do justice to the *ahupua'a* as a whole. The following available resources mark the richness of this land unit:

1. Twelve 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-Laulaunui for example.
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 of 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 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*: 1) the coastal zone including Kalaeloa (Barber's Point), Ko'olina (West Beach), and One'ula ('Ewa Marina), 2) the Honouliuli Taro Lands and 3) the inland area of Pu'u Ku'ua.

B. The Coastal Zone

1. Kalaeloa (Barber's Point)

Archaeological research at Barber's Point has focused on the areas in and around the recently constructed Deep Draft Harbor (see Table 1). A series of small clustered shelters, enclosures and platforms show limited but recurrent use at the shoreline zone for marine 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.

An attraction of the area to early Hawaiians was the plentiful and easily exploited bird population. Particular evidence for taking of petrel occurs at State Inventory of Historic Properties (SIHP) site 50-80-12-2763 located just south of the current project area (Hammatt and Folk 1981:213). Initial heavy exploitation of nesting seabirds and other species, in conjunction with habitat destruction, probably led to early extinction of these bird communities.

The archaeological content of the sites here indicates a major focus on marine resources. There is, however, some indication of agriculture in mulched sinkholes and soil areas. Considering rainfall, this activity would have been constrained by accessibility to water, probably involving tree crops and roots (sweet potatoes).

Bertel Davis (1990a:135), in his Ph.D. dissertation, summarizes our knowledge of traditional Hawaiian use of the coastal zone of Honouliuli:

> I suggest the west coast of O'ahu, including the area off Barbers Point, (a) probably became a well established fishery at least by AD 1000, perhaps much earlier; (b) the initial settlement at Barbers Point also began around this time or possibly earlier; and (c) the settlement initially involved task-specific groups exploiting the adjacent fishery on a seasonal round, probably during the winter months.

2. Ko'olina (West Beach)

Studies associated with the Ko'olina area, which includes the western portion of the present project, document around 200 component features at approximately 50 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 (1987:37) describe as "one of the longest local sequences in Hawaiian prehistory." Information for the

earliest part of the sequence comes from an inland marsh site but early dates were also obtained for a beachfront site and an inland rock shelter.

C. 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. This area bordering West Loch was clearly a major focus of population within the Hawaiian Islands. 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. As early as 1825 all the roads of southwest O'ahu converge as they descend the *pali* funneling into the locality that gave the district of Honouliuli its name. Dicks et al. (1987:78-79) conclude, on the basis of 19 radiocarbon 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. Prehistoric population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census (1831-1832) the land of Honouliuli contained 1026 men, women, and children (Schmitt 1973:19). It is not clear whether this population relates to Honouliuli Village or district 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 pre-contact population of Honouliuli Village may well have been significantly greater than it was in the 1830s.

D. Pu'u Ku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic due to a general absence of archaeological studies. 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 traditional importance.

In 1899 Hawaiian Newspaper "*Ka Loea Kalaiaina*" relates a story of Pu'u Ku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

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 [in Sterling and Summers 1978:33].

McAllister (1933:134, 137) recorded three sites in this area: two *heiau,* Pu'u Kuina and Pu'u Ku'ua (both destroyed), and most interesting, a series of enclosures in Kukuilua which he calls "kuleana sites." There is no direct archaeological evidence available that Hawaiian settlement occurred here but extensive settlement appears likely from traditional accounts. Geographically, the area is well-watered and would have had abundant locally available forest resources.

E. Summary of Settlement Patterns in Honouliuli

Based on the above summary of areas of Honouliuli settlement the following general considerations are made to place the project area in the context of the *ahupua'a* settlement pattern. There are three areas of Hawaiian settlement in the *ahupua'a*; two are well documented while the third is more problematic:

1) The extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;

2) The rich cultivated lands of Honouliuli *'ili* for extensive wetland taro- the *ahupua'a* population center;

3) The uplands around Pu'uku'ua probably for agriculture and forest resource utilization.

Honouliuli, as a unit, contains 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 highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, as well as an extensive limestone plain that 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 forestland for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The *mauka/makai* route would have been up Honouliuli Gulch or up the Makakilo ridge, paralleling the coast from Honouliuli Gulch to Kahe. The most convenient route to *mauka* lands, even from the western end of the coast (Ko'olina), would have been *mauka* only to the base of the hills and then either up the Makakilo Ridge or northeast to a trail to Pu'u Ku'ua. The *makai* slope is the dry side of the ridgeline. Here streams would respond to rainfall quickly but drain quickly leaving little available water for even short-term use.

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 continuation of the Ko'olina 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. Supported by seasonal dry land planting and forest foraging, this *mauka* habitation could have been the lower portion of a thinly scattered, but widespread zone of settlement stretching eastward and northeast along the east Wai'anae Range slopes, possible increasing in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

There is to date no archaeological evidence of high status residences in Honouliuli. Large residential structures are not present along the 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) but to date there is no direct archaeological evidence of this. Concerning status associations with Honouliuli it is interesting to note the connection of the Pu'uku'ua settlement with pariah (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

The central place of the *ahupua'a* of Honouliuli in terms of population, as well as cultivated foods, was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive agricultural resources in other locations during prehistoric times, that all other habitation zones were economically and socially co-dependent.

F. Summary of Settlement Patterns in Project Area

The project area lies back from the coast, on the extensive 'Ewa limestone plain, which was, according to Honouliuli settlement predictions, probably never permanently inhabited. It could have, however, provided temporary habitation for gatherers and fisherman traveling to the coast. A relatively barren and waterless area, it nonetheless might have been occasionally transversed, as the project area lay between the greater populated and watered uplands and *makai* resources. The extended limestone plain would have been used for bird catching, and would include the temporary habitations that would result from such forays. Planters could have also used the natural limestone sinks for agriculture, though it would have been seasonal and on a small scale. In general the project area lies in a region that would have been less than bountiful, and therefore sparsely utilized, even in ancient times.

IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES

A. Overview of Archaeological Studies in Western Honouliuli

The Barbers Point area (western Honouliuli Ahupua‘a) has a reputation as the most archaeologically studied place in Polynesia. An overview of archaeological studies in the west half of Honouliuli Ahupua‘a is presented in Table 1 and Figure 8. A discussion of archaeological findings germane to the present project area follows.

Table 1. Archaeological and related studies in western Honouliuli Ahupua‘a

Reference	Nature of Study	General Location of Study
Thrum 1907	*Heiau* study	Hawaiian Islands
McAllister 1933	All island survey	O‘ahu Island
Kikuchi 1959	Site letter report	Barbers Point
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
Frierson 1972	Study of land use & vegetation change	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 1977	Reconnaissance survey	Kalo‘i Gulch
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 1978	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)

Reference	Nature of Study	General Location of Study
Komori and Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
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 Investigation	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 Homon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch
Ahlo and Homon 1984	Test excavations	Barbers Point (harbor area)
Hammatt 1984	Reconnaissance survey	Kahe Point
Haun and Kelly 1984	Research resign	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
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. 1986 a and b	Research design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Davis and Haun 1987	Intensive survey & test excavations	West Beach
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Survey report	Kapolei Town
Welch 1987	Reconnaissance survey	Naval Air Station
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial documentation	Kahe
Burgett and Rosendahl 1989	Subsurface archaeological testing	North of O.R.&L.

Reference	Nature of Study	General Location of Study
Hammatt and Shideler 1989a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1989b	Reconnaissance survey	Kahe
Carlson and Rosendahl 1990	Inventory survey	Kaomi Loop Subdivision
Cleghorn and Davis 1990	Archaeological and paleontological investigation	Barbers Point (harbor area)
Davis 1990b	Archaeological and paleontological investigation	Barbers Point (HECO area)
Davis 1990a	Archaeological and paleontological study (Ph.D. dissertation)	Barbers Point (harbor area)
Rosendahl 1990	Letter report	Kapolei Town
Kennedy 1991	Subsurface testing	Pu‘u o Kapolei
Hammatt et al. 1991	Inventory survey	Makaiwa Hills
Hammatt and Shideler 1991	Archaeological assessment	Barbers Point (harbor area)
Haun et al. 1991	Survey report	Naval Air Station
Burgett and Rosendahl 1992	Inventory survey	Barbers Point (harbor area)
Hammatt and Folk 1992	Subsurface testing	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Jones 1993	Fossil coral reefs study (Ph.D. dissertation)	Hawaiian Islands
Landrum 1993	Reconnaissance and subsurface testing	Naval Air Station
Miller 1993	Data recovery	Barbers Point (harbor area)
Hammatt and Shideler 1994	Archaeological assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory survey	Barbers Point (harbor area)
Davis 1993	Archaeological and paleontological investigation	Barbers Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Hammatt and Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
O’Hare et al. 1996	Intensive survey and testing	Naval Air Station
Wulzen and Rosendahl 1996	Subsurface testing & data recovery	Naval Air Station

Reference	Nature of Study	General Location of Study
Athens et al. 1997	Cultural resource inventory, paleoenvironmental investigation	‘Ewa Plain:Naval Air Station
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	‘Ewa Plain
Tuggle and Tomonari 1997a	Cultural resource inventory survey	Naval Air Station
Wickler and Tuggle 1997	Cultural resource inventory, Inventory Survey	Naval Air Station
McDermott et al. 2000	Data recovery	Barbers Point (harbor area)
Cordy and Hammatt 2003	Archaeological assessment	Barbers Point, North of O.R.&L.

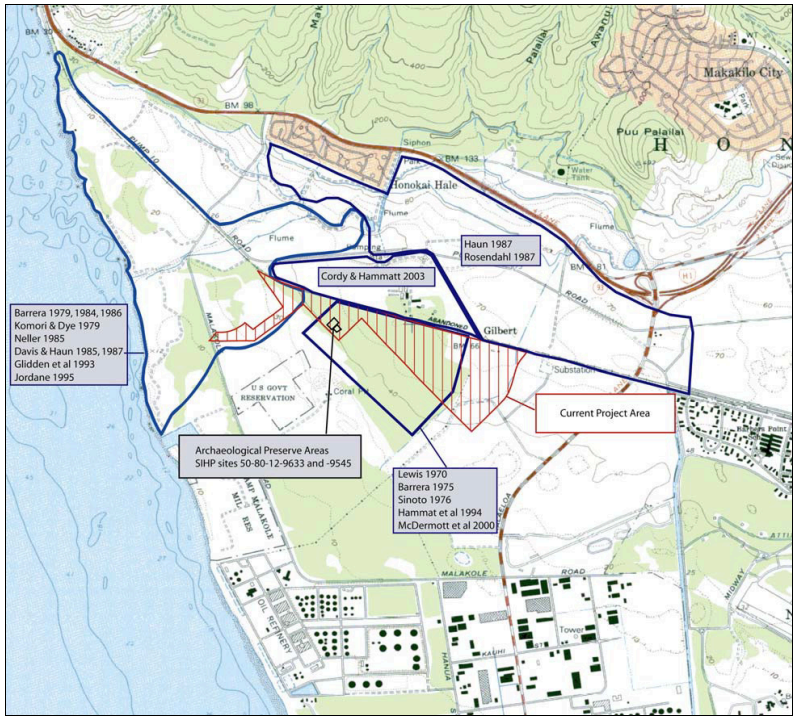

Figure 8. Map showing general areas of archaeological study near the project area

The first effort to record sites at Honouliuli was by Thrum (1907:46) and references "a *heiau* on Kapolei hill, Ewa-size and class unknown. Its walls thrown down for fencing." This *heiau*, Pu‘u Kapolei, is north of the present study area.

In his surface survey of 1930, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of some sites of lesser importance. McAllister (1933:107-108) recorded seven specific sites at Honouliuli (numbered 133-139) and these became the first seven sites in the Bishop Museum's Site Numbering System (OA-B6-1 through OA-B6-7). The nearest of these to the present project area is McAllister Site 138, including the Pu‘u Kapolei Heiau and an adjacent rock shelter. McAllister (1933:109) includes his impressions as follows:

> ‘Ewa coral plains, throughout which are remains of many sites. The great extent of old stone walls, particularly near the Pu‘uloa Salt Works belongs to the ranching period of about 75 years ago. It is probable that the Hawaiians formerly used the holes and pits in the coral. Frequently the soil on the floor of larger pits was used for cultivation, and even today one comes upon bananas and Hawaiian sugar cane still growing in them. They afford shelter and protection, but I doubt if previous to the time of Cook there was ever a large population here.

These Hawaiian sites of the ‘Ewa coral plains would be the subjects of some 37 archaeological reports in the 1970s and 1980s.

From the period between McAllister's 1930 study and the flurry of work that began in 1969, there are only a few sporadic pieces of poorly documented research. "In 1933, Dr. Kenneth P. Emory examined a well-preserved house site and a possible *heiau* in the western part of the coral plain; these sites were later destroyed by sugar-cane planting" (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, south of the present project area (Kikuchi 1959; Davis 1990:146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling made note of a house site (Bishop Museum Site OA-B6-8). “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 (per Sinoto 1960), Lloyd Soehren "carried out salvage excavations at BPBM. Site # 50-OA-B6-13 (a possible fishing shrine.)” The site was reported as destroyed by construction (Barrera 1975:1) but Davis (1990a:148) relocated the shrine and performed additional excavations in 1982. In 1969, artifacts were recovered by Roger Green from a beach midden site (B6-14), south of the barge harbor.

To the west of the project area, Paradise Cove, Lanikūhonua, and West Beach have been the subject of numerous archaeological studies (Barrera 1979, 1984, 1986; Komori & Dye 1979; Neller 1985; Davis & Haun 1986, 1987; Glidden et al. 1993; and Jourdane 1995).

Haun’s (1986) archaeological reconnaissance survey for the ‘Ewa Town Center/Secondary Urban Center study covered an area of approximately 1,400 acres northeast of the present project area. A study by Burgett and Rosendahl (1989) involved the excavation of seventy-two backhoe test trenches in a 360-acre portion of the Haun study area. There were no significant finds relevant to the current study.

Cordy and Hammatt (2003) made a study of a land parcel directly north of the current project area, just across the O.R.&L. Several sinkholes were noted as of potential archaeological interest. The study also documented the presence of a historic chicken farm as well as other twentieth century architectural remains, including a Quonset hut of unknown use.

Several studies have also been carried out within the current project area in the last several decades. In the fall of 1969, Mr. Ellis Cross, a supervisory employee at the nearby oil refinery on the coast, informed Dr. Sinoto that he had found house sites and walls at various locations on Campbell Estate land, near Campbell Industrial Park and the coral quarry (Lewis 1970:2). This resulted in a number of visits by Dr. Sinoto and student volunteers in late 1969 and early 1970. A University of Hawaii graduate student, Mr. Ernest Lewis, did a preliminary survey and test excavations for a graduate seminar in Polynesian Archaeology and donated his report to the Bishop Museum. Lewis was the first to document sites within the present project area (Figure 9).

The sites Lewis documented just south of the O.R. & L. line were subject to a number of further studies including Barrera 1975, Sinoto 1976, Hammatt et al. 1994 and McDermott et al. 2000 (Figures 10 and 11). Two sites were identified for protection within fenced off preserve areas. SIHP site 50-80-12-9633 is a cave that was found to contain human created rock piles and wall, a human burial, and part of what appears to be a wooden canoe (Hammatt et al. 1994:93-94). Because of its function as a burial site, the cave was not excavated and remains protected in the state in which it was discovered. Just east of that fenced preserve is another smaller preserve area surrounding SIHP site 50-80-12-9545. This site is a very large sinkhole measuring about nine meters in diameter and six meters deep (Sinoto 1976:16). The interior of the sinkhole has been modified for human habitation in traditional times, including "cleared areas, low terraces, firepits, and a large *ahu* which was probably constructed to facilitate entry and egress" (Hammat et al. 1994:87). The two preserve areas are marked on Figure 8.

Sites in or near the present project area are listed below in Table 2.

Table 2. Sites near the project area

Site # (50-80-12-)	**Type of Site**	**Source**
4893	Sink	Hammatt et al. 1994:35
4894	Enclosure	Hammatt et al. 1994:35
4895	Mounds	Hammatt et al. 1994:39
4896	Sink complex	Hammatt et al. 1994:39
4897	Mound complex	Hammatt et al. 1994:43
4898	Mounds	Hammatt et al. 1994:43
4900	Complex of sinks and wall	Hammatt et al. 1994:46
9546	Wall ("Long Wall")	Lewis 1970:33; Barrera 1975:8; Sinoto 1976:16 (B6-23)
9547	Enclosure	Lewis 1970:36 (B6-24)
9548	Enclosure	Lewis 1970:35; Barrera 1975:8; Sinoto 1976:16(B6-25)

9551	Mound	Lewis 1970:356 (B6-29)
9552	Mound cluster	Lewis 1970:36 (B6-30)
9553	Cluster of mounds	Lewis 1970:36 (B6-31)
9555	*Ahu*	Lewis 1970:35 (B6-33)
9556	Terrace, mounds, paved area, enclosure	Lewis 1970:35 (B6-34)

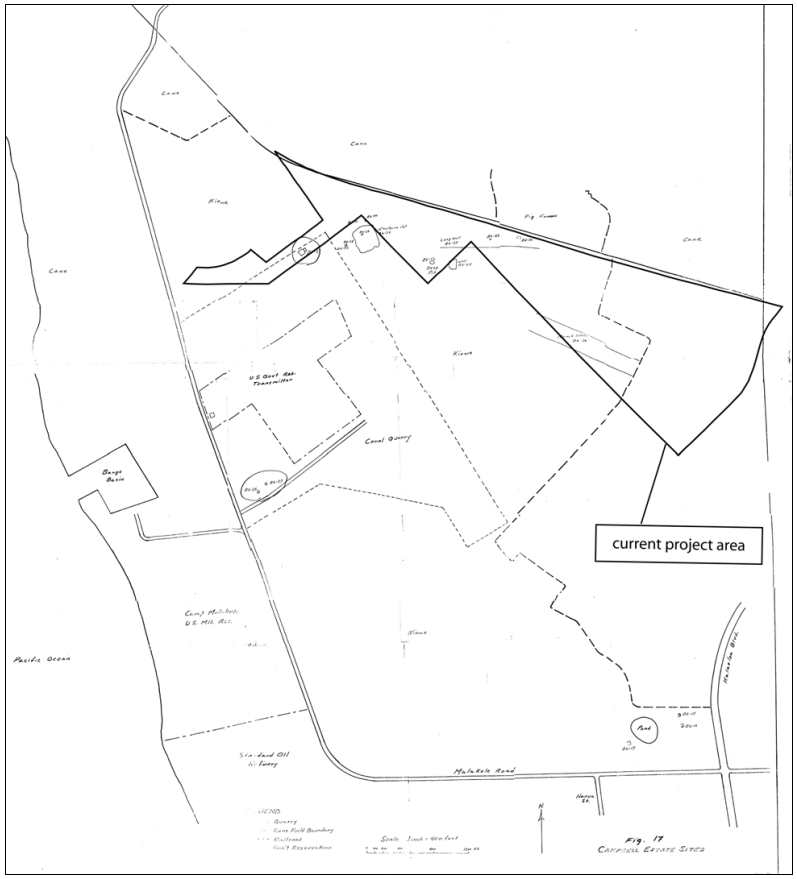

Figure 9. Site map from Lewis 1970 showing the current project area

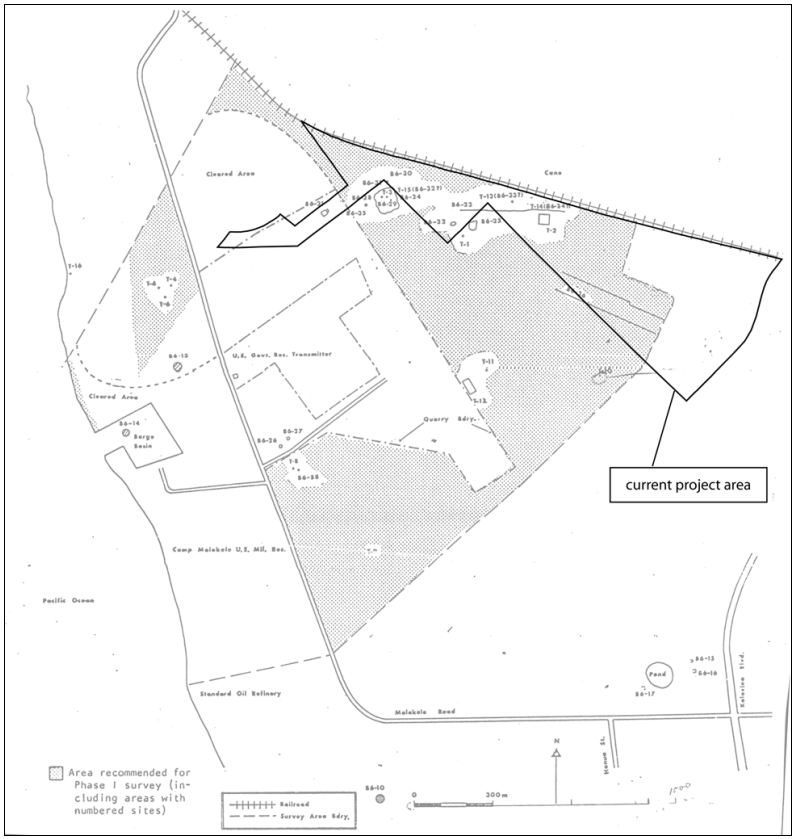

Figure 10. Site map from Barrera 1975 showing the current project area

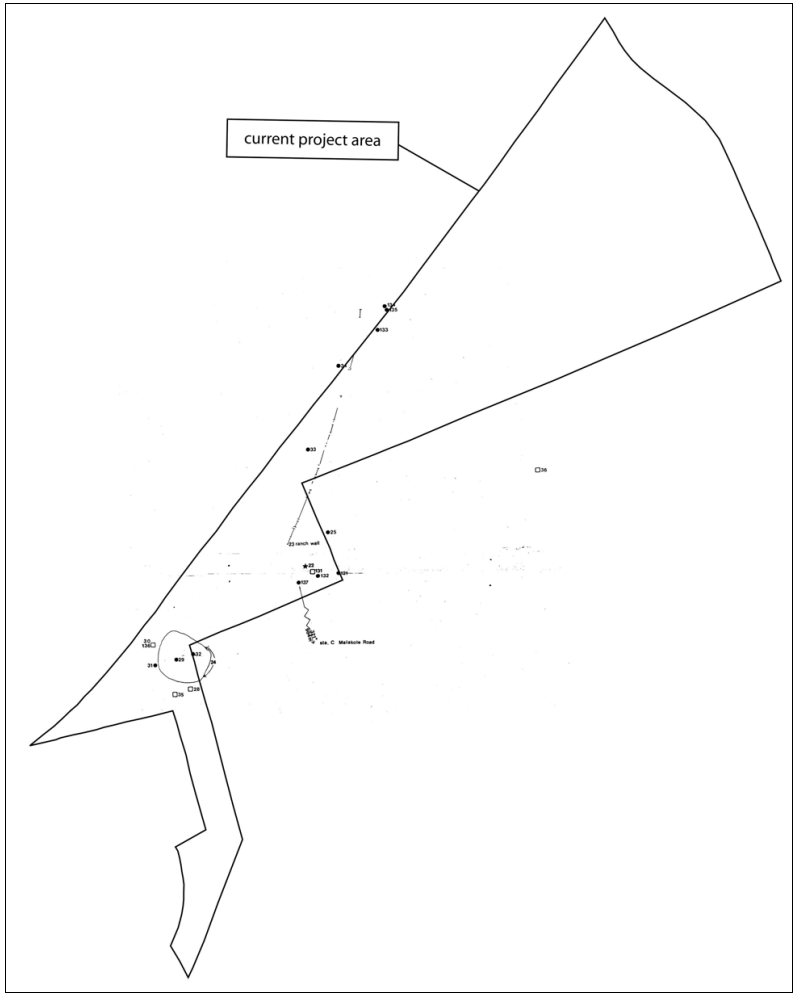

Figure 11. Site map from Sinoto 1976 showing the current project area

B. Predictive Model

The one general observation regarding the archaeology of southwestern O‘ahu is that there was more pre-contact utilization of the area than might be expected given its present day uninviting ambiance and “marginal ecology” (Sinoto 1976:71). In our area of interest, however, back from the coast and seaward of the forested inlands, pre-contact land use appears to have dropped off dramatically. This area of Honouliuli would be expected to yield traditional Hawaiian remains of temporary habitations used during forays for marine resources. This limestone bedrock has in previous studies yielded sinkholes with historic deposits (Hammatt et al. 1994). Burials and the remains of bird hunting activities may be encountered within some of the sinkholes within the project area. Remains of plantation infrastructure and possibly other twentieth century activities could also be expected to be present.

V. FIELD INVESTIGATION

A. Field Inspection Methods

Field investigation of the project portion of the land parcel in the west of TMK:9-1-14:27 and east of TMK:0-1-15:20 was undertaken on 23 January, 2004 by two archaeologists from Cultural Surveys Hawai‘i, Inc., David W. Shideler, M.A. and Tracy Hoffman, M.A. The purpose of this field inspection was to determine the nature, density and distribution of historic properties present. Part of the archaeological concern involves filled limestone sinkholes that may contain burials, other cultural finds, or extinct species. Previous archaeological surveys in the area have also identified traditional Hawaiian constructions including enclosures and possible burial mounds, which also informed the current research. In addition, archaeologists identified any World War II or plantation era infrastructure that would now be regarded as of historic significance.

The project area was inspected on foot, beginning with the western extension that runs just north of Barbers Point Harbor. Archaeologists then swept through the area to the northwest, to the border with the Ko‘olina Resort. The field inspection proceeded through the central portion of the project area, where a significant amount of land remains undisturbed or only moderately disturbed by modern activities. The pedestrian survey then continued to the east and south. All features of historical interest that were observed were described, photographed, and assigned a temporary CSH site number.

B. Field Inspection Findings

Approximately two-thirds of the current project area has been heavily impacted by construction activities. This includes bulldozing of large areas associated with construction of the O.R.&L. Alignment, the Ko‘olina Golf Course, and with the coral quarry south of the project area, which extends into the eastern central part of the project area. These areas were all surveyed by archaeologists and determined to contain no features of historic significance.

Several portions of the project area remain undisturbed to moderately disturbed by bulldozing and other modern activities, and include wooded areas of *kiawe* and scattered banyan. Within these areas, intact historic properties were found, both of pre-contact and post-contact dates. These archaeologically significant areas are marked on Figure 12, and include a relatively large wooded area in the center of the project area, and two smaller wooded patches just west of this and to the east of the Gilbert Trig Station. In addition, the Gilbert Trig Station and a large irrigation canal are preserved historic properties in otherwise bulldozed areas.

Following are the sites identified during the current archaeological field inspection, as well as an attempt to note which of these may have been previously reported:

CSH 1: A pavement of limestone slab cobble fill with limestone slab uprights delineating the edge on the north and northeast sides (Figure 13).

Maximum height is 35 cm.

CSH 2: A pavement of 100 plus small cobble sized limestone slabs, roughly square in shape (Figure 14).

Measures 2.0 x 2.1m.

Possibly a filled sinkhole with a bulldozer push pile immediately to the west.

CSH 3: Very large sinkhole with a banyan tree growing out of the north side, and a large *kiawe* stump in the center (Figure 15).

Measures roughly 9 x 5 m, maximum observed depth of 3 m.

This may be State Site 50-80-12-4896A (Hammatt et al. 1994:39)

CSH 4: Area of a collapsing sinkhole with overhangs. Located in area of *koa haole* and banyan approximately 13 m northwest of CSH 3, and 20 m west of burial preserve perimeter fence.

Approximately 80 cm in diameter and 1 m deep.

This may be State Site 50-80-12-4896B (Hammatt et al. 1994:39)

CSH 5: Sinkhole roughly filled with limestone cobbles and boulders located in graded road between CSH 2 and CSH 4 (Figure 16).

Measures 110 x 80 cm. Maximum observed depth was 80 cm.

CSH 6: Stacked stone wall in field with extensive bulldozer piles. Stone wall is two courses high. Possible enclosure (Figure 17).

Measures 50 cm high and 2.6 m long.

CSH 7: Two limestone slab boulder mounds within a ten-meter radius-

Feature A is the larger of the two. The mound has a distinct central ridge running east-west with a maximum height of one meter (Figure 18).

Measures 2.6 x. 2.6 m

Feature B is a smaller mound about seven meters to the east (Figure 19).

Measures 1.7 m in diameter.

CSH 8: Modified sinkhole with a limestone boulder wall to the east and an upright limestone slab at the east corner (Figure 20). Located 50 to 60 m northeast of CSH 7.

Sinkhole measures 5 x 8 m. The limestone wall is two courses high (40 cm) and two courses wide. The limestone upright is 90 cm high.

Feature is a possible shrine or habitation.

CSH 9: Wall of limestone slab boulders, probably used for historic-era ranching (Figure 21).

Measures 85 cm high and may be 50 meters long.

Described in previous archaeological studies- SIHP site 50-80-12-9546 (Hammatt et al. 1994:87).

CSH 10: Limestone slab cist mound. The mound was constructed with a small open space in the middle, capped with a slab lintel stone (Figure 22).

Measures 1.6 x 1.8 m with a maximum height of 60 cm.

Possible burial function.

This may be Lewis's site B6-33

> Small, stacked slab ahu, enclosing an upright-slab cist. Measures 2.2 by 1.5 meters and o.55 meters in height. Apparent roof slabs present. Possible burial [Sinoto 1976:18].

This may be Barrera's site T-13:

> It is a mound constructed of horizontally placed coral slabs, and measures 2.4 by 2.3 meters. In the center of the feature is a vault formed by vertically placed coral slabs. The vault measures 65 by 80 cm and, and is roofed with horizontal coral slabs [Barrera 1975:19].

CSH 11: Gilbert Trig Station. Cement and aggregate slab square supported by two pylons of basalt boulders and cement. A central post supports four metal vanes perforated with large diameter holes (Figure 23).

Slab measures 10 cm thick and 1.6 m across and height is 109 cm. The pole extends up another 145 cm.

CSH 12: Sinkhole surrounded by fragments of historic glass with some historic garbage in the interior (Figure 24). The associated rubbish appears to be of early to mid-twentieth century origin. There are several other sinkholes in the immediate vicinity.

The sinkhole measures 1.7 x 1.3 m with a depth of 90 cm.

CSH 13: Concrete flume running roughly north-south, constructed of basalt boulders and cement (Figure 25). An inscribed date of "June 1937" appears in the cement on the *mauka* end (Figure 26).

The flume measures 140 cm across and the interior channel measures 90 cm across and 60 cm deep. Large pieces of metal flume remains were also located in the general area, further *makai*.

Probably part of sugar cane cultivation infrastructure.

CSH 14: Irrigation canal with cement walls and earthen berms on either side (Figure 27).

Measures approximately 10 meters across, and runs the entire length of the eastern end of the project area.

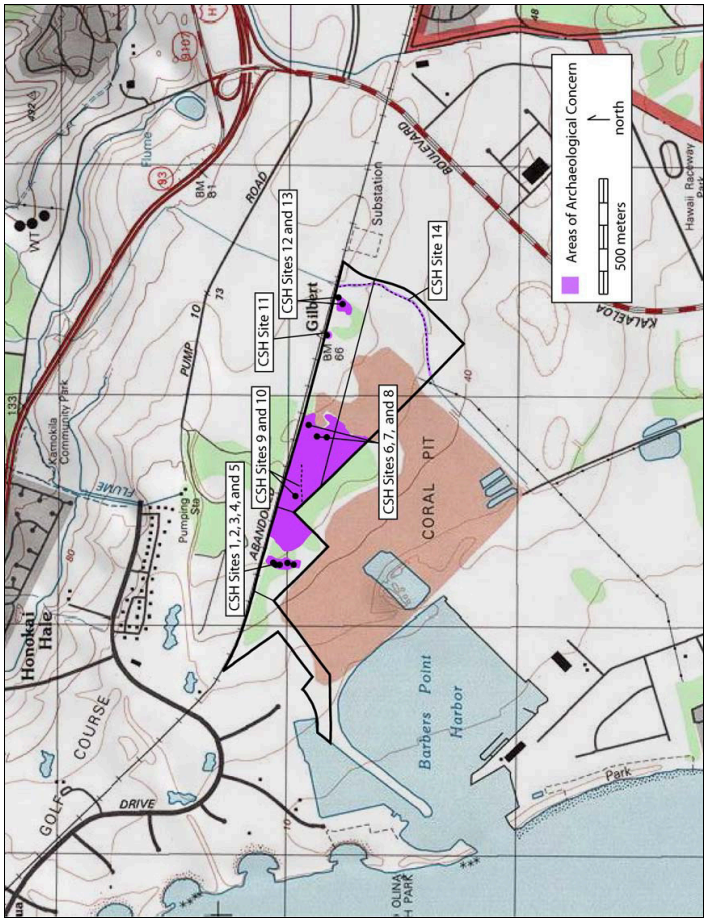

Figure 12. Map identifying historic properties within the project area



Figure 13. Photograph of CSH 1, view to the west



Figure 14. Photograph of CHS 2 surrounded by *kiawe* debris



Figure 15. Photograph of CSH 3, view to the southeast



Figure 16. Photograph of CSH 5, filled sinkhole



Figure 17. Photograph of CSH 6, possible enclosure



Figure 18. Photograph of CSH 7 Feature A



Figure 19. Photograph of CSH 7, Feature B



Figure 20. Photograph of CSH 8 showing wall and upright



Figure 21. Photograph of CSH 9, "Long wall"



Figure 22. Photograph of CHS 10, cist mound



Figure 23. Photograph of CSH 11, the Gilbert Trig Station



Figure 24. Photograph of CSH 12, sinkhole with historic debris



Figure 25. Photograph of CSH 13, cement flume



Figure 26. Photograph of CSH 13, engraved date



Figure 27. Photograph of CSH 14, long irrigation canal

VI. SUMMARY AND RECOMMENDATIONS

The predicted settlement patterns in the region of the project area indicate that the vicinity was utilized in ancient times mostly for bird hunting, sinkhole agriculture, temporary habitation, with a couple of known instances of human burial. The intensity of land use would be anticipated to have been higher nearer the coast with significantly less intensive use in more inland areas of the coastal plains such as the vicinity of the present study area.

The field inspection focused on the determination of the nature, distribution and density of archaeological sites present. Within the project area, one larger and two smaller plots of archaeological concern were delineated. Within these areas a number of historic properties were identified, including stone pavements, sinkholes and modified sinkholes, stone walls, stone mounds, and remnants of plantation-era infrastructure. Four of the 14 identified sites in this field inspection may have been noted in previous archaeological studies. Based on the properties observed and background research on the area, further archaeological study of specific portions of the project area is recommended. This would inventory archaeological remains present. In addition, background research indicates the importance of sinkholes as potential locations for subsurface historic deposits. Based on previous archaeological studies in the project area (Hammatt et al. 1994) that have yielded historic deposits from sinkhole excavations, the potential to encounter subsurface deposits in sinks is evaluated as fairly high.

Large portions of the project area were closely examined and found to be clear of archaeological concerns (see Figure 28). The western portion of the project area (west of the forested area including CSH designated sites 1 through 5) is found to be clear of archaeological concerns. The eastern 40% or so of the project area is largely free of archaeological concerns with the exceptions of the Gilbert Trig Station, the small wooded area including CSH sites 12 and 13, and the large cement irrigation ditch designated site 14.

Cultural Surveys Hawai‘i recommends that an archaeological inventory survey with subsurface testing be undertaken for the areas specified as of historic interest. This would serve to mitigate historic properties that may be affected by further development in the area, and to shed light on traditional land use and plantation-era agricultural practices.

Also of concern in this area is the historic O.R.&L. alignment, which runs along the north side of the current project area. As noted earlier, this railway alignment was developed beginning in 1886 and played a large role in the sugar industry in this part of O‘ahu. In December of 1975, the O.R.&L. right-of-way was added to the National Register of Historic Places. In addition to the archaeological concerns located within the project area, any further development should take this national historic site into consideration.

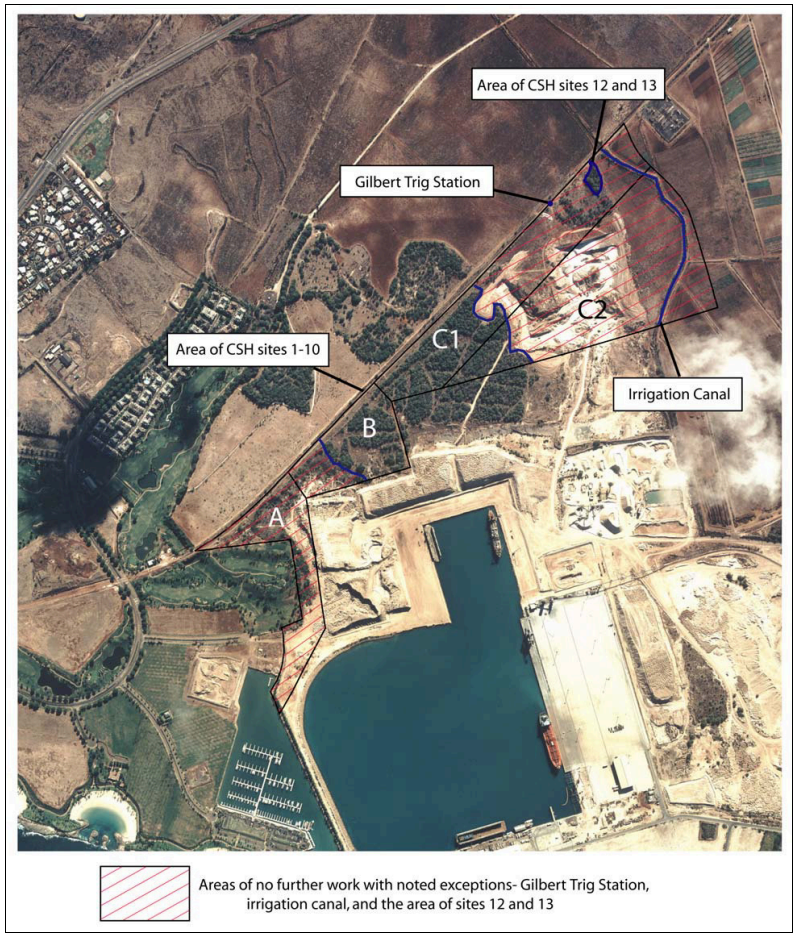

Figure 28. Aerial photo of the project area showing recommendations for further work

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CSH Project No.: KAPO 8

25 May, 2005

Melanie Chinen, O'ahu Archaeologist
State Historic Preservation Division
Kākuhihewa Building Room 555
601 Kamōkila Blvd.
Kapolei, Hawai'i 96707

Subject: Revised *Archaeological Inventory Survey of Approximately 124 Acres at Kapolei, Honouliuli Ahupua'a, 'Ewa District, O'ahu; TMK: 9-1-14:33 and 9-1-15:20*

Aloha Ms. Melanie Chinen:

Thank you for your review comments included in the letter dated May 6, 2005 (LOG NO: 2005.0949; DOC NO: 0505MC06) (copy enclosed). Enclosed please find a revised draft copy of our *Archaeological Inventory Survey of Approximately 124 Acres at Kapolei, Honouliuli Ahupua'a, 'Ewa District, O'ahu; TMK: 9-1-14:33 and 9-1-15:20* for your review. Your requested revisions per the review letter dated May 6, 2005 have been incorporated within the document. Attached is a table with notes and locations of these revisions. The revisions are addressed in the order noted in the review letter.

We note that the first draft of this study was under SHPD review for 19 weeks. We would be most thankful if review could be concluded promptly. Please feel free to contact me with any questions or comments.

Mahalo for your *kōkua*.

Sincerely,

Hallett H. Hammatt, Ph.D.
Cultural Surveys Hawai'i, Inc.

Table Indicating Revisions of CSH's *Archaeological Inventory Survey of Approximately 124 Acres at Kapolei, Honouliuli Ahupua'a, 'Ewa District, O'ahu; TMK: 9-1-14:33 and 9-1-15:20*

Requested Revision	Revisions	Location Within Document
Documentation of results of additional testing completed on 5-19-05 (SIHP Site -4893).	Documentation of testing of SIHP Site -4893 added. Documentation includes Test Unit 9 description of findings and Figure 59 (Test Unit 9 profile).	Pg. ii, 3rd row in the Management Summary Pg. 7, 1st sentence under Field Methods Pg 35, last paragraph under Site -4893 description Pg. 68, Table 4 Pg. 80, description of Test Unit 9 Pg. 81, Figure 56
HAR 13-276-5 (4): Note locations of test units on plan views of sites that were tested.	The locations of the test units are noted on plan views of sites (sites –4895, -4897, -6684, -6685, -6687, -9555, -9617) that were tested.	Pg. 37, Figure 16 Pg. 42, Figure 23 Pg. 47, Figure 27 Pg. 48, Figure 28 Pg. 53, Figure 33 Pg. 63, Figure 42 Pg. 65, Figure 43
Pg. 57: Clarify age of Site –9546 and appropriate corresponding function	Age and appropriate corresponding function of the historic ranching wall (Site –9546) have been clarified under the site description.	Pg. 60, under Site Description
HAR 13-276-5 (a)(2): Note that portion of project area falls within the Barber's Point Archaeological District.	It has been noted that a portion of project area falls within the Barber's Point Archaeological District.	Pg. 25, Figure 8; Pg. 26, notes in text
HAR 13-276-5 (c)(6): Clarify methods.	Methods have been clarified (how sites were left after testing, mesh of screens used, etc.).	Pg. 6, 3rd paragraph under Field Methods
HAR 13-276-5 (d)(1): Note any previous site numbers to previously described sites.	Previous site numbers have been noted.	Pg. 28, Table 3

Requested Revision	Revisions	Location Within Document
HAR 13-276-5 (e); Figure 3: Map depicting the extent of the grading may help answer questions regarding the current status of sites within the project area identified by Sinoto (1976).	SIHP Sites have been overlaid upon aerial photograph (Figure 3); Sinoto (1976) sites have been overlaid upon aerial photograph (Figure 11). Figure 11 shows Sites 28, 29, and 35 to be located within the light-colored areas (disturbed by grading and/or mining activities). Field inspection conducted for this study (current project) confirmed that these three sites, as well as Sinoto's (1976) Sites 30, 31, and 136 have been destroyed by grading and/or mining activities.	Pg. 4, Figure 3 Pg. 27, 3rd paragraph Pg. 31, Figure 11
HAR 13-276-5 (g); Include more specific information on community consultation process.	Information on consultation process has been added, including a table with community members contacted, community members interviewed, and their corresponding comments.	Pg. 6, 2nd paragraph under Background Research Pg. 11-12, Community Consultation Summary Section Pg. 11-12, Table 1 added
HAR 13-276-6 (a): Clarify disposition of artifacts.	Disposition of artifacts has been clarified (as being temporarily curated at CSH).	Pg. 7, under Field Methods
HAR 13-276-7: Change significance criteria for Sites –9366, -4896, and –9545 to reflect SHPD determinations.	Significance criteria for Sites –9366, -4896, and –9545 have been changed to reflect SHPD determinations. Site -9633, the burial cave, has been changed to Criteria C, D, and E; Site -4896 A/B, the temporary habitation and agricultural site complex, has been changed to Criteria C and D; and Site-9545, the habitation sinkhole, has been changed to Criteria C and D.	Pg. ii, first row in the Management Summary Pg. 84, 2nd paragraph under Significance Pg. 85-86, in Table 6
Pg. 65, Section C: Clarify number of test units.	Number of test units has been clarified (nine test units at eight sites were carried out).	Pg. 68, 1st paragraph under Section C
Pg. 65, Table 3: Include site type.	A third columns has been added to the table indicating site type.	Pg. 68, Table 4
Pg. 62, Figures 43 and 44: Clarify which features these depict; note location of test unit.	The location of the test unit has been added; the figure captions have been clarified to indicate that the figures depict Feature A.	Pg. 65, Figures 43 and 44 captions

Requested Revision	Revisions	Location Within Document
Pg. 50, Figure 33: Indicate locations of test units and cultural material found on surface.	The locations of the test units and the cultural material found on the surface of the site have been added.	Pg. 53, Figure 33
Site –4897: Note features on Table 5 [now Table 6]; note which features is depicted in Figure 22.	Features A, B, C, and D have been noted on Table 6; the caption for Figure 22 has been changed to indicate that the figure depicts Feature A.	Pg. 85, Table 6 Pg. 41, Figure 22 caption
Site –4900: Clarify current condition of site and features.	Current condition of site and features has been clarified. The wall is in remnant condition and the two sinkholes have been destroyed.	Pg. 43, under Site Description Pg. 85, Table 6
Site –4898: Note on Table 5 [now Table 6] that site has been destroyed.	It has been noted that site -4898 has been destroyed.	Pg. 85, Table 6
Site –6686: Note on plan view where features were bisected; note on Table 5 [now Table 6] that features were tested.	The locations where the features were bisected have been noted on the plan view of site –6686. It has also been noted on Table 6 that the site was tested.	Pg. 53, Figure 33 Pg. 85, Table 6
Site –9546: Note remaining length of site.	The remaining approximate length (110 m) of the wall has been added.	Pg. 60, last sentence under the Site Description
Site –9617: Note features on Table 5 [now Table 6].	Features A and B have been noted on table.	Pg. 85, Table 6

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CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

May 6, 2005

VIA US MAIL AND FAX
LOG NO: 2005.0949
DOC NO: 0505MC06

Dr. Hallett Hammatt, President
Cultural Surveys Hawaii, Inc.
P.O. Box 1114
Kailua, Hawai`i 96734
FAX: 262-4950

Dear Dr. Hammatt:

SUBJECT: Chapter 6E-42 Historic Preservation Review of a Report Documenting the Results of an Archaeological Inventory Survey for a 124 Acre Parcel at Barber's Point Harbor
Honouliuli, `Ewa, O`ahu
TMK: (1) 9-1-014:033 and 9-1-015:020

Thank you for the submission of a report documenting the results of an archaeological inventory survey at the proposed 18 hole golf course, park spaces (as in parking lot spaces?), and single and multi-family residences in Kapolei (Hoffman, Freeman, Shideler and Hammatt. 2004. *Archaeological Inventory Survey of Approximately 124 Acres at Kapolei, Honouliuli Ahupua`a, `Ewa District, O`ahu [TMK: 9-1-14:33 and 9-1-15:20*]). We received the subject plan on December 23, 2004 and provide the following comments. Our review is late and we apologize for any inconvenience this has caused you or your client.

The historical background and settlement patterns sections are thorough and well done, providing sufficient data for predicting the probable types of historic sites in the project area. The management summary of the project was particularly helpful. The survey work was carried out in June and July 2004 by four field archaeologists under the field direction of Tracy Hoffman, M.A.. Thirteen previously recorded sites were re-identified and six new sites were identified (50-80-12-6684 through -6689). The sites include traditional native Hawaiian burials, agricultural features, temporary habitation features, rock walls, historic features associated with cattle ranching and sugarcane cultivation, and a portion of the O.R. & L. railroad. Eight test units were excavated at seven of the sites which yielded a scant amount of traditional native Hawaiian artifacts, midden and modern refuse.

SHPD has already commented on some of the sites identified during previous archaeological studies. This letter is included for your reference, as you were not initially copied on this correspondence (Hibbard to Ehrhorn. October 13, 1994. LOG NO: 12901, DOC NO: 9410TD14). A draft preservation plan was written by your firm in 1995 (Hammatt. 1995.

Preservation Plan for Archaeological Sites within the Proposed Barber's Point Harbor Expansion Area [TMK: 9-1-14:02]). Some of the sites in the current study have already been slated for preservation. We concur with your recommendation for preservation of the following sites: -4896 Features A and B, two agricultural mounds already in preservation plan; -6697, possible shrine; -6688, Gilbert Trig Station; -9545, habitation sinkhole already in preservation plan; -9617, temporary habitation site complex already in preservation plan; -9633, burial cave already in preservation plan and burial treatment plan which was approved by the O`ahu Island Burial Council, cave was sealed in 1996; and -9714, OR & L right of way, already on the National Register. We also recommend preservation of Site -9546, the remnant of a bifaced, core filled rock wall, as it had already been slated for preservation in the preservation plan.

Before we can deem the report adequate, and accept it as final, there are some items to address as described here and in the following attachment. The most significant area of concern is SIHP 50-80-12-4893. This feature, described as a "filled sinkhole," should be tested. You recommend no further work for this site in the current study, but in a previous inventory survey conducted by your firm (Hammatt, Shideler, Heidel & Stride. 1994. *Archaeological Inventory Survey of the Proposed Barbers Point Harbor Expansion [TMK: 9-1-14:02]*), you recommended data recovery for this site. Please conduct testing of Site -4893 and submit your findings in a revised inventory survey report for review and acceptance. Please also include the requested revisions as noted in the following attachment.

Should you have any questions, please contact Mary Carney at 692-8027.

Aloha,

for Melanie Chinen

Melanie A. Chinen, Administrator
State Historic Preservation Division

MC:jen

2 Attachments

c: Mr. A. Van Horn Diamond, Chair, O`ahu Island Burial Council
Mr. Nathan Napoka, History and Culture Branch Chief
Ms. Corlyn Orr, Helber, Hastert and Fee, VIA FAX: 545-2050

ATTACHMENT

Comments on an Archaeological Inventory Survey Report
for the 124 Acre Parcel in Kapolei
Cultural Surveys Hawai`i, Inc.

HAR 13-276-5 (4)
Please note the locations of the test units on the plan views of the sites that were tested.

Page 57: Site 50-80-12-9546 says the bifaced, filled wall is pre-contact Hawaiian and was used for ranching, and then described on page 58 as an historic wall. Please clarify the suggested age of the wall and its appropriate corresponding function.

HAR 13-276-5 (a)(2)
Previous Archaeology: A portion of the project area falls within the Barbers Point Archaeological District, SIHP 50-80-12-2888, please note this in the text and on Figure 8 Map showing general areas of archaeological study near the project area.

HAR 13-276-5 (c)(6)
Methods: Was the excavated material screened? What size screen was used? How were the sites left after testing? Were they reconstructed?

HAR 13-276-5 (d) (1)
Please note any previous site numbers to the previously described sites. SHPD has the following corresponding site numbers:

Site -9545: B6-22
Site -9546: B6-23
Site -9617: B6-12
Site -9633: B6-13

HAR 13-276-5 (e)
Figure 3: Aerial photograph shows bulldozed and graded areas of the project area, but it would be very helpful to have that same data transferred to a map showing the locations of the archaeological sites in relation to disturbed areas. A map depicting the extent of the grading may help answer the following question: Were the sites (30, 138, 31, 29, 35, and 28) identified by Sinoto in 1976, which are within the current project area, destroyed by mass grading/mining activities? Please include a statement about these sites if they were no longer present or could not be located.

HAR 13-276-5 (g)
Page 6, Background Research: Please include more specific information on the consultation process such as which personnel are doing the consultation, the methods for identifying and contacting knowledgeable persons, the names of persons being consulted, and any conclusions.

HAR 13-276-6(a)
Disposition: What is the final disposition of the coffee bean sinkers, basalt flake and hammerstone?

HAR 13-276-7
Please change the significance criteria for Burial Site -9633 to reflect previous SHPD determinations. Site -9633 is considered significant under criteria C, D and E because of its traditional importance as a resting place for Hawaiian ancestral remains, because it is an excellent example of a site type and for the information on Hawaiian history and prehistory that it has yielded and is likely to yield. SHPD also already determined that Sites -4896 Features A and B, a temporary habitation and agricultural complex, and -9545, a large sinkhole containing habitation structures, are significant under criteria C and D, because they are excellent examples of their respective site types and for the information on Hawaiian prehistory and history that they have yielded and are likely to yield.

Other Specific Comments:
Page 65, Section C: Second sentence says that nine test excavations were carried out, but the table and text only discuss eight test units.

Page 65, Table 3: Please include site type within this table.

Page 62, Figures 43 and 44: Are these figures of Site -9617 Feature A or B? Please note the location of the test unit.

Page 50, Figure 33: Please show the location of the cultural material that was found on the surface of Site -6687 and the location of the two test units.

Site -4897: This site has Features A, B, C, D, please note this on Table 5. Which feature is photographed in Figure 22?

Site -4900: SHPD database says this site has three features, 2 sinkholes and 1 wall; only the wall is described. Were the two sinkholes destroyed by the bulldozing?

Site -4898: This site has been destroyed by bulldozing activities. Please note this on Table 5.

Site -6686: Please show on planview where Features A and B were bisected. Also note on Table 5 that these features were tested.

Site -9546: Used to be 154 meters long, how long is the remaining portion now?

Site -9617: Please note Features A and B on Table 5.

Archaeological Inventory Survey

of Approximately 124 Acres at

Kapolei, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu

TMK: 9-1-14:33 and 9-1-15:20

by

Tracy Hoffman, M.A.
Sallee D.M. Freeman, M.A.
David W. Shideler, M.A.
and
Hallett H. Hammatt, Ph.D.

Prepared for
Helber Hastert & Fee
733 Bishop St, Suite 2590
Honolulu, HI 96813

by

Cultural Surveys Hawai‘i, Inc.
May 2005

MANAGEMENT SUMMARY

Title	Archaeological Inventory Survey of Approximately 124 Acres at Kapolei, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu
Date	May 2005
Project Number	Cultural Surveys Hawai‘i Inc. (CSH) Project No. KAPO 8
Agency	State of Hawai‘i Department of Land and Natural Resources / State Historic Preservation Division (DLNR / SHPD)
Permit Number	Fieldwork was performed under CSH’s annual archaeological research permit, No. 0404, issued by DLNR / SHPD
Location	The project area lies within TMK: 9-1-14:33 and 9-1-15:20, lying south of the O.R.&L. alignment, west of Kalaeloa Blvd., and north and east of the Barber’s Point Harbor in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southwestern O‘ahu. This area is depicted on the 2002 ‘Ewa 7.5-minute USGS topographic quadrangle.
Land Jurisdiction	Private, owned by the Estate of James Campbell
Project Acreage	Approximately 124 acres
Project Description	The proposed development of the current property includes an 18-hole golf course, park spaces, and single and multi-family residences. Most of the project area will have subsurface ground disturbance.
Area of Potential Effect (APE) and Inventory Survey Acreage	For this inventory survey investigation, the project’s APE is defined as the entire approximately 124-acre footprint of the proposed development. Accordingly, for the current inventory survey investigation the survey area and the project APE are one and the same.
Document Purpose	At the request of Helber Hastert & Fee, CSH undertook this archaeological inventory survey. In consultation with SHPD, the inventory survey investigation was designed to fulfill the state requirements for an archaeological inventory survey [Hawai‘i Administrative Rules (HAR) Chapter 13-276].
Dates, Personnel, and Number of Person-days Required for Field Effort	Fieldwork for the project was conducted on June 21-30, July 27-29, and May 19, 2004 by four Cultural Surveys Hawai‘i staff archaeologists, under the field direction of Tracy Hoffman M.A. and general supervision of Hallett H. Hammatt, Ph.D. (principal investigator).
Number of historic properties identified	Nineteen sites were identified by CSH during the field inventory. Thirteen of these sites already had State Inventory of Historic Properties (SIHP) site numbers and six new sites were recently assigned SIHP site numbers (50-80-12-6684 to -6689).

Historic Properties Recommended Eligible to the Hawai'i Register of Historic Places (Hawai'i Register)	Site 50-80-12-4893, Filled sinkhole (safety filling assoc. with ranching or military), Criterion "D" Site 50-80-12-4895, Agricultural mounds (agricultural clearing), Criterion "D" Site 50-80-12-4896 A/B, Temporary habitation, agricultural site complex, Criteria "C, D" Site 50-80-12-4897, Agricultural site, Criterion "D" Site 50-80-12-4898, Agricultural mounds, Criterion "D" Site 50-80-12-4900, Agricultural wall, Criterion "D" Site 50-80-12-6679, Plantation flood control canal, Criterion "D" Site 50-80-12-6684, Temporary habitation pavement with uprights, Criterion "D" Site 50-80-12-6685, Temporary habitation, enclosure, Criterion "D" Site 50-80-12-6686 A/B, Mound complex, agricultural clearing, Criterion "D" Site 50-80-12-6687, Enclosure with upright, possible shrine, Criterion "D" Site 50-80-12-6688, Gilbert Trig Station geographic marker, Criterion "D" Site 50-80-12-6689, Agricultural concrete flume, Criterion "D" Site 50-80-12-9545, Sinkhole, habitation, Criteria "C, D" Site 50-80-12-9546, Historic ranching wall, Criterion "D" Site 50-80-12-9555, Cist mound, (possible storage), Criterion "D" Site 50-80-12-9617, Temporary habitation site complex Criterion "D" Site 50-80-12-9633, Burial cave, Criteria "C, D, E" Site 50-80-12-9714, O.R.&L. right of way, Criteria "A, B, C, D"
Historic Properties Recommended Ineligible for the Hawai'i Register	None
Results of Archaeological Inventory Survey	Prior to the project's fieldwork, an extensive archaeological and historical literature review was conducted to inform on the project area's cultural setting. The project area was inspected on foot. Spacing between archaeologists was typically ten meters or less. The majority of the project area is free of archaeological concerns. Much of the area has been bulldozed, and part of the project area is currently a limestone quarry. All features of historical interest observed were described, photographed, and assigned a temporary CSH site number. Limited subsurface testing consisted of the partial excavation, by hand, of selected surface archaeological features located during the pedestrian survey. Sites -4893, -4895, -4897, -6684, -6685, -6687, -9555, and -9617, were selected for subsurface testing. The predicted settlement pattern indicated that the vicinity of the project area was utilized in ancient times mostly for bird hunting, sinkhole agriculture, and temporary habitation, with a couple of known instances of human burial. In general, finds conformed to expectations.

Recommendations	Seven sites warrant further consideration in our opinion. SIHP site -4896 Features A and B are two large sinkholes containing cultural materials that we are recommending for data recovery prior to any development of this immediate area, SIHP site -6687 is an enclosure with an upright that may be a shrine and we are recommending consultation with the SHPD to determine if preservation is appropriate. SIHP site -9617 is a platform we are recommending preservation of, due to the presence of midden deposits and a basalt hammer stone, and its proximity to the preserved fenced sinkhole site -9545. The Gilbert Trig Station (site -6688) is an historic geographical marker located along the O.R.&L. railway that should be preserved as it continues to function in its original purpose. Three of the seven sites that warrant further consideration in our opinion have been recommended for preservation of long standing. Two of these are SIHP sites -9633, a burial cave, and -9545, a large sinkhole used as a traditional Hawaiian habitation site. Both of these sites are already under archaeological preservation, and should remain fenced off and protected from further development. The third is the O.R.&L. railway (site -9714), which runs along the north side of the current project area and was added to the National Register of Historic Places in 1975. Any further development should take this national historic site into consideration.

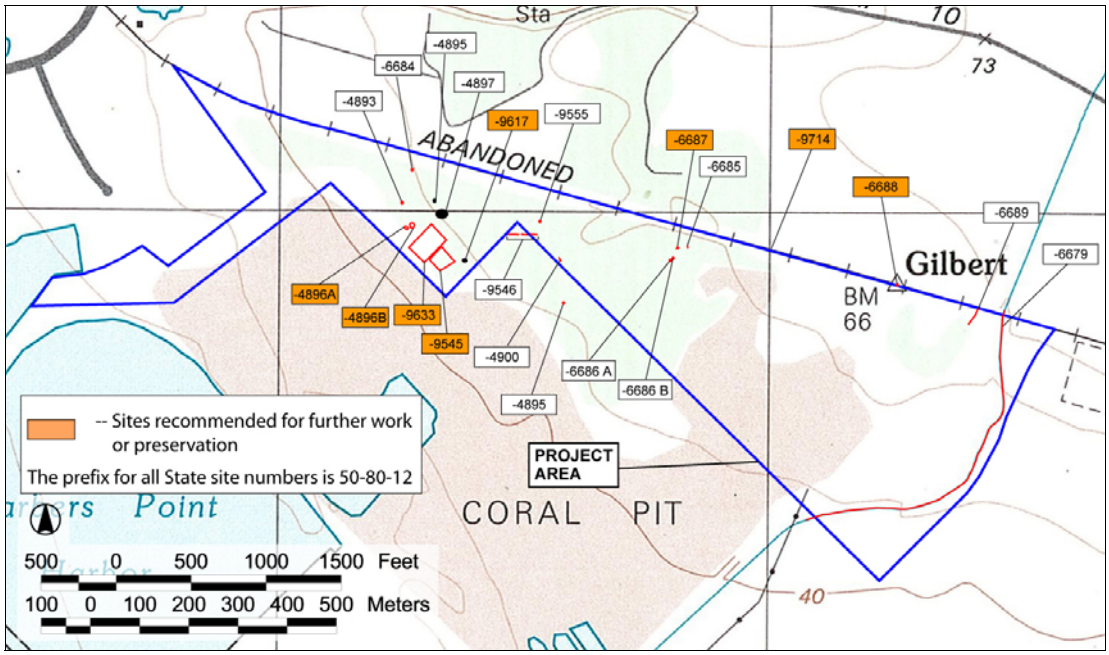

Figure i. Map of the project area showing location of sites recommended for further work or preservation

TABLE OF CONTENTS

MANAGEMENT SUMMARY i
LIST OF FIGURES vii
LIST OF TABLES ix
I. INTRODUCTION 1
A. Project Background 1
B. Project Area Description 1
C. Scope of Work 5
D. Methods 6
1. Background Research 6
2. Field Methods 6
II. HISTORICAL BACKGROUND 8
A. Pre-contact and Early History 8
B. Mid to late 19th Century 10
C. Twentieth Century 11
D. Modern Land Use 11
E. Community Consultation Summary 11
III. HONOULIULI SETTLEMENT PATTERNS 16
A. The Physical Layout 16
B. The Coastal Zone 17
1. Kalaeloa (Barber's Point) 17
2. Ko'olina (West Beach) 17
C. Honouliuli Taro Lands 18
D. Pu'u Ku'ua: Inland Settlement 18
E. Summary of Settlement Patterns in Honouliuli 19
F. Summary of Settlement Patterns in Project Area 20
IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES 21
A. Overview of Archaeological Studies in Western Honouliuli 21
B. Predictive Model 27

V. INVENTORY SURVEY RESULTS 34
A. Field Inspection Findings 34
B. Sites Identified 34
C. Excavation Results 69
1. Test Unit 1 70
2. Test Unit 2 71
3. Test Unit 3 72
4. Test Unit 4 74
5. Test Unit 5 75
6. Test Unit 6 76
7. Test Unit 7 77
8. Test Unit 8 78
9. Test Unit 9 81
VI. SUMMARY 83
A. Agriculture and/or Ranching Sites 83
B. Habitation Sites 84
C. Other Site Functions 84
D. Dating of the Sites 84
VII. SIGNIFICANCE AND RECOMMENDATIONS 85
A. Significance 85
B. Recommendations 85
VIII. REFERENCES CITED 89

LIST OF FIGURES

Figure 1. Portion of U.S. Geological Survey ‘Ewa Quad (2002), map showing location of project area 2
Figure 2. Portion of TMK 9-1-14 showing the location of the project area 3
Figure 3. Aerial photograph (2000) showing the location of the project area and SIHP sites 4
Figure 4. Map showing location of Honouliuli Ahupua‘a in west O‘ahu (adapted from Sterling and Summers 1978) 9
Figure 5. Portion of 1922 War Department Fire Control, Barber’s Point Quad Map, showing project area 13
Figure 6. Portion of 1928 U.S. Geological Survey Barbers Point Quad Map, showing project area 14
Figure 7. Portion of 1943 War Department Barbers Point Quad Map, showing project area 15
Figure 8. Map showing general areas of archaeological study near the project area 25
Figure 9. Site map from Lewis 1970 showing the current project area 30
Figure 10. Site map from Barrera (1975) showing the current project area 31
Figure 11. Aerial photograph (2000) showing the location of the project area and sites identified by Sinoto (1976) 32
Figure 12. Map identifying historic properties within the project area 35
Figure 13. Plan view of site -4893 36
Figure 14. Photograph of site -4893, view to the west 37
Figure 15. Photograph of site -4893 surrounded by *kiawe* debris 37
Figure 16. Plan view of site -4895 38
Figure 17. Plan view of site -4896A 40
Figure 18. Profile view of site -4896A, view to southwest 40
Figure 19. Plan view of site -4896B 41
Figure 20. Profile view of site -4896B 41
Figure 21. Photograph of site -4896B, view to the southeast 42
Figure 22. Photograph of site -4897A, mound, view to north 42
Figure 23. Plan view of site -4897 43
Figure 24. Photograph of site -4900, historic wall, view to north 45
Figure 25. Photograph of site -6679, long irrigation canal 47
Figure 26. Photograph of site -6684, platform, view to northeast 47
Figure 27. Plan view of site -6684 48

Figure 28. Plan view of site -6685 49
Figure 29. Photograph of site -6685, possible enclosure 50
Figure 30. Plan view of site -6686 A/B 51
Figure 31. Photograph of site -6686, Feature A 52
Figure 32. Photograph of site -6686, Feature B 53
Figure 33. Plan view of site -6687 54
Figure 34. Photograph of site -6687, showing wall and upright 55
Figure 35. Photograph of site -6688, the Gilbert Trig Station, view to ESE 57
Figure 36. Plan view of site -6689 58
Figure 37. Photograph of site -6689, cement flume 59
Figure 38. Photograph of site -6689, showing engraved date 59
Figure 39. Plan view of site -9545, habitation sinkhole 60
Figure 40. Photograph of site -9546, historic wall 62
Figure 41. Photograph of site -9555, cist mound 63
Figure 42. Plan view of site -9555 64
Figure 43. Plan view of site -9617A 66
Figure 44. Photograph of site -9617A, platform, view to southwest 66
Figure 45. Plan view of site –9633, burial cave 68
Figure 46. Plan view of test unit 1, site -9555, showing location of uprights before excavation 70
Figure 47. Profile of test unit 2, site -6687, view to north 71
Figure 48. Photograph of coffee bean sinkers from test unit 2, site -6687 72
Figure 49. Profile of test unit 3, site -6685 73
Figure 50. Profile of test unit 4, site -6684, view to north 74
Figure 51. Profile view of test unit 5, site -6687, view to west 75
Figure 52. Profile view of test unit 6, site -4895, view to north 77
Figure 53. Profile view of test unit 7, site -4897, view to north 78
Figure 54. Profile view of test unit 8, site -9617, view to north 79
Figure 55. Photograph of basalt hammer stone from test unit 8, site -9617 80
Figure 56. Profile view of test unit 9, site -4893 82
Figure 57. Map of the project area, showing location of sites recommended for further work or preservation 88

LIST OF TABLES

Table 1. Community Contacts and Comments 11
Table 2. Archaeological and Related Studies in Western Honouliuli Ahupua‘a 21
Table 3. Sites in or Near the Project Area 29
Table 4. Summary of Test Excavations by Site 69
Table 5. Ox-Cal Calibration Results for Sample from Site -6687 76
Table 6. Summary of Sites Identified, Work Completed, and Recommendations 86

I. INTRODUCTION

A. Project Background

At the request of Helber Hastert and Fee, Cultural Surveys Hawai‘i, Inc. (CSH) completed an archaeological inventory survey of approximately 124 acres within parcels owned by The Estate of James Campbell designated TMK 9-1-14:33 and 9-1-15:20., lying south of the O.R.&L. alignment, west of Kalaeloa Blvd., and north and east of the Barber’s Point Harbor in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southwestern O‘ahu. The project area lies mostly in the northwest section of the TMK 9-1-14:33 parcel, and includes a large wooded area, portions of which have not undergone previous archaeological survey (Figures 1-3).

CSH completed an archaeological field inspection of the current project area in January 2004 (Hoffman and Hammatt 2004). The field inspection identified a number of historic properties within the current project area, including stone pavements, sinkholes and modified sinkholes, stone walls, stone mounds, and the historic O.R.&L. railway alignment. The field inspection did not meet the State Historic Preservation Division of the Department of Land and Natural Resources (SHPD/DLNR) requirements for an inventory-level survey, but provided sufficient data to make recommendations for future work. CSH recommended that an archaeological inventory survey with subsurface testing be undertaken for the current project area. The SHPD concurred with CSH’s recommendations.

B. Project Area Description

The project area consists of approximately 124 acres lying south of the O.R.&L. alignment, west of Kalaeloa Blvd., and north and east of the Barber’s Point Harbor in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southwestern O‘ahu. The project area lies mostly in the northwest section of the 227-acre TMK 9-1-14:33 parcel, and includes a large wooded area, portions of which have not undergone previous archaeological survey. Within the western half of the project area are two archaeological preserves delineated with chain-link fencing and marked as restricted. The larger of the two marks off a burial cave designated State Inventory of Historic Properties (SIHP) site 50-80-12-9633. The second preserve protects a very large sinkhole with cultural remains that was designated SIHP site 50-80-12-9545. The O.R.&L. alignment is designated SIHP site 50-80-12-9714.

The project area is located on the ‘Ewa plain, south of the Wai‘anae Mountain Range in the southwest corner of O‘ahu. The terrain is limestone and alluvial deposits, overlying flows of the Wai‘anae volcanic series (Macdonald et al. 1983:423). The project area is generally quite level varying between sea level at the western end of the project area and 70 feet elevation above sea level at the project area’s eastern (*mauka*) end.

The project area is largely covered with thin clay soils including a moderately shallow ‘Ewa silty clay loam, and Mamala stony silty clay loam overlying coral (limestone) outcrop (Foote et al. 1972). Some of these clay and silty clay loam deposits are most likely of historic deposition owing to increased erosion from introduced grazing animals and deliberately induced erosion to improve agricultural fields. In traditional Hawaiian times, the areas of coral outcrop were probably more extensive.

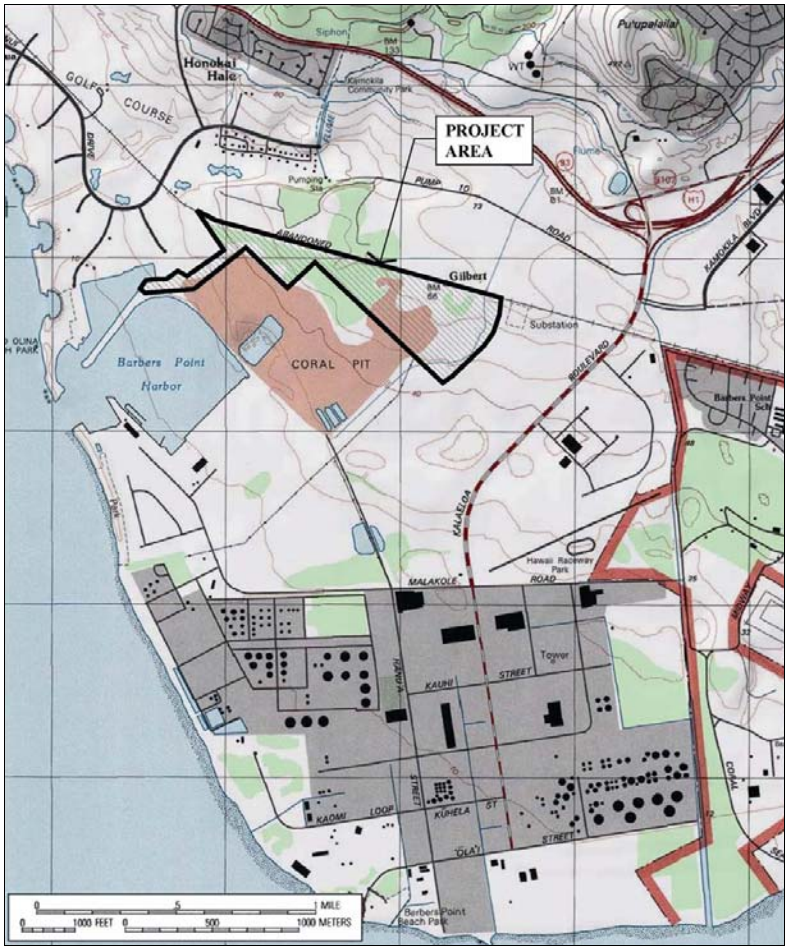

Figure 1. Portion of U.S. Geological Survey ‘Ewa Quad (2002), map showing location of project area

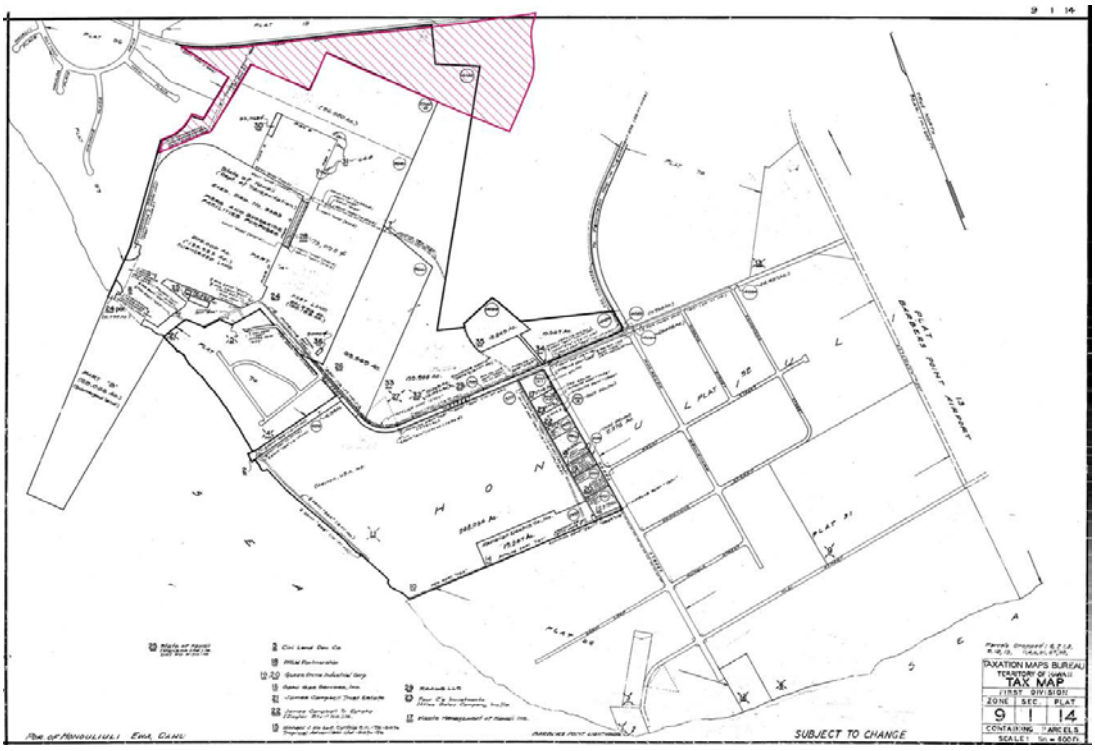

Figure 2. Portion of TMK 9-1-14 showing the location of the project area

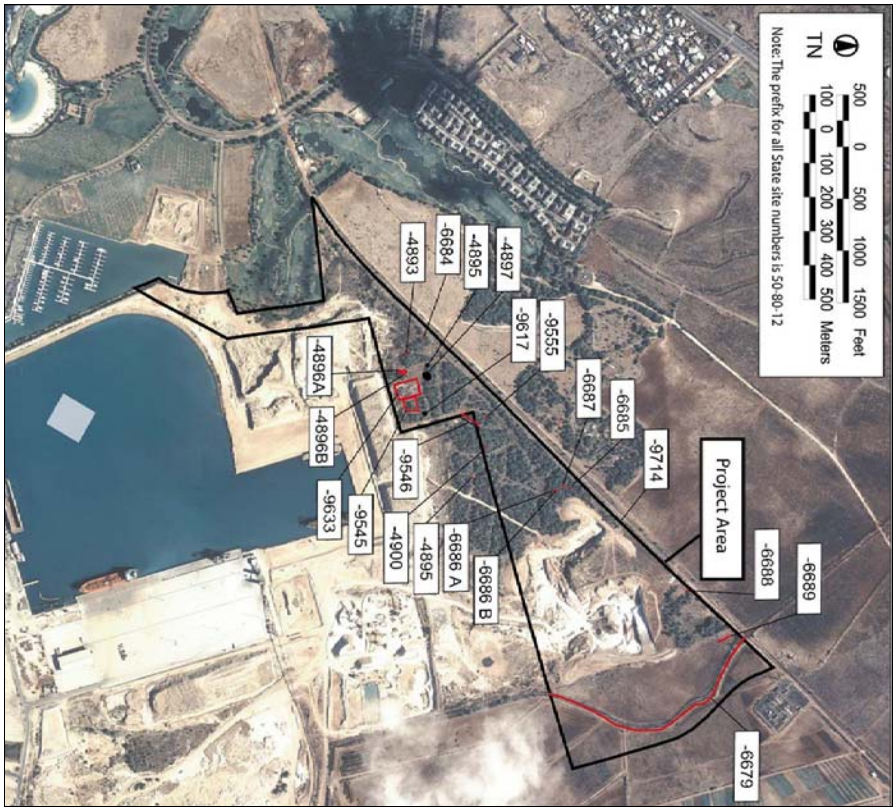

Figure 3. Aerial photograph (2000) showing the location of the project area and SIHP sites

Lying in the lee of the Waiʻanae mountain range, the project area is one of the driest areas of Oʻahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). In pre-contact Hawaiʻi the project area would have been mostly lowland dry shrub and grassland, but this area has been extensively disturbed and transformed by human activity with a variety of exotic grasses, weeds, and shrubs now dominating. These grasses and shrubs, along with pockets of *kiawe* forest, and a few scattered banyan trees are characteristic of the vegetation of the project area.

C. Scope of Work

The purpose of this inventory survey was to determine whether significant historic properties are present within the project parcel. A particular concern involves filled limestone sinkholes that may contain burials, other cultural finds, or extinct species as have been found in immediately adjacent areas. Previous archaeological surveys in the area have identified traditional Hawaiian constructions including enclosures and possible burial mounds. WWII-era and plantation era infrastructure that would now be regarded as of historic significance were also investigated.

The archaeological inventory survey and its accompanying report document all historic properties within the subject lands. Given the size and location, and types of features within the parcel, subsurface testing with detailed hand excavation was needed during the inventory survey. Testing focused on locating and evaluating subsurface deposits, such as buried cultural layers and/or deposits with potential for significant paleo-environmental data in sinkholes.

The scope of work included:

1. A complete ground survey of the entire project area for the purpose of site inventory. All sites were to be located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation includes photographs and scale drawings of selected sites and complexes. All sites are assigned State site numbers.
2. Limited subsurface testing to determine if subsurface deposits are located in the project area, and, if so, evaluate their significance. If appropriate samples from these excavations were found, they were to be analyzed for chronological and paleo-environmental information.
3. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research focuses on the specific area with general background on the *ahupuaʻa* and district and emphasizes settlement patterns.
4. Preparation of a survey report to include the following:
   a. A topographic map, if available, of the survey area showing all archaeological sites and site areas;
   b. Description of all archaeological sites with selected photographs, scale drawings, and discussions of function;
   c. Historical and archaeological background sections summarizing pre-contact and historic land use as they relate to the archaeological features;
   d. A summary of site categories and their significance in an archaeological and historic context;

   e. Recommendations based on all information generated 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 are developed in consultation with the client and the SHPD.

This scope of work also includes full coordination with the SHPD and County relating to archaeological matters. This coordination takes place after consent of the owner or representatives.

D. Methods

1. Background Research

Background research included a review of previous archaeological studies on file at the SHPD/DLNR and a review of documents and maps at the CSH library.

Individuals knowledgeable about the project area's history were consulted in conjunction with the companion Cultural Impact Assessment for the project area, entitled *A Cultural Impact Assessment of Approximately 595 Acres at Kapolei, Honouliuli Ahupuaʻa, ʻEwa District of Oʻahu (TMK 9-1-14: 33 and 9-1-15: 4, 18, and por. 20)* (Mitchell and Hammatt 2004). A brief summary of the Cultural Impact Assessment is included in the "Historical Background" of this document under "Community Consultation Summary" (Section II.E).

2. Field Methods

The pedestrian inspection of the project area was conducted on June 21-30 and July 27-29, 2004 by four Cultural Surveys Hawaiʻi staff archaeologists, under the general direction of Hallett H. Hammatt, Ph.D. and the field direction of Tracy Hoffman M.A. Spacing between archaeologists was typically ten meters or less. The project area was inspected on foot beginning with the western extension that runs just north of Barbers Point Harbor. Archaeologists then swept through the area to the northwest, to the border with the Koʻolina Resort. The field inspection proceeded through the central portion of the project area, where a significant area remains undisturbed or only moderately disturbed by modern activities. The pedestrian survey then continued to the east and south. All features of historical interest observed were described, photographed, and assigned a temporary CSH site number.

Limited subsurface testing consisted of the partial excavation, by hand, of selected surface archaeological features located during the pedestrian survey. The purpose of the subsurface testing was to better determine the function of located surface sites, as well as to possibly obtain datable materials for radiocarbon dating. Sites -4893, -4895, -4897, -6684, -6685, -6687, -9555, and -9617, were selected for subsurface testing. Test excavations were generally made in the central portion of each feature, down to clearly sterile sediments or bedrock. After testing, sites were reconstructed.

All excavated sediment was sieved through 1/8-inch mesh screen in the field. All cultural material was collected and labeled by provenience, including test unit, stratum, and depth. Sediment descriptions included Munsell color, texture, consistence, structure, plasticity, cementation, origin of sediments, descriptions of any inclusions such as cultural material and/or roots and rootlets, lower boundary distinctiveness and topography, and other general observations.

The test excavations consisted of 1 x 1 meter test units within sites -4893, -4895, -4897, -6684, -6685, -9555, and -9617. Two 0.5 x 0.5 meter units were excavated within site -6687. Each unit was excavated by hand, conducted by cultural strata or in arbitrary 10 cm levels where cultural strata exceed 10 cm in thickness, and documented with scale profiles, photographs, and sediment descriptions. All traditional Hawaiian artifacts, samples of historic artifacts and sediment samples were recovered and are presently located at the CSH office for temporary curation until otherwise requested by the landowner.

II. HISTORICAL BACKGROUND

A. Pre-contact and Early History

Various legends and early historical accounts indicate that the *ahupuaʻa* of Honouliuli (Figure 4) was once heavily populated by pre-contact Hawaiians. This substantial settlement is attributable for the most part to the plentiful marine and estuarine resources available at the coast, as well as lowlands fronting the west loch of Pearl Harbor (Kaihuopalaʻai) suitable for wetland taro cultivation. In addition, forest resources along the slopes of the Waiʻanae Range, as suggested by E.S. and E.G. Handy, probably acted as a viable subsistence alternative during times of famine and/or low rainfall.

> The length or depth of the valleys and the gradual slope of the ridges made the inhabited lowlands much more distant from the *ʻwao*, or upland jungle, than was the case on the windward coast. Yet the *ʻwao* here was more extensive, giving greater opportunity to forage for wild foods during famine time [Handy and Handy 1972:469-470].

The upper valley slopes may have also been a resource for sporadic quarrying of basalt for 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 et al. 1991).

John Papa ʻĪʻī describes a network of Leeward Oʻahu trails that in later historic times encircled and crossed the Waiʻanae Range, allowing passage from West Loch to the Honouliuli lowlands, past Puʻu Kapolei and Waimānalo Gulch to the Waiʻanae coast and onward, circumscribing the shoreline of Oʻahu (ʻĪʻī 1959:96-98). Following ʻĪʻī's description, a portion of this trail network would have passed close to the presently existing Farrington Highway alignment.

The Hawaiian *aliʻi* were attracted to this region. One historical account of particular interest refers to an *aliʻi* residing in Koʻolina, just west of the project area:

> Koʻolina is in Waimānalo near the boundary of ʻEwa and Waiʻanae. This was a vacationing place for chief Kākuhihewa and the priest Napuaikamao was the caretaker of the place. Remember reader, this Koʻolina is not situated in the Waimānalo on the Koʻolau side of the island but the Waimānalo in ʻEwa. It is a lovely and delightful place and the chief, Kākuhihewa loved this home of his [*Ke Au Hou* July 13, 1910 in Sterling and Summers 1978:41].

Other early historical accounts of the general region typically refer to the more populated areas of the ʻEwa 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 Ahupuaʻa indicate that pre-contact and early post-contact populations also adapted to less inviting areas, despite the environmental hardships.

Barber's Point is named after Captain Henry Barber whose ship ran aground on October 31, 1796. Subsequent to western contact in the area, the landscape of the ʻEwa plains and Waiʻanae slopes was adversely affected by the over-harvesting of the sandalwood forest, and the

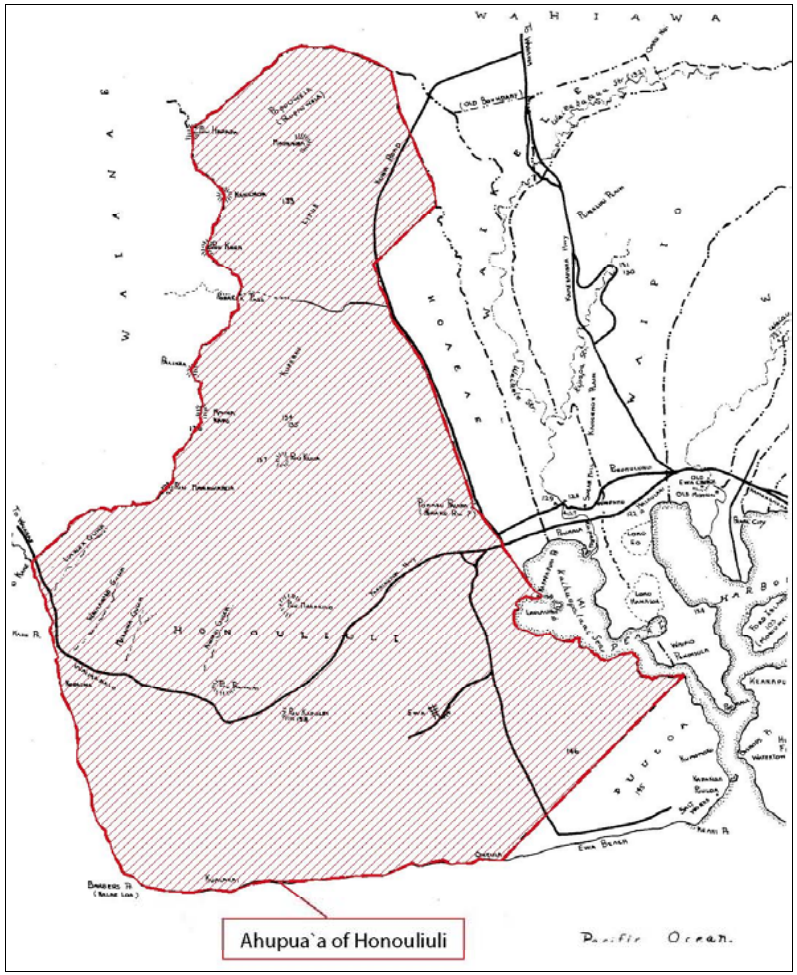

Figure 4. Map showing location of Honouliuli Ahupua‘a in west O‘ahu (adapted from Sterling and Summers 1978)

introduction of domesticated animals and exotic plant species. Domesticated animals including goats, sheep and cattle were brought to the Hawaiian Islands by Capt. George Vancouver in the early 1790s, and allowed to graze freely about the land for some time after. L.A. Henke reports the existence of a longhorn cattle ranch in Wai‘anae by at least 1840 (in Frierson 1972:10).

During this same time, perhaps as early as 1790, exotic vegetation species were introduced to and flourished in the area. The following dates of specific vegetation introduced to Hawai‘i, given by R. Smith and outlined by Frierson (1972:10-11), are relevant when identifying and selecting charcoal samples used for radiocarbon dating:

> 1) “early”, c. 1790: Prickly pear cactus, *Opuntia tuna*; *Haole koa*, *Leucaena glauca*; Guava, *Psidium guajava*
>
> 2) 1835-1840: Burmuda [sic] grass, *Cynodon dactylon;* Wire grass, *Eleusine indica*
>
> 3) 1858: Lantana, *Lantana camara*
>
> The *kiawe* tree was also introduced during this period, either in 1828 or 1837 [Frierson 1972:11].

B. Mid to late 19th Century

Following the Mahele of 1848, 99 individual land claims in the *ahupua‘a* of Honouliuli were registered and awarded by King Kamehameha III. The present study area appears to have been included in the largest award (Royal Patent 6071, LCA 11216, *‘Āpana* 8) granted in Honouliuli Ahupua‘a to Miriam Ke‘ahi-Kuni Kekau‘ōnohi on January 1848 (Native Register). Kekau‘ōnohi acquired a deed to all unclaimed land within the *ahupua‘a*, totaling 43,250 acres.

Kekau‘ōnohi was one of Liholiho’s (Kamehameha II’s) wives, and after his death, she lived with her half-brother, Luanu‘u Kahala‘i‘a, who was governor of Kaua‘i. Subsequently, Kekau‘ōnohi ran away with Queen Ka‘ahumanu’s stepson, Keli‘i-ahonui, 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. When Levi Ha‘alelea, died the property went to his surviving wife, who in turn leased it to James Dowsett and John Meek in 1871 for stock running and grazing.

In 1877 James Campbell purchased most of Honouliuli Ahupua‘a -including the present study area- for a total of $95,000. He then drove off 32,347 head of cattle belonging to Dowsett, Meek and James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). By 1881 the Campbell property of Honouliuli prospered as a cattle ranch with “abundant pasturage of various kinds” (Briggs in Haun and Kelly 1984:45).

In 1889, Campbell leased his property to Benjamin Dillingham, who subsequently formed the O‘ahu Railway and Land Company (O.R. & L.) as the result of a franchise granted by King Kalākaua in 1886. In 1889, Dillingham opened the first nine miles of narrow gauge track on the King’s birthday. To attract business to his new railroad system, Dillingham subleased all land below 200 feet to William Castle who in turn sublet the area to the ‘Ewa Plantation Company for sugar cane cultivation (Frierson 1972:15).

‘Ewa Plantation Co. grew quickly and continued in full operation up into modern times. As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the

‘Ewa Plantation Co. installed ditches running from the lower slopes of the mountain range to the lowlands and then plowed the slopes vertically just before the rainy season to induce erosion (Frierson 1972:17).

C. Twentieth Century

Twentieth century land use of the project area has been for transportation along the former O.R.& L. alignment. The 1922 War Department Fire Control Map (Figure 5) shows a road and architectural features in the area of the Gilbert Station understood as the site of a very small Gilbert Camp associated with the railway and ‘Ewa Plantation. These features also appear, though less extensive, in the 1928 U.S. Geological Survey map (Figure 6). A 1943 war department map (Figure 7) shows the same features and indicates that only a small part of the northeast portion of the project area (light shading) may have been under cultivation at that time. None of these three maps shows any further development within the area of present concern.

D. Modern Land Use

Today the project area borders the Ko‘olina resort complex on the northwest, the O.R.&L. alignment to the north and old cane land to the east. Much of the current project area appears to have had no formal use for quite some time. Portions of the area have been used for harvesting kiawe for manufacturing charcoal and portions of the area are currently part of a quarry for coral limestone. Adjacent to areas of active development include the Barber’s Point Deep Draft Harbor and Ko‘olina resort areas.

E. Community Consultation Summary

Individuals knowledgeable about the project area’s history were consulted in conjunction with the companion Cultural Impact Assessment for the project area, entitled *A Cultural Impact Assessment of Approximately 595 Acres at Kapolei, Honouliuli Ahupua‘a, ‘Ewa District of O‘ahu (TMK 9-1-14: 33 and 9-1-15: 4, 18, and por. 20)* (Mitchell and Hammatt 2004).

The individuals, organizations, and agencies CSH attempted to contact are presented in the table below (Table 1). The initial contact letter was followed-up with at least three attempts to contact each of the individuals, organizations and agencies by telephone. CSH cultural anthropologist Auli‘i Mitchell conducted the community consultations and interviews

Table 1. Community Contacts and Comments

Name	Affiliation	Comments
Batalon, Pedro	‘Ewa Plantation Worker	No Comment.
Cayan, Coochie	O‘ahu Island Burial Council	Referred to Shad Kane
Collins, Sarah	State Historic Preservation Division	No response.
Debutiaco, Gregorio	‘Ewa Plantation Worker	No response.
Eaton, Arlene	Hale O Na‘auao Society	No response.
Espero, Willie	Hawai‘i State Legislature	No response.
Gabbard, Mike	Honolulu City Council	No response.
Guth, Heidi	Office of Hawaiian Affairs	Referred to Shad Kane
Hermosura, Jowe	‘Ewa Plantation Worker	No comment.

Name	Affiliation	Comments
Ka‘eliwai, George Jr.	Hawaiian Civic Club of Pu‘uloa and ‘Ewa	Telephone interviewed on February 2, 2004.
Kane, Shad	‘Ahahui Siwila Hawaiian Civic Club	Interviewed on February 6, 2004.
Kanno, Brian	Hawai‘i State Legislature	No response.
Kapeliela, Kana‘i	State Historic Preservation Division	No response.
Kimoto, Ernest	Office of Hawaiian Affairs	No response.
Komori, Eric	State Historic Preservation Division	Referred to reports at SHPD
Lonowaila, Peter	Kapolei High School	No response.
Malama, Tesha	‘Ewa Neighborhood Board No. 23	No response.
McKinzie, Edith	Kupuna	Her childhood was spent in ‘Ewa.
Moses, Mark S.	Hawai‘i State Legislature	Referred to Shad Kanē
Napōka, Nathan	State Historic Preservation Division	Referred to Shad Kane and John Kaimikaua.
Tamayo, Tulsi, Gabbard	Hawai‘i State Legislature	No response.
Tawata, Shigeru	‘Ewa Plantation Employee	No response.
Tiffany, Nettie Pualani	O‘ahu Island Burial Council	No response.

As a result of the contact process, two interviews were subsequently conducted with Mr. Shad Kane and Mr. George Ka‘eliwai, both of whom have knowledge and concerns about the project area.

None of the interviewees or community contacts queried for this evaluation identified any cultural sites in the project area, or recalled anyone entering the project area – either in the past or present – for any traditional cultural practice. It appears that at present no contemporary or continuing cultural practices occur within the project area.

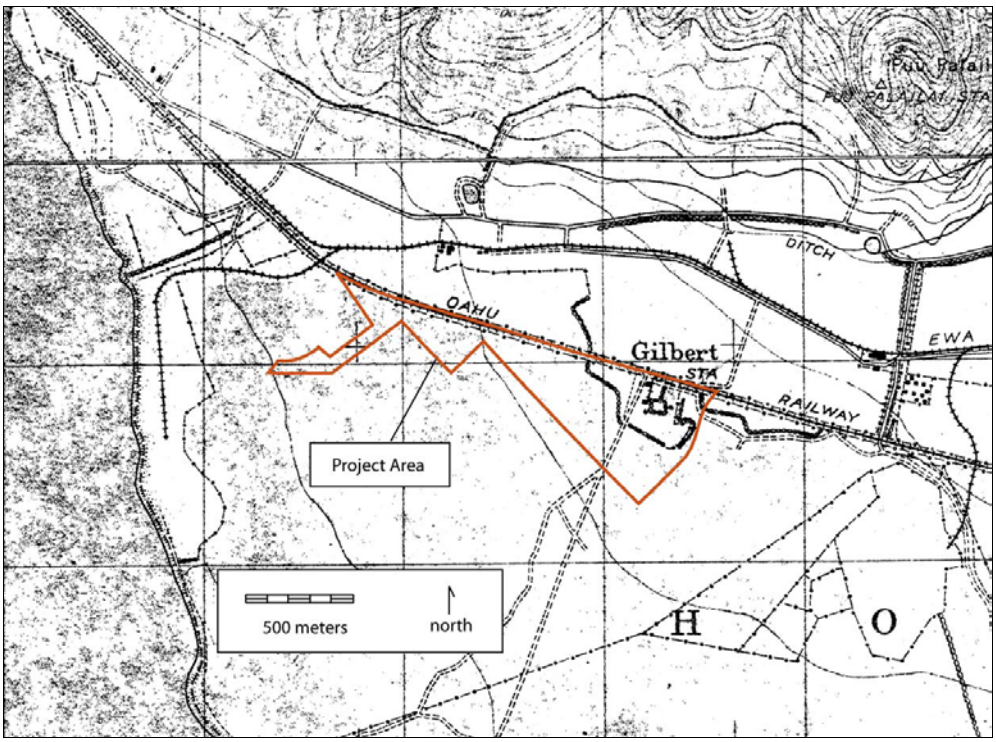

Figure 5. Portion of 1922 War Department Fire Control, Barber's Point Quad Map, showing project area

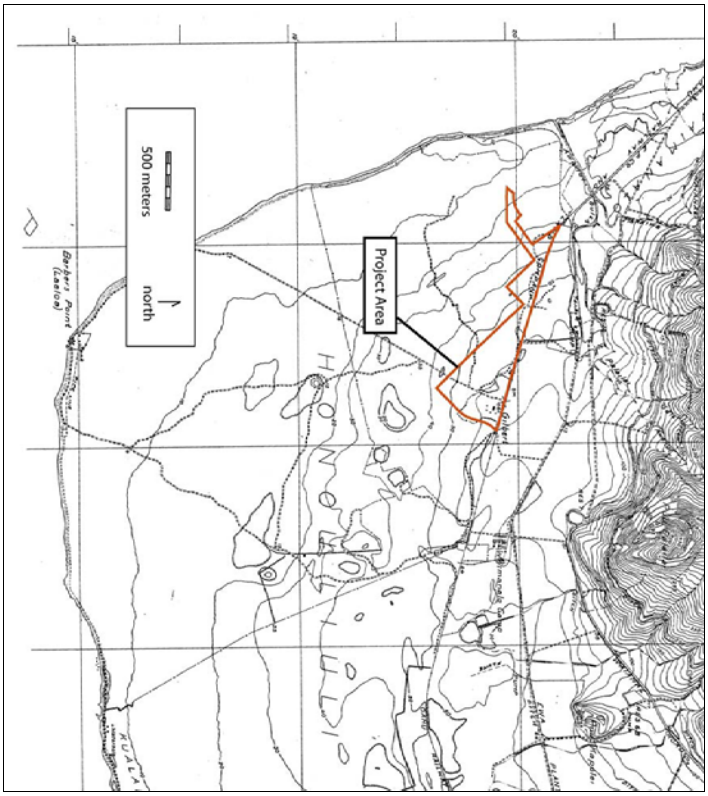

Figure 6. Portion of 1928 U.S. Geological Survey Barbers Point Quad Map, showing project area

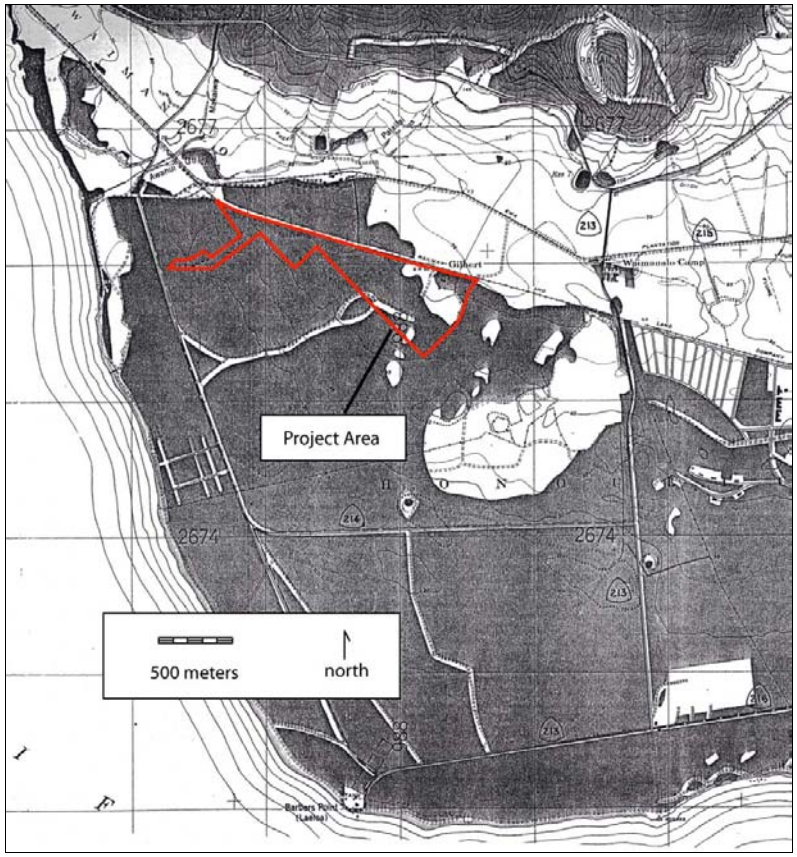

Figure 7. Portion of 1943 War Department Barbers Point Quad Map, showing project area

III. HONOULIULI SETTLEMENT PATTERNS

A. The Physical Layout

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* 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 does Honouliuli boast a long coastline along the normally calm waters of leeward O'ahu, but there are four miles of waterfront running along the west side of West Loch. The land immediately inland of the sea coast consists of a flat karstic raised limestone reef forming a level, nearly featureless "desert" plain covered in pre-contact times by a sparse soil mantle. The microtopography is notable in containing countless sinkholes in some areas, created by chemical weathering (dissolution) of the limestone shelf. Proceeding inland, this plain is overlain by alluvium deposited through a series of gulches draining the Wai'anae Mountains, the largest of which, Honouliuli gulch, is on the east side of the plain draining into West Loch. To the west are fairly steep gradient gulches forming a more linear than dendritic drainage pattern. The major gulches are (from east to west) Awanui, Palailai, Makaīwa, Waimānalo and Lumaloa. These gulches are 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 inland portions of the plain. These gulches are generally dry, but during seasonal Kona storms they 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 in their upper reaches. These gulches do not have valleys suitable for extensive irrigated agriculture. However, this lack is more than compensated for by the rich, well-watered lowlands at the base of Honouliuli Gulch (the *'ili* of Honouliuli).

Honouliuli Ahupua'a, as a traditional land unit, had tremendous and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain (which is the most readably visible terrain) does not do justice to the *ahupua'a* as a whole. The following available resources mark the richness of this land unit:

1. Twelve 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-Laulaunui for example.
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 of 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 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*: 1) the coastal zone including Kalaeloa (Barber's Point), Ko'olina (West Beach), and One'ula ('Ewa Marina), 2) the Honouliuli Taro Lands and 3) the inland area of Pu'u Ku'ua.

B. The Coastal Zone

1. Kalaeloa (Barber's Point)

Archaeological research at Barber's Point has focused on the areas in and around the recently constructed Deep Draft Harbor. A series of small clustered shelters, enclosures and platforms show limited but recurrent use at the shoreline zone for marine 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.

An attraction of the area to early Hawaiians was the plentiful and easily exploited bird population. Particular evidence for taking of petrel occurs at State Inventory of Historic Properties (SIHP) site 50-80-12-2763 located just south of the current project area (Hammatt and Folk 1981:213). Initial heavy exploitation of nesting seabirds and other species, in conjunction with habitat destruction, probably led to early extinction of these bird communities.

The archaeological content of the sites here indicates a major focus on marine resources. There is, however, some indication of agriculture in mulched sinkholes and soil areas. Considering rainfall, this activity would have been constrained by accessibility to water, probably involving tree crops and roots (sweet potatoes).

Bertel Davis (1990a:135), in his Ph.D. dissertation, summarizes our knowledge of traditional Hawaiian use of the coastal zone of Honouliuli:

> I suggest the west coast of O'ahu, including the area off Barbers Point, (a) probably became a well established fishery at least by AD 1000, perhaps much earlier; (b) the initial settlement at Barbers Point also began around this time or possibly earlier; and (c) the settlement initially involved task-specific groups exploiting the adjacent fishery on a seasonal round, probably during the winter months.

2. Ko'olina (West Beach)

Studies associated with the Ko'olina area, which includes the western portion of the present project, document around 200 component features at approximately 50 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 (1987:37) describe as "one of the longest local sequences in Hawaiian prehistory." Information for the

earliest part of the sequence comes from an inland marsh site but early dates were also obtained for a beachfront site and an inland rock shelter.

C. 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. This area bordering West Loch was clearly a major focus of population within the Hawaiian Islands. 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. As early as 1825 all the roads of southwest O'ahu converge as they descend the *pali* funneling into the locality that gave the district of Honouliuli its name. Dicks et al. (1987:78-79) conclude, on the basis of 19 radiocarbon 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 (1831-1832) the land of Honouliuli contained 1026 men, women, and children (Schmitt 1973:19). It is not clear whether this population relates to Honouliuli Village or district 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 pre-contact population of Honouliuli Village may well have been significantly greater than it was in the 1830s.

D. Pu'u Ku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic due to a general absence of archaeological studies. However, it is probable that the area around Pu'u Ku'ua, on the east side of the Wai'anae Ridge seven miles inland of the coast, was a Hawaiian place of some traditional importance.

In 1899 Hawaiian Newspaper "*Ka Loea Kalai'āina*" relates a story of Pu'u Ku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

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 [in Sterling and Summers 1978:33].

McAllister (1933:134, 137) recorded three sites in this area: two *heiau,* Pu'u Kuina and Pu'u Ku'ua (both destroyed), and most interesting, a series of enclosures in Kukuilua which he calls "*kuleana* sites." There is no other direct archaeological evidence available that Hawaiian settlement occurred here but extensive settlement appears likely from traditional accounts. Geographically, the area is well-watered and would have had abundant locally available forest resources.

E. Summary of Settlement Patterns in Honouliuli

Based on the above summary of areas of Honouliuli settlement the following general considerations are made to place the project area in the context of the *ahupua'a* settlement pattern. There are three areas of Hawaiian settlement in the *ahupua'a*; two are well documented while the third is more problematic:

1) The extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;

2) The rich cultivated lands of Honouliuli *'ili* for extensive wetland taro- the *ahupua'a* population center;

3) The uplands around Pu'u Ku'ua probably for agriculture and forest resource utilization.

Honouliuli, as a unit, contains 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 highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, as well as an extensive limestone plain that 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 forestland for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The *mauka/makai* route would have been up Honouliuli Gulch and then north to a trail to Pu'u Ku'ua or up the Makakilo ridge. The *makai* slope is the dry side of the ridgeline. Here streams would respond to rainfall quickly but drain quickly leaving little available water for even short-term use.

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 continuation of the Ko'olina 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. Supported by seasonal dry land planting and forest foraging, this *mauka* habitation could have been the lower portion of a thinly scattered, but widespread zone of settlement stretching eastward and northeast along the east Wai'anae Range slopes, possible increasing in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

There is to date no archaeological evidence of high status residences in Honouliuli. Large residential structures are not present along the shoreline where they would be expected. The late pre-contact development of chiefs' houses as suggested by the tradition of Kākuhihewa at Ko Olina 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) but to date there is no direct archaeological evidence of this. Concerning status associations with Honouliuli it is interesting to note the connection of the Pu'u Ku'ua settlement with pariah (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

The central place of the *ahupua'a* of Honouliuli in terms of population, as well as cultivated foods, was the *'ili* of Honouliuli by the west loch of Pearl Harbor. There is good reason to

assume, given the lack of other areas suitable for intensive agriculture during pre-contact times, that all other habitation zones were economically and socially co-dependent.

F. Summary of Settlement Patterns in Project Area

The project area lies back from the coast, on the extensive 'Ewa limestone plain, which was, according to Honouliuli settlement predictions, probably never permanently inhabited. It could have, however, provided temporary habitation for gatherers and fisherman traveling to the coast. A relatively barren and waterless area, it nonetheless might have been occasionally traversed, as the project area lay between the relatively well-watered uplands and *makai* resources. The extended limestone plain would have been used for bird catching, and would include the temporary habitations that would support such forays. Planters could have also used the natural limestone sinks for agriculture, though it would have been seasonal and on a small scale. In general the project area lies in a region that would have been less than bountiful, and therefore sparsely utilized, even in pre-contact times.

IV. REVIEW OF PAST ARCHAEOLOGICAL/PALEONTOLOGICAL STUDIES

A. Overview of Archaeological Studies in Western Honouliuli

The Barbers Point area (western Honouliuli Ahupua'a) has a reputation as the most archaeologically studied place in Polynesia. An overview of archaeological studies in the west half of Honouliuli Ahupua'a is presented in Table 2 and Figure 8. A discussion of archaeological findings germane to the present project area follows.

Table 2. Archaeological and Related Studies in Western Honouliuli Ahupua'a

Reference	Nature of Study	General Location of Study
Thrum 1907	*Heiau* study	Hawaiian Islands
McAllister 1933	All island survey	O'ahu Island
Kikuchi 1959	Site letter report	Barbers Point
Lewis 1970	Reconnaissance survey	Barbers Point (harbor area)
Frierson 1972	Study of land use & vegetation change	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 1977	Reconnaissance survey	Kalo'i Gulch
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 1978	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)

Reference	Nature of Study	General Location of Study
Komori and Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barbers Point (harbor area)
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 Investigation	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 Homon 1983	Reconnaissance survey	Barbers Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch
Ahlo and Homon 1984	Test excavations	Barbers Point (harbor area)
Hammatt 1984	Reconnaissance survey	Kahe Point
Haun and Kelly 1984	Research resign	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
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. 1986 a and b	Research design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Davis and Haun 1987	Intensive survey & test excavations	West Beach
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Survey report	Kapolei Town
Welch 1987	Reconnaissance survey	Naval Air Station
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial documentation	Kahe
Burgett and Rosendahl 1989	Subsurface archaeological testing	North of O.R.&L.

Reference	Nature of Study	General Location of Study
Hammatt and Shideler 1989a	Archaeological assessment	Barbers Point (harbor area)
Hammatt and Shideler 1989b	Reconnaissance survey	Kahe
Carlson and Rosendahl 1990	Inventory survey	Kaomi Loop Subdivision
Cleghorn and Davis 1990	Archaeological and paleontological investigation	Barbers Point (harbor area)
Davis 1990b	Archaeological and paleontological investigation	Barbers Point (HECO area)
Davis 1990a	Archaeological and paleontological study (Ph.D. dissertation)	Barbers Point (harbor area)
Rosendahl 1990	Letter report	Kapolei Town
Kennedy 1991	Subsurface testing	Pu‘u o Kapolei
Hammatt et al. 1991	Inventory survey	Makaiwa Hills
Hammatt and Shideler 1991	Archaeological assessment	Barbers Point (harbor area)
Haun et al. 1991	Survey report	Naval Air Station
Burgett and Rosendahl 1992	Inventory survey	Barbers Point (harbor area)
Hammatt and Folk 1992	Subsurface testing	Barbers Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Jones 1993	Fossil coral reefs study (Ph.D. dissertation)	Hawaiian Islands
Landrum 1993	Reconnaissance and subsurface testing	Naval Air Station
Miller 1993	Data recovery	Barbers Point (harbor area)
Hammatt and Shideler 1994	Archaeological assessment	Barbers Point (harbor area)
Hammatt et al. 1994	Inventory survey	Barbers Point (harbor area)
Davis 1993	Archaeological and paleontological investigation	Barbers Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Hammatt and Shideler 1995	Data recovery plan	Barbers Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
O’Hare et al. 1996	Intensive survey and testing	Naval Air Station
Wulzen and Rosendahl 1996	Subsurface testing & data recovery	Naval Air Station

Reference	Nature of Study	General Location of Study
Athens et al. 1997	Cultural resource inventory, paleoenvironmental investigation	‘Ewa Plain:Naval Air Station
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	‘Ewa Plain
Tuggle and Tomonari 1997a	Cultural resource inventory survey	Naval Air Station
Wickler and Tuggle 1997	Cultural resource inventory, Inventory Survey	Naval Air Station
McDermott et al. 2000	Data recovery	Barbers Point (harbor area)
Cordy and Hammatt 2003	Archaeological assessment	Barbers Point, North of O.R.&L.
O‘Hare et al. 2004	Documentation of Plantation Infrastructure	North of O.R.&L.
Terry et al. 2004	Archaeological Inventory Survey of Two Sinkholes	North of O.R.&L.

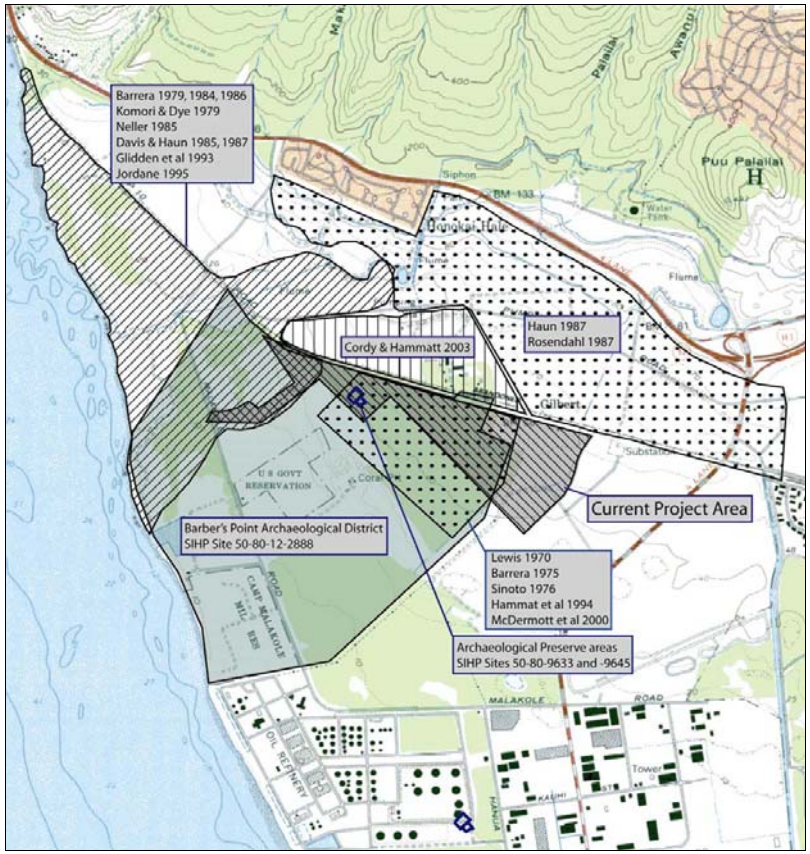

Figure 8. Map showing general areas of archaeological study near the project area

The first effort to record sites at Honouliuli was by Thrum (1907:46) and references "a *heiau* on Kapolei hill, 'Ewa - size and class unknown. Its walls thrown down for fencing." This *heiau*, Pu'u Kapolei, is northeast of the present study area.

In his surface survey of 1930, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of some sites of lesser importance. McAllister (1933:107-108) recorded seven specific sites at Honouliuli (numbered 133-139) and these became the first seven sites in the Bishop Museum's Site Numbering System (OA-B6-1 through OA-B6-7). The nearest of these specific sites to the present project area is McAllister Site 138, including the Pu'u Kapolei Heiau and an adjacent rock shelter. McAllister (1933:109), however designated his site 146 to include archaeological features covering a large but poorly defined area along the coast. His impressions of site 138 are recorded as follows:

> 'Ewa coral plains, throughout which are remains of many sites. The great extent of old stone walls, particularly near the Pu'uloa Salt Works belongs to the ranching period of about 75 years ago [c. 1850s]. It is probable that the Hawaiians formerly used the holes and pits in the coral. Frequently the soil on the floor of larger pits was used for cultivation, and even today one comes upon bananas and Hawaiian sugar cane still growing in them. They afford shelter and protection, but I doubt if previous to the time of Cook there was ever a large population here.

These Hawaiian sites of the 'Ewa coral plains would be the subjects of some 40 or so archaeological reports in the 1970s and 1980s.

From the period between McAllister's 1930 study and the flurry of work that began in 1969, there are only a few sporadic pieces of poorly documented research. "In 1933, Dr. Kenneth P. Emory examined a well-preserved house site and a possible *heiau* in the western part of the coral plain; these sites were later destroyed by sugar-cane planting" (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, south of the present project area (Kikuchi 1959; Davis 1990:146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling made note of a house site (Bishop Museum Site OA-B6-8). "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 (per Sinoto 1960), Lloyd Soehren "carried out salvage excavations at BPBM. Site # 50-OA-B6-13 (a possible fishing shrine.)" The site was reported as destroyed by construction (Barrera 1975:1) but Davis (1990a:148) relocated the shrine and performed additional excavations in 1982. In 1969, artifacts were recovered by Roger Green from a beach midden site (B6-14), south of the barge harbor. In 1977, Barber's Point Archaeological District was assigned Site # 50-80-12-2888 on the National Register of Historic Places, a portion of which overlaps with the current project area (see Figure 8).

To the west of the project area, Paradise Cove, Lanikūhonua, and West Beach have been the subject of numerous archaeological studies (Barrera 1979, 1984, 1986; Komori & Dye 1979; Neller 1985; Davis & Haun 1986, 1987; Glidden et al. 1993; and Jourdane 1995).

Haun's (1986) archaeological reconnaissance survey for the 'Ewa Town Center/Secondary Urban Center study covered an area of approximately 1,400 acres northeast of the present project

area. A study by Burgett and Rosendahl (1989) involved the excavation of seventy-two backhoe test trenches in a 360-acre portion of the Haun study area. There were no significant finds relevant to the current study.

Cordy and Hammatt (2003) made a study of a land parcel directly north of the current project area, just across the O.R.&L. Several sinkholes were noted as of potential archaeological interest. The study also documented the presence of a historic chicken farm as well as other twentieth century architectural remains, including a Quonset hut. Two follow-up studies of plantation infrastructure (O'Hare et al. 2004) and two of these sinkholes (Terry et al. 2004) further addressed cultural resources just north across the O.R.&L. alignment from the present study area.

Several studies have also been carried out within the current project area in the last several decades. In the fall of 1969, Mr. Ellis Cross, a supervisory employee at the nearby oil refinery on the coast, informed Dr. Sinoto that he had found house sites and walls at various locations on Campbell Estate land, near Campbell Industrial Park and the coral quarry (Lewis 1970:2). This resulted in a number of visits by Dr. Sinoto and student volunteers in late 1969 and early 1970. A University of Hawaii graduate student, Mr. Ernest Lewis, did a preliminary survey and test excavations for a graduate seminar in Polynesian Archaeology and donated his report to the Bishop Museum. Lewis was the first to document sites within the present project area (Figure 9).

The sites Lewis documented just south of the O.R. & L. line were subject to a number of further studies including Barrera 1975, Sinoto 1976, Hammatt et al. 1994 and McDermott et al. 2000 (Figures 10 and 11). Two sites were identified for protection within fenced off preserve areas. SIHP site 50-80-12-9633 is a cave that was found to contain human created rock piles and wall, human remains, and part of a wooden canoe (Hammatt et al. 1994:93-94). Because of its function as a burial site, the cave was not excavated and the remains were protected in the state in which they were discovered. Just east of that fenced preserve is another smaller preserve area surrounding SIHP site 50-80-12-9545. This site is a very large sinkhole measuring about nine meters in diameter and six meters deep (Sinoto 1976:16). The interior of the sinkhole has been modified for human habitation in traditional times, including "cleared areas, low terraces, fire pits, and a large *ahu* which was probably constructed to facilitate entry and egress" (Hammatt et al. 1994:87). The two preserve areas are marked on Figure 8. Sites 30, 136, 31, 29, 35, and 28 (Figure 11), identified by Sinoto in 1976 have been destroyed by mass grading and/or mining activities within the project area. Figure 11, an aerial photograph of the project area overlaid with the Sinoto (1976) field map, shows Sites 28, 29, and 35 to be located within the light-colored areas (disturbed by grading and/or mining activities). Field inspection conducted for this study (current project) confirmed that these three sites, as well as Sinoto's (1976) Sites 30, 31, and 136 have been destroyed by grading and/or mining activities.

Sites in or near the present project area that have been previously described are listed below in Table 3.

B. Predictive Model

The one general observation regarding the archaeology of southwestern O'ahu is that there was more pre-contact utilization of the area than might be expected given its present day uninviting ambiance and "marginal ecology" (Sinoto 1976:71). In our area of interest, however, back from the coast and seaward of the forested inlands, pre-contact land use appears to have

dropped off dramatically. This area of Honouliuli would be expected to yield traditional Hawaiian remains of temporary habitations used during forays for marine resources. This

Table 3. Sites in or Near the Project Area

Site # (50-80-12-)	Type of Site	Source
4893	Sink	Hammatt et al. 1994:35
4894	Enclosure	Hammatt et al. 1994:35
4895	Mounds	Hammatt et al. 1994:39
4896	Sink complex	Hammatt et al. 1994:39
4897	Mound complex	Hammatt et al. 1994:43
4898	Mounds	Hammatt et al. 1994:43
4900	Complex of sinks and wall	Hammatt et al. 1994:46
9545	Sink (Habitation)	Sinoto 1976:16(B6-22)
9546	Historic Ranching Wall ("Long Wall")	Lewis 1970:33; Barrera 1975:8; Sinoto 1976:16 (B6-23)
9547	Enclosure	Lewis 1970:36 (B6-24)
9548	Enclosure	Lewis 1970:35; Barrera 1975:8; Sinoto 1976:16(B6-25)
9551	Mound	Lewis 1970:356 (B6-29)
9552	Mound cluster	Lewis 1970:36 (B6-30)
9553	Cluster of mounds	Lewis 1970:36 (B6-31)
9555	*Ahu*	Lewis 1970:35 (B6-33)
9556	Terrace, mounds, paved area, enclosure	Lewis 1970:35 (B6-34)
9617	Site complex (temporary habitation)	Sinoto 1976:16(B6-12)
9633	Burial Cave	Sinoto 1976:16(B6-13)

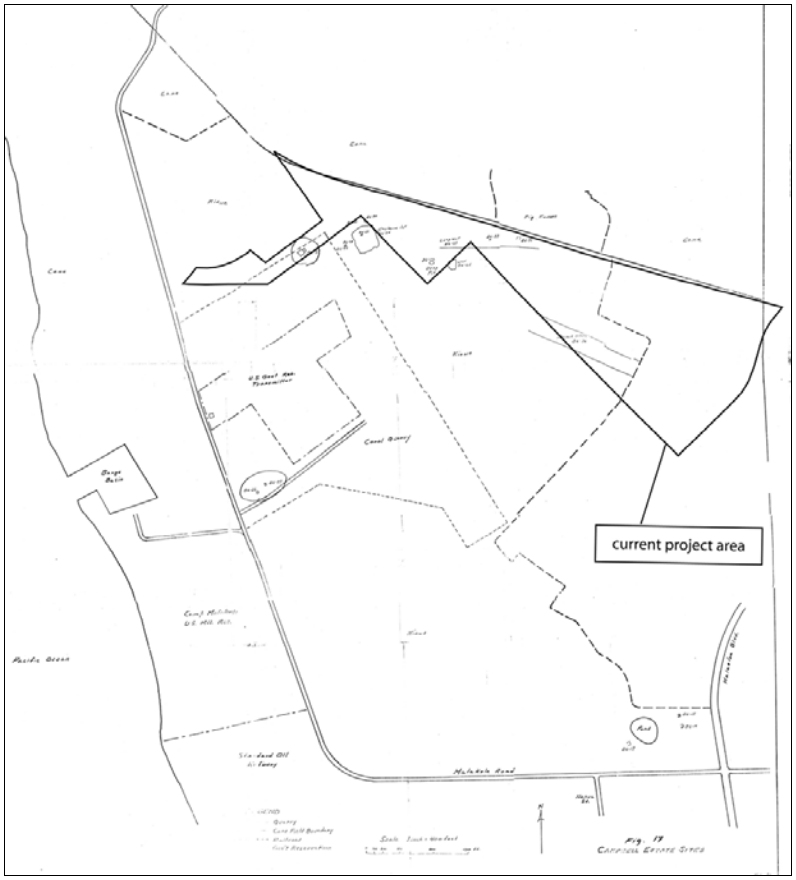

Figure 9. Site map from Lewis 1970 showing the current project area

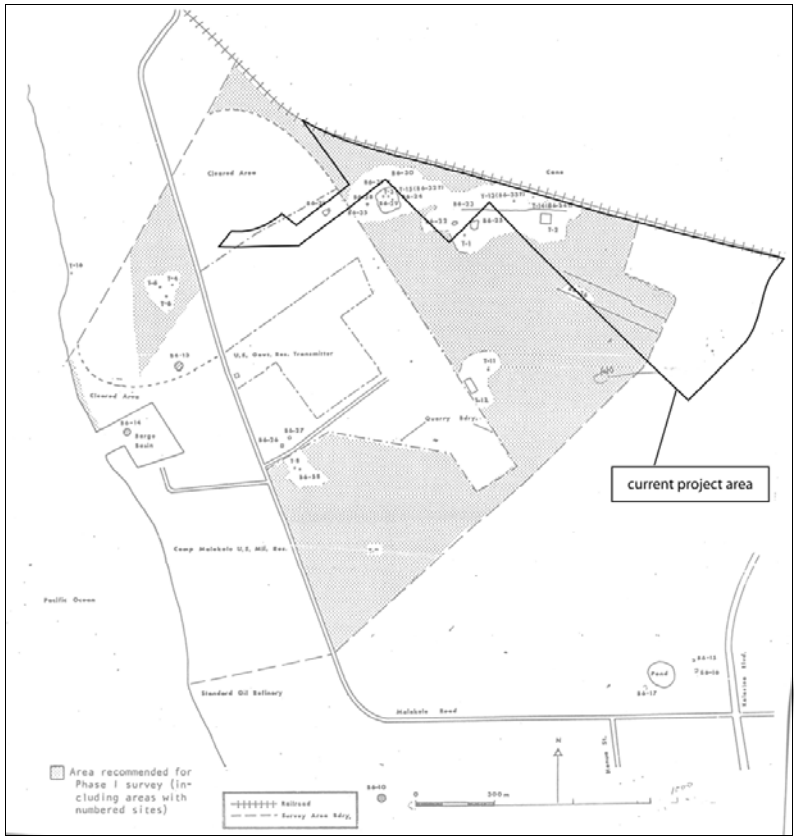

Figure 10. Site map from Barrera (1975) showing the current project area

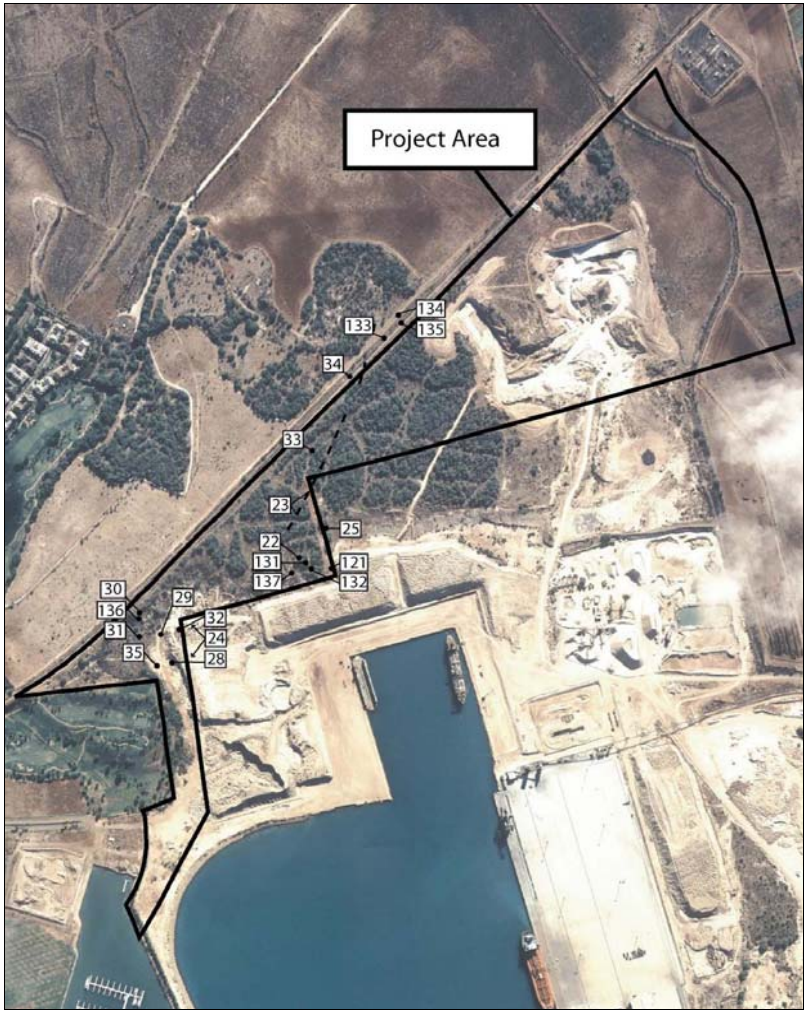

Figure 11. Aerial photograph (2000) showing the location of the project area and sites identified by Sinoto (1976)

limestone bedrock has in previous studies yielded sinkholes with historic deposits (Hammatt et al. 1994). Burials and the remains of bird hunting activities may be encountered within some of the sinkholes within the project area. Remains of plantation infrastructure and possibly other twentieth century activities (ranching, military activity) could also be expected to be present.

V. INVENTORY SURVEY RESULTS

A. Field Inspection Findings

Approximately two-thirds of the current project area has been heavily impacted by previous construction activities. These include bulldozing of the northern edge of the project area for the construction of the O.R.&L. Alignment, land disturbance on the west side associated with the Ko‘olina Golf Course and the barge harbor, within the limestone quarry south of the project area - which extends into the eastern central part of the project area. and bulldozing for various former unimproved roads that cut through the project area. These areas were all surveyed by archaeologists and determined to contain no features of historic significance.

Several portions of the project area remain undisturbed to moderately disturbed by bulldozing and other modern activities, and include wooded areas of *kiawe* and scattered banyan. Within these areas, intact historic properties were found, both of pre-contact and post-contact dates. These archaeologically significant areas include a relatively large wooded area in the center of the project area, and two smaller wooded patches just west of this and to the east of the Gilbert Trig Station (see Figure 3). In addition, the Gilbert Trig Station and a large irrigation canal are historic properties in otherwise bulldozed areas.

B. Sites Identified

A total of 19 sites were identified within the project area during the archaeological inventory survey. These sites are located on Figure 12. Following is a detailed discussion of the sites identified as well as an attempt to note which of these may have been previously reported. The sites are summarized with a listing of posited function, work accomplished, significance, and recommendations in Table 6 in the summary and recommendations section of this report.

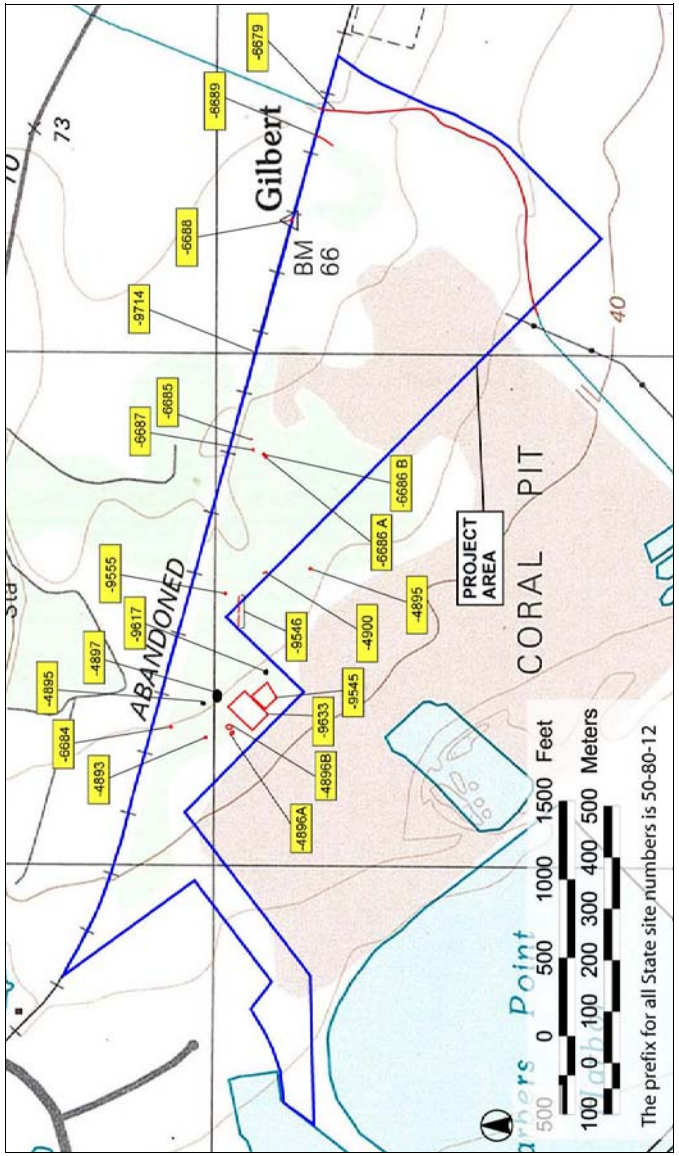

Figure 12. Map identifying historic properties within the project area

SIHP Site #: 50-80-12-4893

Site Type: Pavement

Function: Filled sinkhole

Features (#): 1

Age: unknown

Description: Site 50-80-12-4893 was first identified in the Hammatt et al. 1994 study. The following description is from that report: "State Site 50-80-12-4893 (CSH 32) comprises a small sink located on level limestone terrain with a significant soil deposit.... Vegetation in the area includes *kiawe*, *koa haole*, and various grasses. The sink is located at the western edge of a vegetated area beyond which is an open bulldozed area" (Hammatt et al. 1994:35). The sink measures 1.8 m north-south and 1.7 m east-west. The pavement has a maximum height of 20 cm above the surrounding ground surface (Figures 13 to 15).

A 1 m by 1 m test unit excavated during the current study revealed no cultural material (see the following Excavation Results discussion for Test Unit 9 and Figure 56).

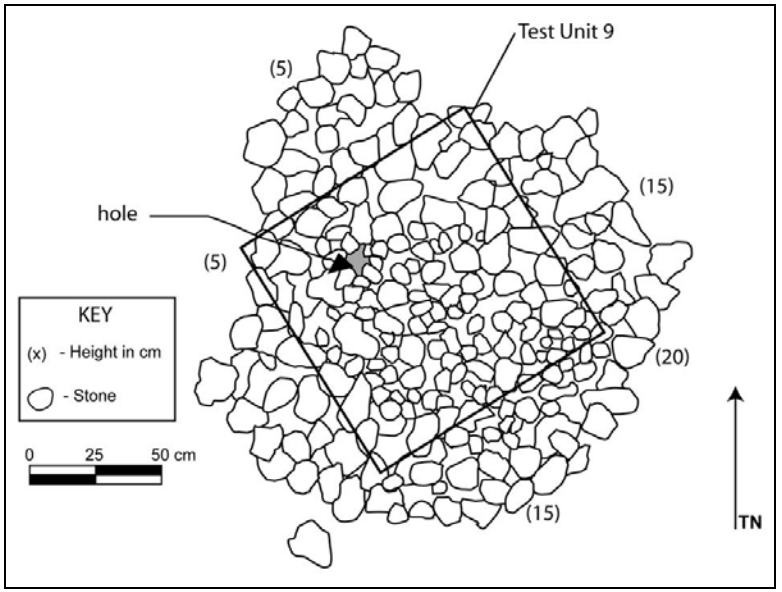

Figure 13. Plan view of site -4893



Figure 14. Photograph of site -4893, view to the west



Figure 15. Photograph of site -4893 surrounded by *kiawe* debris

SIHP Site #: 50-80-12-4895

Site Type: Mounds

Function: Agriculture

Features (#): 1

Age: Historic

Description: Site 50-80-12-4895, (Figure 16) consisting of five mounds (Figure 16) was first identified in the Hammatt et al. 1994 study. The following description is from that report:

> State Site 50-80-12-4895 comprises five amorphous mounds located on level limestone terrain with shallow soil. Nearby vegetation includes kiawe, koa haole, and various grasses. The site is located along the northwest mauka project boundary at the edge of a vegetated area. Open bulldozed areas lie to the south and north.
>
> The five mounds cover an area measuring 4.0 m. (13.1 ft.) N/S by 5.6 m. (18.4 ft.) E/W. They range in size from 0.8 m. (2.6 ft.) N/S by 1.2 m. (3.9 ft.) E/W to 2.3 m. (7.5 ft.) N/S by 1.4 m. (4.6 ft.) E/W with an average height of 0.3 m. (1.0 ft.). The mounds are constructed of cobbles and boulders roughly piled atop outcrop protrusions. Three of the mounds blend into each other.
>
> No artifacts or midden were observed.
>
> The mounds resulted from agricultural clearing.
>
> The site is in fair to good condition and has fair excavation potential.

A 1 m by 1 m test unit excavated during the current study revealed no cultural material (see the following Excavation Results discussion for Test Unit 6 and Figure 52).

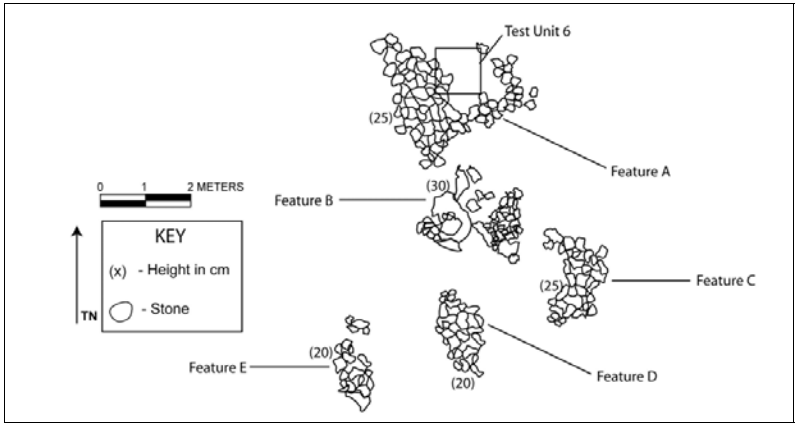

Figure 16. Plan view of site -4895

SIHP Site #: 50-80-12-4896

Site Type: Site complex

Function: Temporary habitation, agriculture

Features (#): 2

Age: Pre-contact Hawaiian

Description: Site 50-80-12-4896, consisting of two sinkholes (Features A and B) was first identified in the Hammatt et al. 1994 study. The following description is from that report:

> State Site 50-80-12-4896 ... is a complex comprised of two sinkholes; Features A and B.... The surrounding terrain is fairly level limestone.... Nearby vegetation includes banyan, koa haole, and various grasses and weeds. State Site 9633... burial sink is located to the southeast across a small quarry excavation.
>
> The complex consists of two sinkholes, designated Features A and B. The complex area measures 10.0 m. (32.8 ft.) N/S by 27.5 m. (90.2 ft.) E/W.
>
> **Feature A** consists of a sinkhole (Figures 17 to 18) measuring 4.0 m. (13.1 ft.) N/S by 3.5 m. (11.5 ft.) E/W and ranging in depth from 0.6 to 2.1 m. (2.0 to 6.9 ft.). The interior consists of level soil with a large banyan tree growing in the center [the current project noted instead a large kiawe stump in the center and a banyan tree growing on the east side of the sink].
>
> A 0.5 m. by 0.5 m. test unit yielding midden, bird bone, and charcoal was excavated within the northeast corner of the sink.
>
> **Feature B** is located 18.0 m. (59.0 ft.) to the east of Feature A and consists of a sinkhole (Figures 19 to 21) measuring 4.0m. (13.1 ft.) N/S x 6.0 m. (19.7 ft.) E/W ranging in depth from 65 to 105 cm. (2.1 to 3.4 ft.). The interior consists of soil and loose cobbles and pebbles with koa haole growing in the center.
>
> Bird bone and occupation debris were observed on the surface of the complex.
>
> Due to the presence of material within the test unit excavated in Feature A, further excavation at this site is recommended [Hammatt et al. 1994:39].

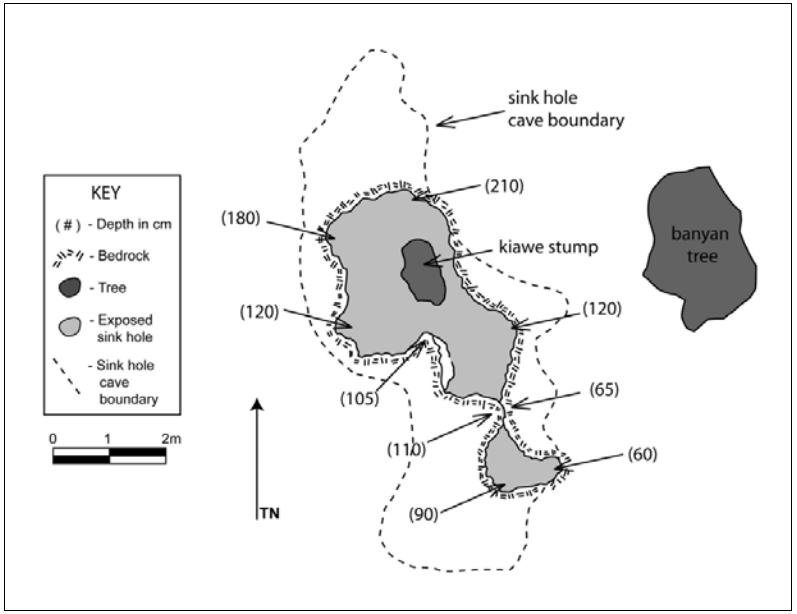

Figure 17. Plan view of site -4896A

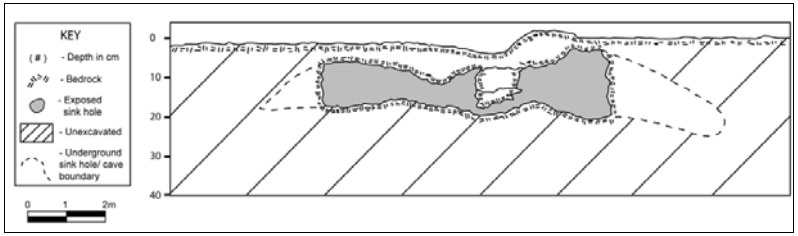

Figure 18. Profile view of site -4896A, view to southwest

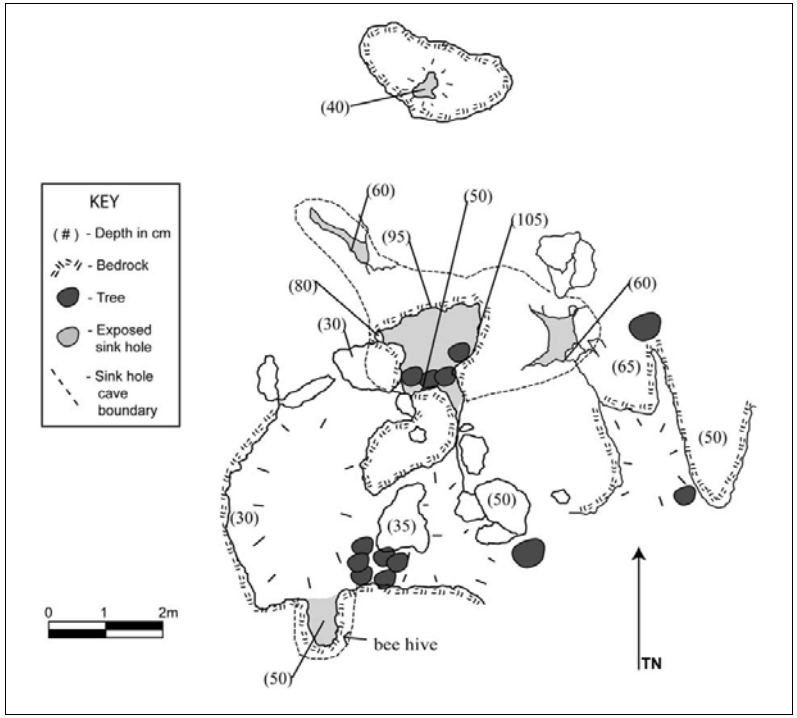

Figure 19. Plan view of site -4896B

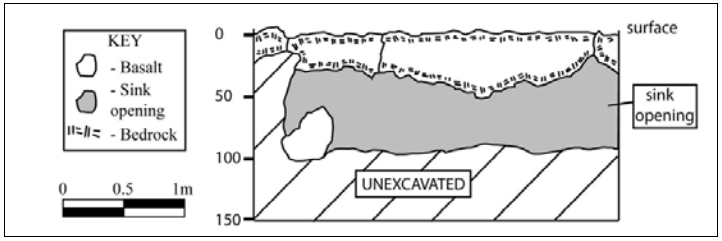

Figure 20. Profile view of site -4896B



Figure 21. Photograph of site -4896B, view to the southeast



Figure 22. Photograph of site -4897A, mound, view to north

SIHP Site #: 50-80-12-4897

Site Type: Site complex

Function: Agriculture

Features (#): 4

Age: Pre-contact Hawaiian

Description: Site 50-80-12-4897, (Figures 22 to 23) consisting of four circular mounds and one linear mound was first identified in the Hammatt et al. 1994 study. The topography in the area consists of level limestone bedrock with shallow soil deposits. Vegetation in the vicinity includes *kiawe*, and *koa haole*. The site lies at the edge of a vegetated area with a large open bulldozed area to the west.

The complex area measures approximately 16.8 m. (55.1 ft.) N/S by 18.3 m. (60.0 ft.) E/W. It consists of three roughly circular mounds and one linear mound. The circular mounds range in size from 0.9 m. (3.0 ft.) in diameter to 1.9 m. (6.2 ft.) N/S by 2.2 m. (7.2 ft.) E/W with maximum heights of 0.3 m. (1.0 ft.). These mounds are constructed of piled small boulders and cobble mix. The largest mound is partially piled atop outcrop. The linear mound measures 4.0 m. (13.1 ft.) NE/SW by 1.0 m. (3.28 ft.) NW/SE with a maximum height of 0.5 m. (1.6 ft.). It is constructed of small boulder and cobble mix piled atop outcrop. The mound's southwest terminus lies amidst bulldozer push.

No artifacts or midden were observed on the surface of the complex, and a 1 m by 1 m test unit revealed no cultural material (see the following Excavation Results section for Test Unit 7 and Figure 53). The mounds are all interpreted as agricultural clearing mounds.

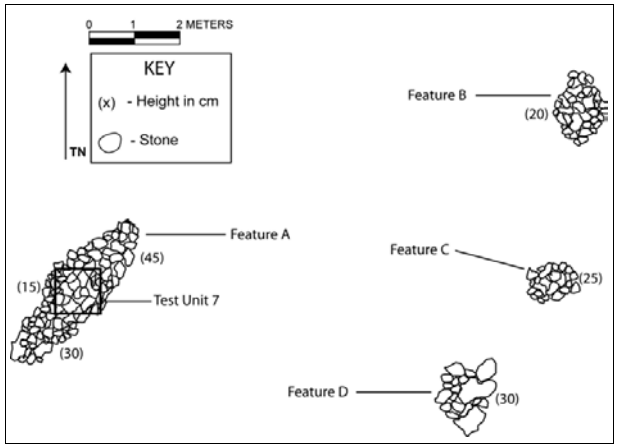

Figure 23. Plan view of site -4897

State Site #: 50-80-12-4898

Site Type: Mounds

Function: Agriculture

Features (#): None designated

Age: Pre-contact Hawaiian, but disturbed in historic times

Description: Site 50-80-12-4898, was identified in the Hammatt et al. 1994 study as consisting of two mounds. The site appears to have been demolished by bulldozer activity in the area, as it no longer exists. The following description is from the Hammatt et al. 1994 report:

> State Site 50-80-12-4898 comprises two mounds on level limestone terrain with shallow soil (Fig. 19). Vegetation in the area includes kiawe, koa haole, and various grasses. The site is located 23.0 m. (75.4 ft.) west of survey stake "RESERVE LINE A #1." An open area (old road cut) runs roughly NE/SW along the southeast edge of the site.
>
> The mounds are roughly circular, lying 1.3 m. (4.3 ft.) apart and measuring 1.8 m. (5.9 ft.) NE/SW by 1.7 m. (5.6 ft.) NW/SE and 1.7 m. (5.6 ft.) in diameter with maximum heights of 0.4 m. (1.3 ft.). The mounds are constructed of roughly piled small to medium boulders and cobble mix. A tin can is lodged within the northeast edge of one mound while another tin can lies 1.0 m. (3.28 ft.) northeast of the other mound. A large tangle of kiawe debris covering mounded stones, most likely bulldozer push resulting from clearing of the adjacent open area (cut road), is located to the southeast of the two mounds.
>
> Artifacts are limited to the historic tin cans observed on or near the mounds. No midden was observed.

SIHP Site #: 50-80-12-4900 A/B/C

Site Type: Wall (Remnant) and 2 sinkholes (destroyed)

Function: Agriculture

Features (#): 1

Age: Historic

Description: Site 50-80-12-4900 (Figure 24) was first identified in the Hammatt et al. (1994) study. The current site consists of the remains of one of the historic walls described in the aforementioned study. These remains consist of seven limestone boulder slab uprights in an alignment, with scattered cobbles and boulders alongside. The site has been cut by a bulldozer on the northwest, and the wall may have originally extended further in that direction. The remains are 4.1 m long, and 35 cm high. The boulder slabs average 50 to 60 cm in width. The two sinkholes were not relocated and are assumed to have been destroyed by bulldozing activities.



Figure 24. Photograph of site -4900, historic wall, view to north

SIHP Site #: 50-80-12-6679

Site Type: Canal

Function: Plantation flood control

Features (#): 1

Age: Historic

Description: Site 50-80-12-6679 (Figure 25) consists of a single drainage canal. The drainage canal runs through the eastern portion of the project area, this being only a small portion of the entire canal. The drainage canal was observed to be mechanically excavated, with the excavated material mounded approximately 3 m above the ground surface along each edge of the canal. The interior of the canal measured approximately 7.5-9.0 m wide and 4.5-6.0 m deep. The canal was generally earth-lined and exhibited significant erosion of the sidewalls.

The canal was observed to have sidewalls reinforced with a cemented basalt boulder lining. The lining extended approximately 2 m above the base of the canal. The base of the canal, throughout its observed length, appeared to be earth-lined, though heavy sedimentation may have covered any evidence of improvements.

Site 50-80-12-6679 appears to serve the function of channeling storm water from gulches upslope, as to prevent flooding of the lowland plantation fields. The canal may also be related to efforts by the Ewa Plantation to induce erosion and sedimentation of the lowlands. Site-50-80-12-6679 is in good condition and appears to continue to function as a flood control measure.



Figure 25. Photograph of site -6679, long irrigation canal



Figure 26. Photograph of site -6684, platform, view to northeast

SIHP Site #: 50-80-12-6684

Site Type: Pavement with slab uprights on north and northeast edges

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: Site 50-80-12-6684 (Figures 26 & 27) consists of a pavement of limestone cobbles. Two limestone slab uprights delineate the north and northeast edges. The site is located in an area of *kiawe* debris, and there is a bulldozer push pile off the site's western edge. The platform measures 2.1 m north-south and 2.3 m east-west. The height of the platform is about 15 cm above the surrounding ground surface, while the maximum height of the uprights is 40 cm above the ground surface.

No cultural remains were observed on the surface. A 1m by 1m test unit yielded a single basalt flake and a very small amount of midden(see following Excavation Results Section discussion for Test Unit 4 and Figure 50).

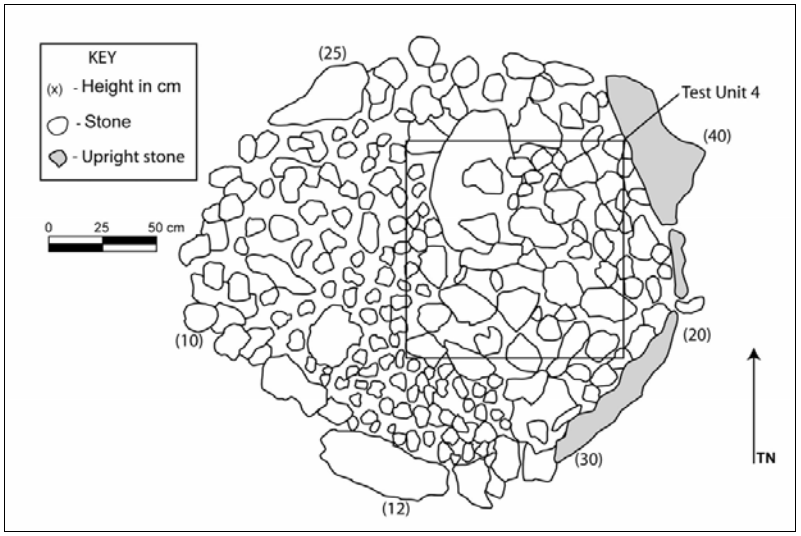

Figure 27. Plan view of site -6684

SIHP Site #: 50-80-12-6685

Site Type: Enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This site (Figures 28 & 29) consists of a stacked stone wall adjacent to a limestone outcrop that together form a C-shaped enclosure. The enclosure is in an area of *kiawe* and grasses with numerous bulldozer push piles. The enclosure measures 1.5 m north-south and 2.4 m east-west. The stacked wall is 2.0 m long and 40 cm high.

No cultural material was observed on the surface. A 1 m by 1 m test unit in the center of the enclosure yielded no cultural material (see following Excavation Results Section discussion for Test Unit 3 and Figure 49).

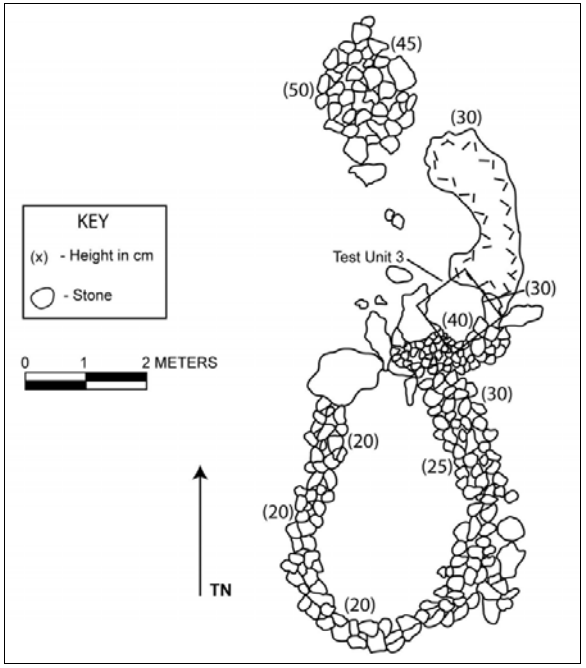

Figure 28. Plan view of site -6685



Figure 29. Photograph of site -6685, possible enclosure

SIHP Site #: 50-80-12-6686 A/B

Site Type: Mound complex

Function: Clearing

Features (#): 2

Age: Historic

Description: Site 50-80-12-6686 (Figures 30 to 32) consists of two mounds constructed of stacked limestone boulders and cobbles, designated Features A and B. These two features are the largest and best defined of a series of six stone mounds forming a roughly east-west line. These mounds are in an area of kiawe woods with areas of coral limestone outcrops and extensive bulldozer push piles. Due to the lack of cultural material and the surrounding clearance mounds, these mounds are interpreted to be the result of historic clearing activities.

Feature A, the western most mound (Figures 30 & 31), measures 3.2 m north-south and 3.6 m east west. The maximum height of this mound is 90 cm. The mound was bisected and found to lie directly on a coral limestone outcrop. No cultural material was observed.

Feature B, a smaller and less well-defined mound (Figures 30 & 32) to the east of A, measures 2.8 m north-south and 3.2 m east west. The maximum height of this mound is 90 cm. The mound was bisected and found to lie directly on a coral limestone outcrop. No cultural material was observed.

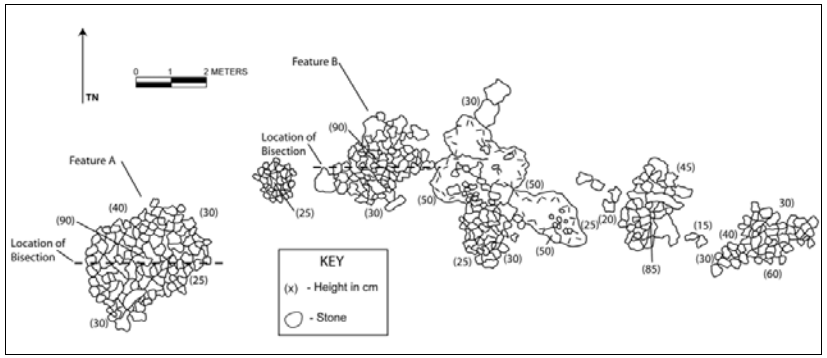

Figure 30. Plan view of site -6686 A/B



Figure 31. Photograph of site -6686, Feature A



Figure 32. Photograph of site -6686, Feature B

SIHP Site #: 50-80-12-6687

Site Type: enclosure with upright

Function: possible shrine

Features (#): 1

Age: pre-contact Hawaiian, disturbed in historic times

Description: Site 50-80-12-6687 (Figures 33 & 34) consists of a depression in the limestone bedrock, with a stacked stonewall along the eastern edge of the depression. The wall is constructed of limestone boulders averaging 40 to 50 cm across in size. Several stones are placed upright, including a tall one at the northeast corner of the wall. The enclosure is located in an area with extensive *kiawe* debris and many bulldozer push piles. Part of this site may have been disturbed in historic times.

The wall is 3.2 m long and averages about 60 cm high. The whole area of the enclosure is about 4 m across. The tall upright is 105 cm high. Cultural material on the surface included rusted metal cans, a bit of charcoal, and a basalt coffee bean sinker. A second coffee bean sinker was found within test unit 2 in the southwest portion of the enclosure (see following Excavation Results Section discussion for Test Units 2 & 5 and Figures 47, 48 & 51).

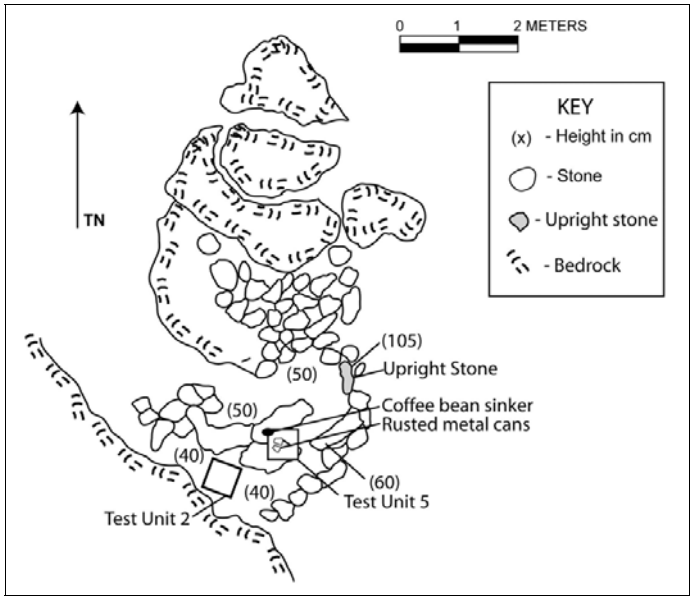

Figure 33. Plan view of site -6687



Figure 34. Photograph of site -6687, showing wall and upright

SIHP Site #: 50-80-12-6688

Site Type: Gilbert Trig Station

Function: Geographic marker

Features (#): 1

Age: Historic

Description: Gilbert Trig Station (Figure 35). Cement and aggregate slab square supported by two pylons of basalt boulders and cement. A central post supports four metal vanes perforated with large diameter holes.

Slab measures 10 cm thick and 1.6 m across and height is 109 cm. The pole extends up another 145 cm.

SIHP Site #: 50-80-12-6689

Site Type: Concrete flume

Function: Agriculture

Features (#): 1

Age: Historic

Description: Concrete flume running roughly north-south, constructed of basalt boulders and cement (Figures 36 to 38). An inscribed date of "June 1937" appears in the cement on the *mauka* end (Figure 38).

The flume measures 140 cm across and the interior channel measures 90 cm across and 60 cm deep. Large pieces of metal flume remains were also located in the general area, further *makai*.

Probably part of sugar cane cultivation infrastructure.



Figure 35. Photograph of site -6688, the Gilbert Trig Station, view to ESE

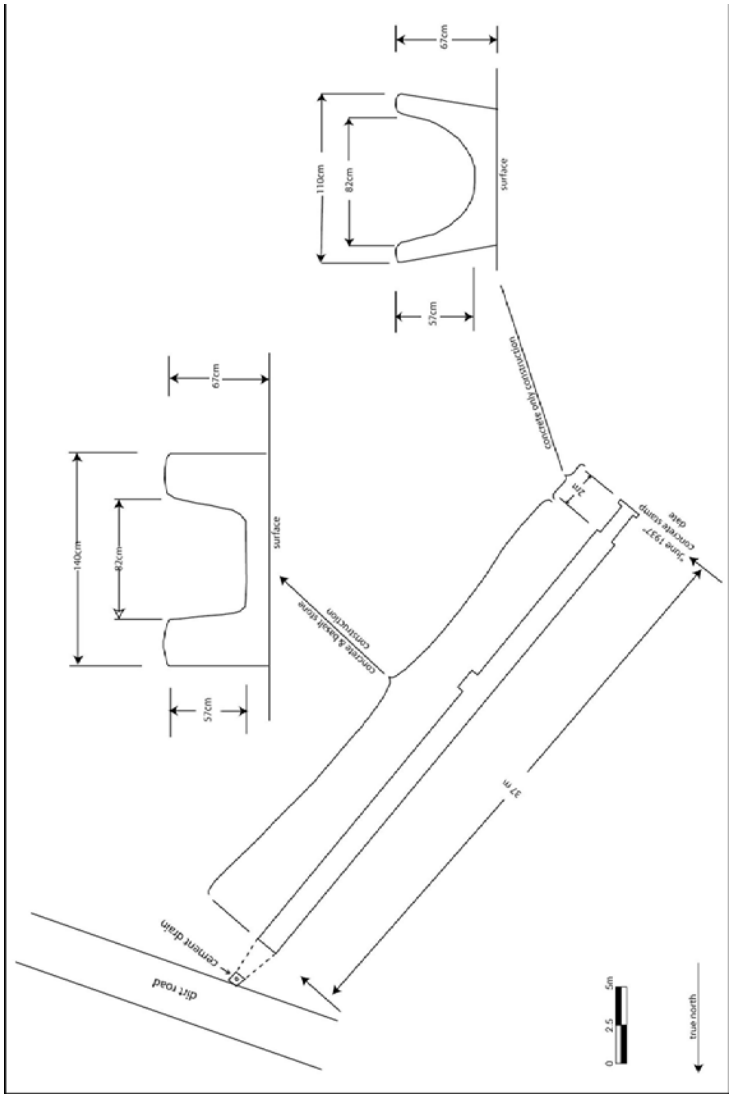

Figure 36. Plan view of site -6689



Figure 37. Photograph of site -6689, cement flume



Figure 38. Photograph of site -6689, showing engraved date

SIHP Site #: 50-80-12-9545

Site Type: Sink

Function: Habitation

Features (#): 1 (with internal features)

Age: unknown

Description: Site 50-80-12-9545 (Figure 39) has been previously described by Sinoto (1976), Olson and James (1982), and Hammatt et al. (1994:13) and is currently surrounded by a chain link fence for preservation. The most recent description states:

> The site is a large bell-shaped sinkhole with a modified interior including cleared areas, low terraces, fire pits, and a large *ahu* which was probably constructed to facilitate entry and egress. This site has been the focus of several archaeological and faunal studies and is presently surrounded by a chain link fence. Sinoto (1976) provides a discussion of some of his excavations at this site. The excavations are further discussed in Olson and James (1982).

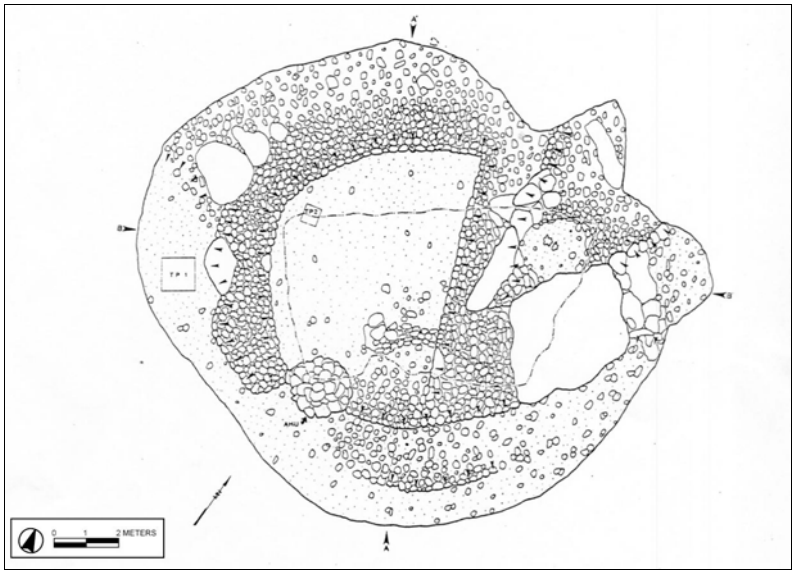

Figure 39. Plan view of site -9545, habitation sinkhole

SIHP Site #: 50-80-12-9546

Site Type: Wall

Function: Ranching, animal enclosure

Features (#): 1

Age: Historic

Description: Site 50-80-12-9546 (Figure 40) has been previously described by Lewis (1970:33-34), Barrera (1975:8), Sinoto (1976:16), and Hammatt et al. (1994:87). The wall most likely dates to ca. 1850-1870, the historic ranching period of the area. The most recent description states:

> State Site 50-80-12-9546... comprises a long wall.... The topography in the area consists of level limestone with shallow soil deposits. Vegetation in the vicinity includes kiawe, koa haole, and various grasses and weeds....
>
> The wall is oriented roughly E/W.... It has a maximum wall width of 0.9m. (3.0 ft.) and a maximum height of 1.1 m. (3.6 ft.). The wall is bifaced, constructed of fill. Towards the west terminus are several upright boulder limestone slabs forming the base of the wall. The wall is collapsed in some places and cut by bulldozed roads.

During the current field survey, the wall was observed to be intact only in small part, measuring approximately 110 m, bulldozing having destroyed most of the original wall.



Figure 40. Photograph of site -9546, historic wall

SIHP Site #: 50-80-12-9555

Site Type: Cist mound

Function: Storage (?)

Features (#): 1

Age: unknown

Description: Site 50-80-12-9555 (Figures 41 & 42) consists of a mound constructed of limestone boulders and cobbles with an open cupboard in the center. In the middle of the mound, four uprights delineate a square opening, which is capped with two slab lintel stones. It was previously described by Sinoto (1976:18): "Small, stacked slab *ahu*, enclosing an upright-slab cist. Measures 2.2 by 1.5 meters and 0.55 meters in height. Apparent roof slabs present. Possible burial" and Barrera (1975:19): "It is a mound constructed of horizontally placed coral slabs, and measures 2.4 by 2.3 meters. In the center of the feature is a vault formed by vertically placed coral slabs. The vault measures 65 by 80 cm and, and is roofed with horizontal coral slabs."

The only cultural materials observed on the surface were fragments of a single clear glass bottle. A 1 m by 1 m test unit excavated within the cupboard revealed limestone slabs lining the bottom of the opening, but no cultural material (see following Excavation Results Section discussion for Test Unit 1 and Figure 46).



Figure 41. Photograph of site -9555, cist mound

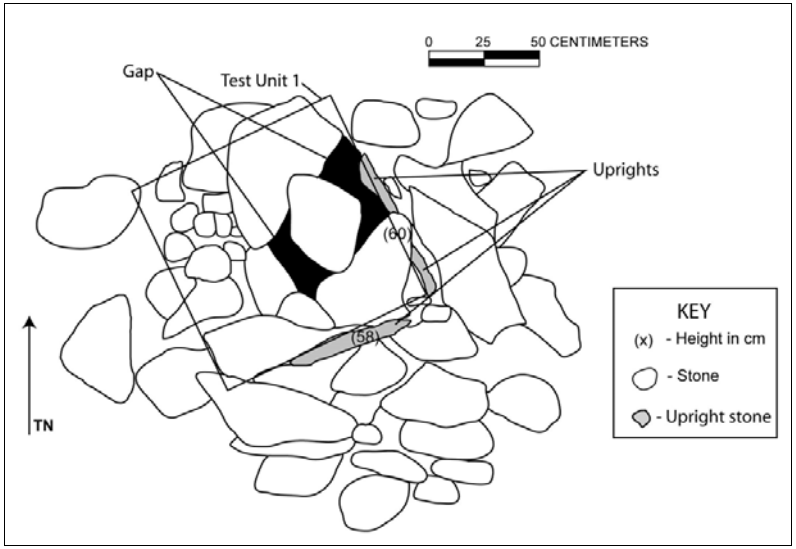

Figure 42. Plan view of site -9555

SIHP Site#: 50-80-12-9617

Site Type: Site complex

Function: Temporary habitation

Features (#): 2

Age: Pre-contact Hawaiian

Description: Site 50-80-12-9617 (Figures 43 & 44), consisting of two features (Features A and B) measures 7.5 m. (24.6 ft.) N/S by 8.5 m. (27.9 ft.) E/W, and was first identified in the Hammatt et al. 1994 study. The following description is from that report:

> State Site 50-80-12-9617…is a complex comprised of two features located on level limestone and soil terrain. Vegetation in the area includes kiawe, koa haole, and various grasses and weeds. The complex is located within a small vegetated area just northeast of State Site 9545 fenced sinkhole.
>
> Feature A comprises a platform measuring 3.5 m. (11.5 ft.) N/S by 4.0 m. (13.1 ft.) E/W with a maximum height of 0.3 m. (1.0 ft.). It is constructed of limestone boulders and cobbles and upright limestone slabs which delineate the interior paving. The platform has no visible facing aside from the upright limestone slabs.
>
> Feature B comprises a feature remnant located approximately 4.0 m. (13.1 ft.) northwest of Feature A. This feature measures 5.5 m. (18.0 ft.) N/S by 3.5 m. (11.5 ft.) E/W. Feature B has been partially destroyed by bulldozer push with little evidence of the feature remaining. Visible signs of cobble paving can be seen in the central portion of the remnant feature.
>
> Feature A platform is interpreted as a temporary habitation structure as indicated by its construction type. Feature B remnant probably served the same function as evidenced by the remnant cobble paving.

No midden or artifacts were observed on the surface of the complex, but a 1 m by 1 m test unit excavated within feature A yielded charcoal, marine shell, and a discoidal basalt hammer stone with battering evident on the entire circumference(see the following Excavation Results section for Test Unit 8 and Figures 54 & 55).

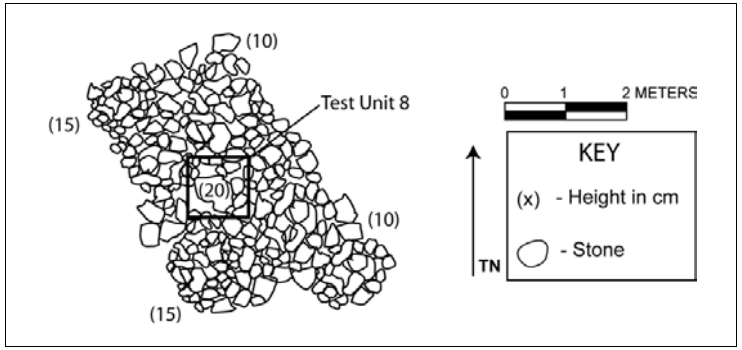

Figure 43. Plan view of site -9617A



Figure 44. Photograph of site -9617A, platform, view to southwest

SIHP Site #: 50-80-12-9633

Site Type: Cave

Function: Burial

Features (#): 1

Age: unknown

Description: Site 50-80-12-9633 (Figure 45) is currently surrounded by a chain link fence for preservation purposes. The site was previously described in Hammatt et al. (1994):

> State site 50-80-12-9633 comprises a burial cave located along the eastern edge of a recently quarried area in the northwest portion of the project area (Fig. 47). Topography consists of the quarry depression to the west of the site and level bulldozed limestone to the south, east, and north. Vegetation in the vicinity consists only of low weed growth in the bulldozed region. The site is located 24.5 m. (80.4 ft.) north of State Site 50-80-12-9545's west corner.
>
> The cave measures 11.8 m. (38.7 ft.) NE/SW by 7.0 m. (23.0 ft.) NW/SE with a maximum ceiling height of 2.0 m. (6.6 ft.). The cave has a level limestone ceiling and is partially filled with large boulders. Alcoves between the boulders contain soil and limestone rubble. Human modification includes a rough boulder wall retaining a soil deposit in an alcove in which the ceiling is 1.2 m. (3.9 ft.) above the soil level. Partially under a boulder overhang are exposed human remains consisting of metacarpal and scapula as well as rib fragments and other small fragments. Within 0.3 m. (1.0 ft.) of the remains is a piece of carved wood with a perforated edge. The wood measures 43 cm. (1.4 ft.) long and 10 cm. (0.3 ft.) wide. It is pointed at one end and is part of the gunnel of a wooden canoe. Other modifications include pebbles and cobbles piled on a large boulder measuring 3.0 to 4.0 m. (9.8 to 13.1 ft.) in diameter forming the south side of the soil deposit containing the human remains. East of this same soil deposit is a crude wall standing 0.5 m. (1.6 ft.) high and retaining a paved area approximately 1.0 m. (3.28 ft.) N/S by 1.5 m. (4.9 ft.) E/W. This paving may contain another burial. At the south corner of the cave is another possible paved area with mixed soil and limestone rubble piled 0.5 m. (1.6 ft.) high and measuring 1.5 m. (4.9 ft.) N/S by 2.0 m. (6.6 ft.) E/W. The present entrance is on the northwest side of the cave. This entrance has been recently opened by quarrying operations. The original entrance lies to the southwest and is still visible from the present ground surface, but has been filled in historic times with a large dirt pile which covers much of the southwest portion of the cave.
>
> One basalt water-worn pebble, possibly a hammer stone, sits on a shelf at the southwest end of the cave. Midden materials were not observed but may be present under the dirt pile at the southwest end.
>
> The cave functions as a burial as evidenced by the presence of human remains and accompanying materials as well as human modification throughout the cave.

> The site is in fair condition. It has been partly disturbed in that a previously nonexistent entrance was created when quarrying operations opened up the northwest side of the cave.

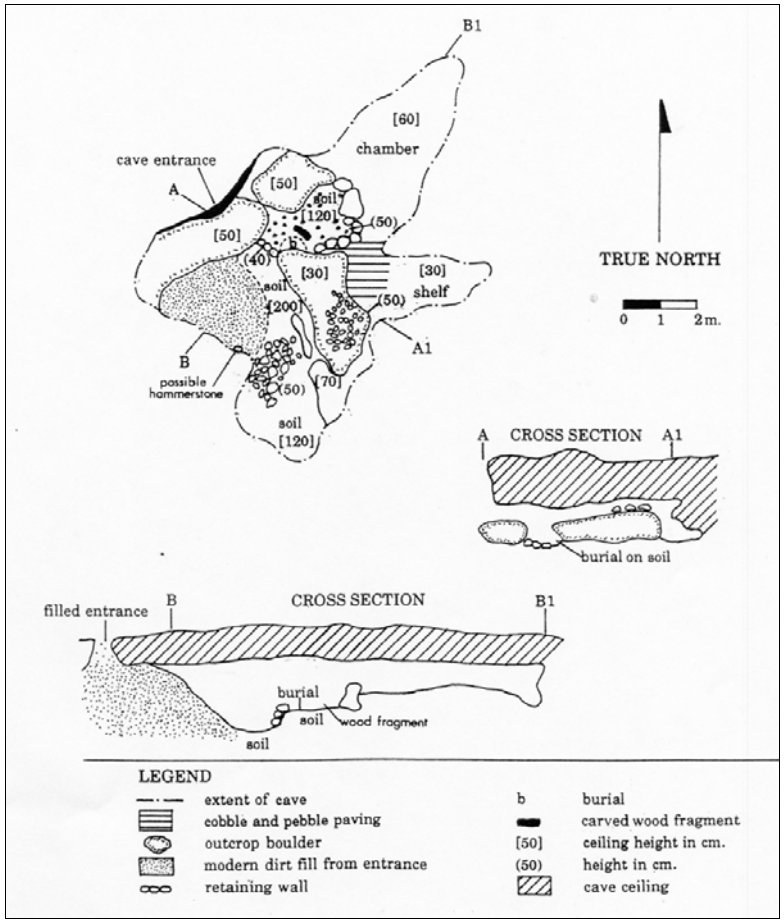

Figure 45. Plan view of site –9633, burial cave

SIHP Site #: 50-80-12-9714

Site Type: Railroad Alignment

Function: Transportation

Age: Historic

Description: Site 50-80-12-9714 consists of a portion of the O.R.&L Railroad berm which was formerly used to transport sugarcane from Wai'anae Sugar Company land to the 'Ewa Mill. The track was completed in 1898 when the line was extended around Ka'ena Point, linking Wai'anae with Waialua. The portion of the berm still present adjacent the project area extends along the north boundary of the project area. Presently, the Hawaiian Railway Society maintains the portion of the railway in the town of Ewa, and offers guided train rides on the old railway.

C. Excavation Results

The subsurface testing portion of the inventory survey was conducted from June 21-30, 2004 by four CSH archaeologists, and on May 19, 2005 by two CSH archaeologists. Sites previously identified during the field inspection were subsequently revisited, a tentative function was deduced, and the sites were mapped with nine test excavations carried out at eight sites to better determine site function (Table 4).

Table 4. Summary of Test Excavations by Site

Site	Test Units Excavated/Size of Unit(s)	Site Type
-4893	Test Unit 9, 1 m^2	Filled sinkhole
-4895	Test Unit 6, 1 m^2	Historic agricultural mounds
-4897	Test Unit 7, 1 m^2	Pre-contact agricultural site complex (4 circular mounds, 1 linear mound)
-6684	Test Unit 4, 1 m^2	Pre-contact temporary habitation (pavement with slab uprights on north and northeast edges)
-6685	Test Unit 3, 1 m^2	Pre-contact temporary habitation eenclosure
-6687	Test Units 2 & 5, both 0.5 m^2	Pre-contact enclosure with upright (possible shrine)
-9555	Test Unit 1, 1 m^2	Cist mound, possible storage age unknown
-9617	Test Unit 8, 1 m^2	Pre-contact temporary habitation site complex

Each unit was excavated by hand, conducted by cultural strata or in arbitrary 10 cm levels where cultural strata exceed 10 cm in thickness, and documented with scale profiles, photographs, and sediment descriptions. Samples of artifacts and sediments were taken. The following excavation results are presented consecutively by test unit number and include a description of the findings and stratigraphy each test unit.

1. Test Unit 1

SIHP Site 50-80-12-9555

Site -9555 was dismantled, removing the capstones and clearing the west and northwest sides of the mound. Two upright stones on the northwest and southwest sides of the cupboard opening were removed, and a single 1-meter by 1-meter test unit was made (Figure 46). Excavations revealed a stratum of silt loam. The stones that made up the interior portion of the mound were observed to extend below the soil surface to a depth of approximately 10 cm. Fragments of bottle glass were observed at the soil surface. No cultural material was observed during the test excavation. The test excavation was made down to the limestone bedrock at approximately 23/30cmbs. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-23/30 cmbs	7.5YR4/6 strong brown structureless silt loam, very fine, loose consistency, non plastic, few small roots and rootlets, limestone pebbles. No cultural material observed. Lower boundary is at limestone bedrock.

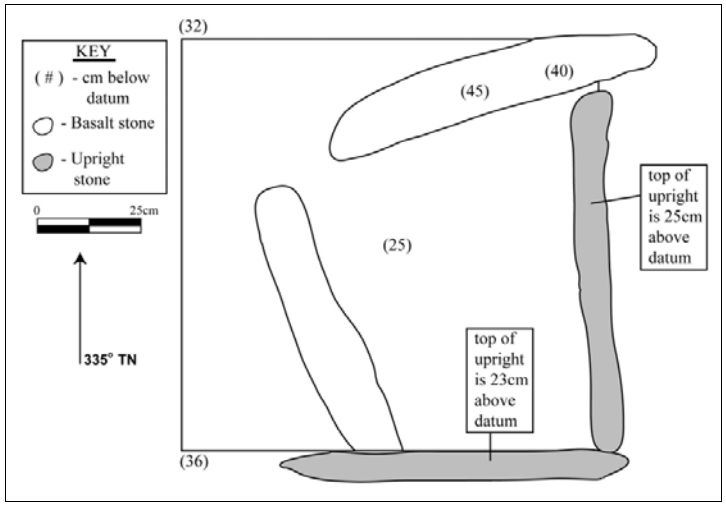

Figure 46. Plan view of test unit 1, site -9555, showing location of uprights before excavation

2. Test Unit 2

SIHP Site 50-80-12-6687

Two test excavations (Test Units 2 & 5) were excavated at Site –6687. Test Unit 2 was a 0.50-meter by 0.50-meter test unit excavation (Figure 47). A stacked wall, with a small amount of cement and cobbles was observed on the east side of the test unit. Cultural material on the surface included rusted metal cans, a bit of charcoal, and a basalt coffee bean sinker (Figure 48). A second coffee bean sinker was found within the test unit in the southwest portion of the enclosure at 15cmbd, among cobbles just below the level of cement. The coral cobbles that made up the interior portion of the mound were observed to end at the soil surface. Excavations revealed an O-Horizon of silt loam and decomposing leaf litter overlying a silt loam sediment. The limestone bedrock was encountered at approximately 24-29cmbs. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-9/15 cmbs	O horizon; 7.5YR2.5/2 very dark brown silt loam; structureless; dry, loose consistency; organic sediments, limestone cobbles and boulders. Rusted can and glass fragments observed; LB is abrupt, smooth. 2 coffee bean sinkers found, one on surface in southwest corner of unit, and one at 40 cmbd.
Stratum II	1/15-24/29	7.5YR4/6 strong brown silt loam, structureless; dry, loose consistency; few roots and rootlets; no cultural material observed; Lower boundary is at limestone bedrock

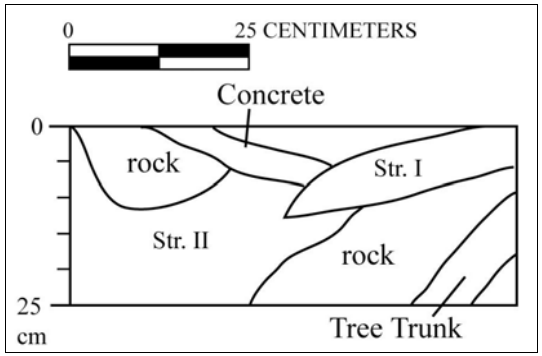

Figure 47. Profile of test unit 2, site -6687, view to north



Figure 48. Photograph of coffee bean sinkers from test unit 2, site -6687

3. Test Unit 3

SIHP Site 50-80-12-6685

This site consists of a stacked stone wall adjacent to a limestone outcrop that together form a C-shaped enclosure. A 1-meter by 1-meter test unit was excavated, yielding no cultural material on the surface or in the unit. Excavations revealed two strata of silt loam (Figure 49). Limestone bedrock was encountered at approximately 73/115 cmbd. Detailed sediment descriptions are as follows:

Strata	Depth (cmbd)	Description
Stratum I	42/56-55/64 cmbd	7.5YR2.5/2 very dark brown silt loam; fine, loose consistency; organic sediments, abundant rootlets and leaf litter, lower boundary clear, wavy, no cultural material observed.
Stratum II	55/64-73/115 cmbd	10YR7/4 very pale brown fine silt, structureless; dry, friable, non-cement consistency; few roots and rootlets, 35-40% pebble inclusions, no cultural material observed; Lower boundary is at limestone bedrock

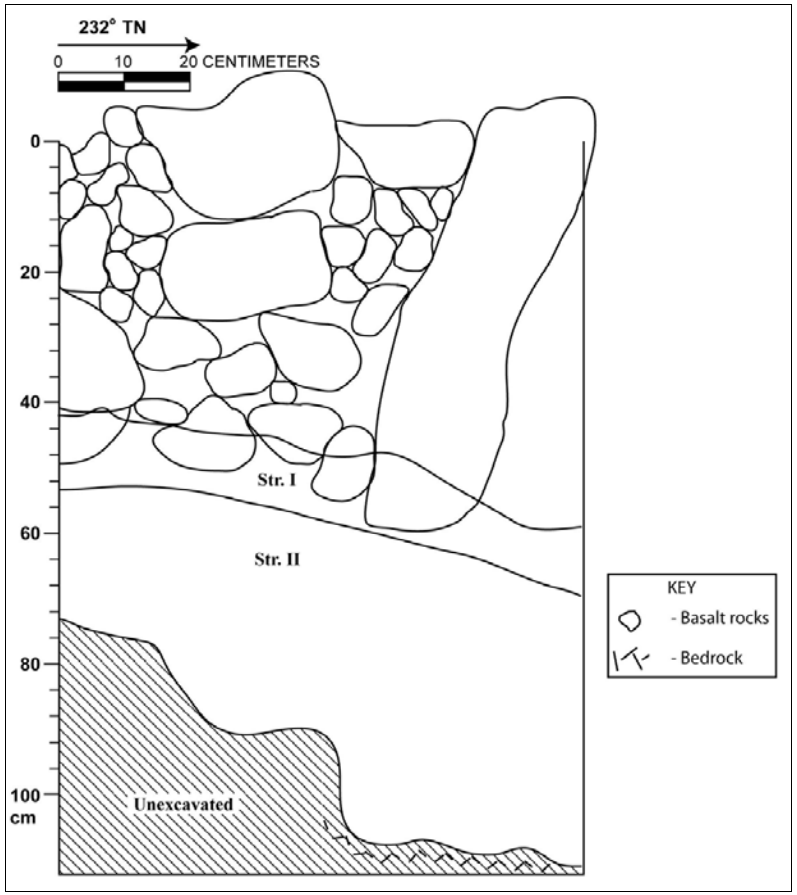

Figure 49. Profile of test unit 3, site -6685

4. Test Unit 4

SIHP Site 50-80-12-6684

The surface of the test unit consisted of a pavement of limestone cobbles. Two limestone slab uprights delineated the north and northeast edges. The pavement stones and uprights were removed and a single 1-meter by 1-meter test unit was excavated. Excavations revealed two strata of silt loam (Figure 50). No cultural remains were observed on the surface. A single basalt flake at 7cmbs and a very small amount of midden, consisting of two marine shells at 8-9cmbs were observed. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-25/36 cmbs	7.5YR3/2 dark brown silt loam; structureless; dry, loose consistency; organic sediments, 90% limestone cobbles and cobble pavement. One basalt flake at 7 cmbs, 2 marine shells at 8-9cmbs.
Stratum II	25/36-41/60 cmbs	7.5YR5/6 strong brown silt loam, weak, medium, crumb structure; dry, loose consistency; 20-35% limestone pebbles and cobbles; lower boundary is at limestone bedrock

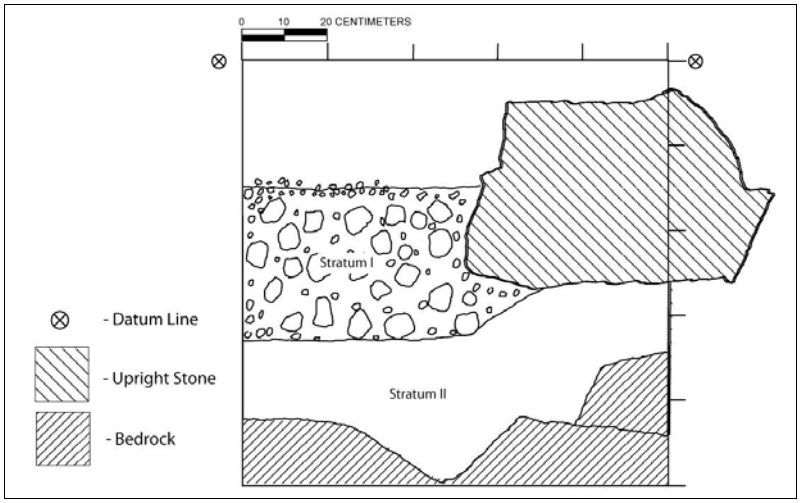

Figure 50. Profile of test unit 4, site -6684, view to north

5. Test Unit 5

SIHP Site 50-80-12-6687

Two test excavations (Test Units 2 & 5) were excavated at Site –6687. Test Unit 5 was a 0.50-meter by 0.50-meter test unit. Cultural material on the surface of the test unit included rusted metal cans and can fragments. A historic fire pit at approximately 10-15 cmbs was observed and a charcoal sample was taken and sent for accelerator radiocarbon dating (Table 5). One basalt flake and a small amount of *opihi* shell were found at approximately 22cmbs. The limestone bedrock was encountered at approximately 50/81cmbs. Detailed sediment descriptions (Figure 51) are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-10 cmbs	5YR2.5/2 dark reddish brown silt loam; weak, granular structure, dry, loose consistency.
Stratum II	10-29/32 cmbs	10YR4/4 dark yellowish brown silt, structureless; dry, loose consistency, non-plastic, charcoal-historic fire-pit remnants, two shells and one basalt flake observed.
Stratum III	29/32-50/81 cmbs	10YR6/6 brownish yellow silt, weak crumb structure, non-plastic, no cultural material observed. Lower boundary is at limestone bedrock.

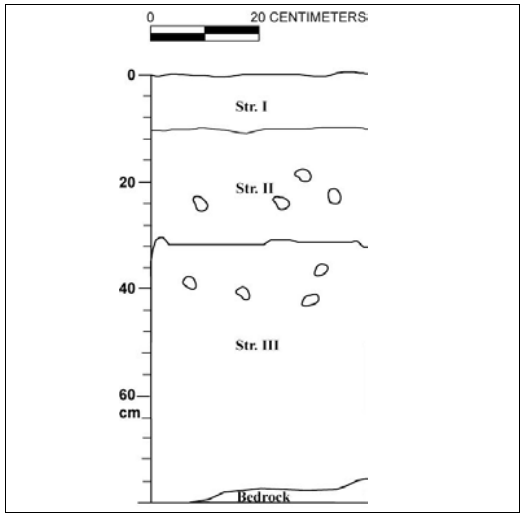

Figure 51. Profile view of test unit 5, site -6687, view to west

Radiocarbon Analysis Results from Site -6687

The charcoal sample KAPO8-1 was collected at 10-15 cm below the surface from stratum II soil of Test Unit 5 at Site -6687, which was described as 10YR4/4 dark yellowish brown silt, structureless and non-plastic, with a dry, loose consistency.

The carbon sample (Table 5) yielded a conventional age of 190+/-40 years BP (Before Present). The Ox-Cal calibration resulted in a multiple probability date range, with a 50.6 % probability of being between 1720 and 1820 AD, a 22.2 % probability of being between 1640 to 1710 AD, a 15.3% probability of being between 1910 and 1960 AD, and a 7.3% probability of being between 1830 and 1890 AD.

In conclusion, the radiocarbon age ranges do not provide much information on the date of the fire pit. The sample has a wide date range from AD 1640 to 1960, indicating that the fire pit could date to the late pre-contact period, the early post-contact period, or even up to the late 20th century. It may have been built earlier but disturbed in the first half of the 20th century.

Table 5. Ox-Cal Calibration Results for Sample from Site -6687

Sample No.	Beta No.	Service	Measured Age	13C/12C	Conventional Age	Ox-cal Calibration (1 Sigma)
KAPO8-1	193921	AMS-Advance Delivery	170 +/- 40 BP	-23.5 o/oo	190 +/- 40 BP	AD 1720-1820 (50.6% probability) AD 1640-1710 (22.2% probability) AD1830-1890 (7.3% probability) AD1910-1960 (15.3% probability)

6. Test Unit 6

SIHP Site 50-80-12-4895

A 1-meter by 1-meter test unit was excavated within feature A of the site (Figure 52). Feature A is an amorphous mound located on level limestone terrain with shallow soil. The surface of the test unit consisted of cobbles and boulders roughly piled atop outcrop protrusions. The cobbles and boulders were removed and a single test unit was made. Excavations revealed three strata of silt loam, with the third having a substratum containing 70-80% limestone cobbles. No cultural remains were observed on the surface or within the unit. The limestone bedrock was encountered at approximately 40-45cmbd. Detailed sediment descriptions are as follows:

Strata	Depth (cmbd)	Description
Stratum I	5-15 cmbd	10YR2/2 very dark brown silt loam; weak, medium granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; terrestrial sediments; clear, smooth boundary.

Stratum II	20-30 cmbd	7.5YR3/4 dark brown silt loam, weak, fine, granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; terrestrial sediments; clear, broken boundary.
Stratum III	30-40 cmbd	10YR4/4 dark yellowish brown silt loam, weak, fine, granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; mixed terrestrial/marine sediments; clear, wavy boundary.
Stratum IIIB	40-45 cmbd	10YR4/4 dark yellowish brown silt loam, weak, fine, granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; mixed terrestrial/marine sediments; clear, wavy boundary; 70-80% limestone cobbles.

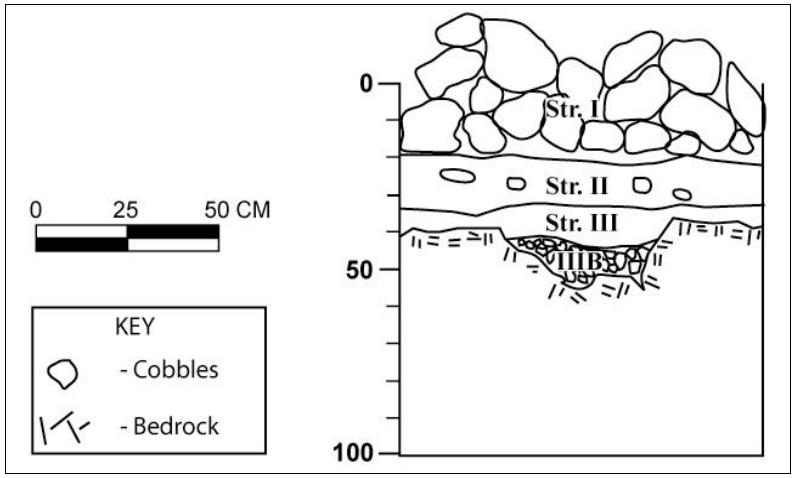

Figure 52. Profile view of test unit 6, site -4895, view to north

7. Test Unit 7

SIHP Site 50-80-12-4897

A 1-meter by 1-meter test unit was excavated within Feature A of the site complex (Figure 53). Feature A is a linear mound measuring 4.0 m. (13.1 ft.) NE/SW by 1.0 m. (3.28 ft.) NW/SE with a maximum height of 0.5 m. (1.6 ft.). It is constructed of small boulder and cobble mix piled atop

outcrop. The mound's southwest terminus lies amidst bulldozer push. The cobbles and boulders were removed and a single test unit was made. Excavations revealed two strata of silt loam. Samples of coral bedrock masses measuring approximately 6-10 cm in diameter were encountered at approximately 53-54cmbd. The limestone and coral bedrock was encountered at approximately 41/60cmbd. No artifacts or midden were observed on the surface of the complex, and the test unit revealed no cultural material. Detailed sediment descriptions are as follows:

Strata	Depth (cmbd)	Description
Stratum I	0-36 cmbd	10YR2/2 very dark brown silt loam; weak, medium granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; terrestrial sediments; clear, smooth boundary.
Stratum II	36-54 cmbd	7.5YR3/4 very dark brown silt loam; weak, fine granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; terrestrial sediments; clear, broken boundary.

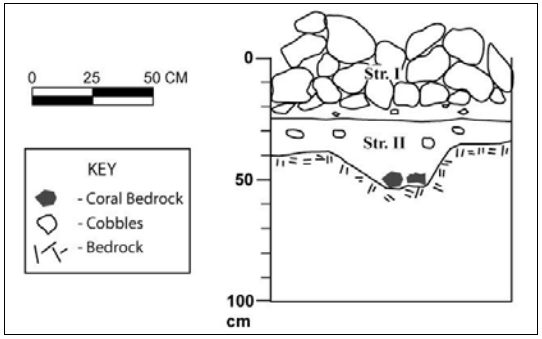

Figure 53. Profile view of test unit 7, site -4897, view to north

8. Test Unit 8

SIHP Site 50-80-12-9617

A 1-meter by 1-meter test unit was excavated within Feature A of the site complex (Figure 54). Feature A is a platform measuring 3.5 m. (11.5 ft.) N/S by 4.0 m. (13.1 ft.) E/W with a maximum height of 0.3 m. (1.0 ft.). It is constructed of limestone boulders and cobbles and upright limestone slabs which delineate the interior paving. The platform has no visible facing aside from the upright limestone slabs. The cobbles and slabs were removed and a single test unit was made. Excavations revealed three strata of silt loam. The limestone bedrock was encountered at approximately 80/90cmbd. Detailed sediment descriptions are as follows:

No cultural remains were observed on the surface, but marine shell midden deposits from 45-80cmbd and charcoal deposits from 60-70cmbd were observed. A single bird bone was found at 49cmbd. A basalt discoidal hammer stone was encountered at 55cmbd (Figure 55). Detailed sediment descriptions are as follows:

Strata	Depth (cmbd)	Description
Stratum I	0-50 cmbd	10YR3/3 dark brown silt loam; weak, medium granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; terrestrial sediments; abrupt, smooth boundary; marine shell midden deposits encountered at 45cmbd, single bird bone encountered at 49cmbd.
Stratum II	50-60 cmbd	7.5YR4/6 strong brown silt loam; weak, fine granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; terrestrial sediments; abrupt, irregular boundary; marine shell midden throughout; basalt discoidal hammer stone encountered at 55cmbd.
Stratum III	60-90 cmbd	7.5YR5/6 strong brown silt loam; weak, fine granular structure; dry, loose, non-sticky consistency; non-plastic; no cementation; terrestrial sediments; abrupt, irregular boundary; marine shell midden from approximately 60-80cmbd; charcoal deposits from approximately 60-70cmbd.

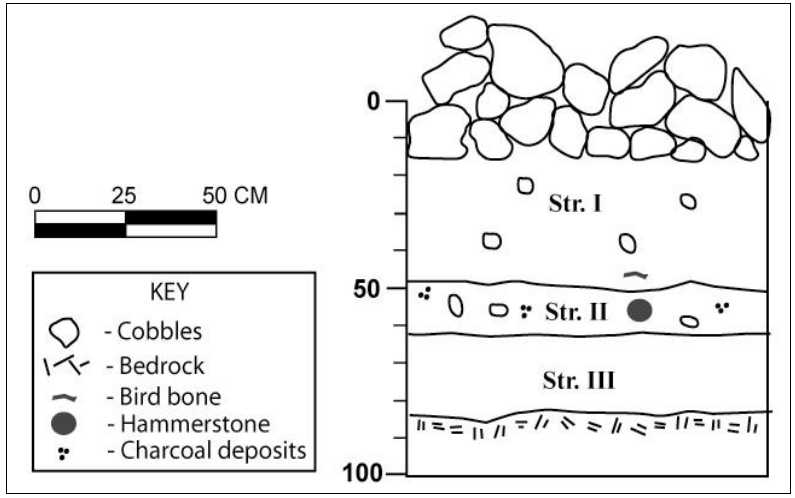

Figure 54. Profile view of test unit 8, site -9617, view to north



Figure 55. Photograph of basalt hammer stone from test unit 8, site -9617

9. Test Unit 9

SIHP Site 50-80-12-4893

One test excavation (Test Unit 9) was made within Site –4893. Test Unit 9 consisted of a 1 m by 1 m test excavation within the central portion of the site (Figures 1 and 2). The surface of the test unit consisted of a slightly sloping, leaf litter covered, limestone cobble and pebble pavement. An approximately 10 cm diameter depression within the pavement and observed hollow interior cavity indicated the site was a filled sinkhole. No surface cultural material was observed. Excavation of the limestone cobble and pebble pavement revealed a relatively small, approximately 65 cm deep, sinkhole (Figure 3). The lateral extent of the sinkhole was beyond the limits of the test excavation, though it is not likely to extend beyond the observed surface pavement. The sinkhole was observed to be initially filled with larger limestone boulders, then infilled with smaller limestone cobbles and pebbles. Stratum I consisted of decomposing leaf litter on the surface of the pavement and diffusing down through the stone fill. Stratum II consisted of yellowish red silt on the surface of the limestone bedrock, outside of the sinkhole cavity. Stratum III consisted of a dark brown silt loam at the base and outer edge of the sinkhole cavity. Limestone cobbles were not observed within Stratum III at the base of the sinkhole, indicating these sediments were deposited prior to the filling of the sinkhole. No cultural material was observed during the excavation of Test Unit 9. Detailed sediment descriptions are as follows:

Strata	Depth (cmbd)	Description
Stratum I	15/22-17/25	O horizon (decomposing leaf litter); 10YR 3/2 very dark grayish brown silt loam; structureless; dry, loose consistency; non-plastic; no cementation; terrestrial origin; Lower Boundary (LB) is diffuse, irregular.
Stratum II	20/22-41/50	5YR 4/6 yellowish red silt; moderate, medium crumb structure; dry, slightly hard consistency; non-plastic; no cementation; includes few roots and rootlets; no cultural material observed; LB is at limestone bedrock.
Stratum III	50/54-BOE	10YR 3/3 dark brown silt loam; structureless; dry, slightly hard consistency; non-plastic; no cementation; includes abundant rootlets; no cultural material observed; LB is at base of excavation at limestone bedrock.

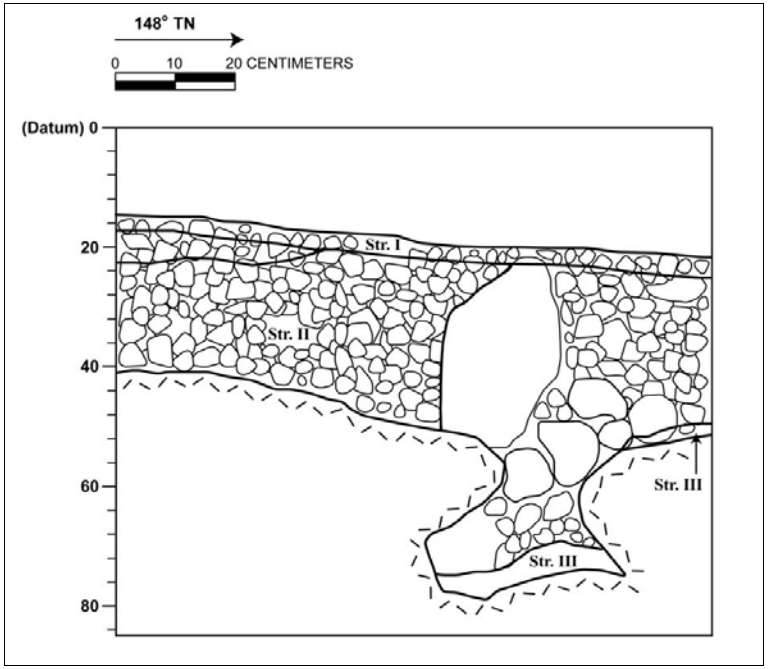

Figure 56. Profile view of test unit 9, site -4893

VI. SUMMARY

The approximately 124 acre project area lies south of the O.R.&L. alignment, west of Kalaeloa Blvd., and north and east of the Barber's Point Harbor in the Kapolei area of Honouliuli Ahupua'a, 'Ewa District, southwestern O'ahu. The project area lies mostly in the northwest section of the 227-acre TMK 9-1-14:33 parcel. Within the western half of the project area are two archaeological preserves delineated with chain-link fencing and marked as restricted. The larger of the two marks off a burial cave designated SIHP site -9633. The second preserve protects a very large sinkhole with cultural remains that was designated SIHP site -9548.

Approximately two-thirds of the current project area has been heavily impacted by construction activities. This includes bulldozing of large areas associated with construction of the O.R.&L. Alignment, the Ko'olina Golf Course, and grading associated with the coral quarry south of the project area, which extends into the eastern central part of the project area. These areas were determined to contain no features of historic significance.

Portions of the project area were found to be undisturbed to moderately disturbed by bulldozing and other modern activities, and include wooded areas of *kiawe* and scattered banyan. Within these areas, intact historic properties were found, both of pre-contact and post-contact dates. These archaeologically significant areas include a relatively large wooded area in the center of the project area, and two smaller wooded patches just west of this and to the east of the Gilbert Trig Station. In addition, the Gilbert Trig Station and a large irrigation canal are preserved historic properties in otherwise bulldozed areas. In total, 19 sites were identified by CSH during the field inventory. Thirteen of these sites already had SIHP site numbers and six new sites were recently assigned SIHP site numbers (-6684 to –6689).

The predicted settlement pattern indicated that the vicinity of the project area was utilized in ancient times mostly for bird hunting, sinkhole agriculture, and temporary habitation, with a couple of known instances of human burial. The intensity of land use was anticipated to have been higher nearer the coast with significantly less intensive use in more inland areas of the coastal plains such as the vicinity of the present study area. The nineteen sites within the project area include ten sites associated with agriculture and/or ranching, six habitation sites, 1 burial site (identified and designated for preservation long ago), 1 transportation site (the O.R.&L.) and 1 marker (Gilbert Trig Station). In general finds conformed to expectations.

A. Agriculture and/or Ranching Sites

The ten sites associated with agriculture and/or ranching included sites -4893, -4895, -4897, -4898, -4900, -6679, -6686, -6689, -6546, and -9555. These include a variety of site types serving a variety of functions. Site 4893 is understood as most likely a sinkhole filled in for safety purposes and as most probably associated with ranching. Sites -4895, -4897, -4898, -6686 are understood as primarily clearing mounds associated with traditional subsistence agriculture while sites -6679 and -6689 are irrigation canals associated with sugar cane cultivation ca. 1937 and sites -4900 and -9546 is associated with ranching. The cist mound, Site -9555, most likely served as a cupboard associated with traditional agriculture.

B. Habitation Sites

The six habitation sites included temporary habitation sites -4896, -6684, -6685, -6687, and -9617 and the very large sinkhole site -9545 which may have had a permanent habitation function (and was recommended for preservation long ago). Site -6687 was anomalous for the presence of an upright (see Figures 33 & 34) and the presence of two coffee bean octopus lure sinkers (*lū he'e;* Figure 48) and may have had a function as a small shrine. The paucity of midden and general paucity of artifacts suggest that these sites were of the nature of single-use or possibly recurrent-use shelters with relatively little occupational history represented.

C. Other Site Functions

Three other site functions were present within the site assemblage. Site -6688 designates the Gilbert Trig Station which serves as a geographic marker and is understood to relate to a train stop and small plantation camp that briefly stood near the marker in the early twentieth century.

The sinkhole site -9633 functions as a burial interment site and has long been recommended for preservation. This is the only known burial site within the present project area.

The O.R. &L. alignment, site -9714 was regarded as of sufficient historic merit to be placed on the National Register in 1975 and this stretch of railroad is used today for educational and recreational purposes.

D. Dating of the Sites

The sites within the project area are understood to date from late pre-contact times up to the early twentieth century. Only one carbon date was recovered (from Site -6687) but this sample yielded a date range from very late pre-contact times (1720) right up to modern times. It seems probable that early sites were established on the coast with relative use of the hinterlands of the present project area increasing over time right into the post-contact period.

VII. SIGNIFICANCE AND RECOMMENDATIONS

A. Significance

A total of 19 sites (13 of which were previously designated) of varied archaeological significance are present in the project area. Individual significance and recommended treatment are specified in Table 6. Sites were evaluated for significance according to the broad criteria established for the National and State Registers. The five criteria are:

A	Site reflects major trends or events in the history of the state or nation.
B	Site is associated with the lives of persons significant in our past.
C	Site is an excellent example of a site type.
D	Site may be likely to yield information important in prehistory or history.
E	Site has cultural significance; probable religious structures and/or burials present.

All 19 sites are all considered Significant under Criterion D for information content. Four sites are significant under multiple criteria. Sites –4896 A/B, the temporary habitation and agricultural complex, and -9545, the large sinkhole with habitation structures, are excellent examples of a site type (Criterion C). The burial sink - Site -9633 - is an excellent example of a site type (Criterion C) and is considered culturally significant (Criterion E) because of the occurrence of human remains. The O.R.&L. right of way, site -9714, is considered significant under criteria A, B, C, and D.

B. Recommendations

The majority of the project area is free of archaeological concerns. Much of the area has been bulldozed, and part of the project area is currently a limestone quarry. Seven sites warrant further consideration in our opinion. SIHP site -4896 Features A and B are two large sinkholes containing cultural materials that we are recommending for data recovery prior to any development of this immediate area, SIHP site -6687 is an enclosure with an upright that may be a shrine and we are recommending consultation with the State Historic Preservation Division to determine if preservation is appropriate. SIHP site –9617 is a platform we are recommending preservation of, due to the presence of midden deposits and a basalt hammer stone, and its proximity to the preserved fenced sinkhole site –9545. The Gilbert Trig Station (site –6688) is an historic geographical marker located along the O.R.&L. railway that should be preserved as it continues to function in its original purpose.

Three of the seven sites that warrant further consideration in our opinion have been recommended for preservation of long standing. Two of these are SIHP sites -9633, a burial cave, and -9545, a large sinkhole used as a traditional Hawaiian habitation site. Both of these sites are already under archaeological preservation, and should remain fenced off and protected from further development. The third is the O.R.&L. railway (site -9714), which runs along the north side of the current project area and was added to the National Register of Historic Places in 1975. As noted earlier, this railway alignment was developed beginning in 1886 and played a large role in the sugar industry in this part of O'ahu. Currently, it is a functioning railway used for historic and educational tours. In addition to the archaeological concerns located within the project area, any further development should take this national historic site into consideration. Table 6 and Figure 57 summarize the sites identified, the work completed on these sites, and recommendations for further work. The prefix for all these state site numbers is 50-80-12.

Table 6. Summary of Sites Identified, Work Completed, and Recommendations

SIHP Site #	Previously Identified?	Nature of Site	Posited Function	Work Accomplished	Significance	Recommendation
-4893	Hammatt et al. 1994	Pavement	Filled sinkhole (safety filling assoc. with ranching or military)	L, M, P, D, T	D	No further work
-4895	Hammatt et al. 1994	Mounds	Agriculture (agricultural clearing)	L, M, P, D, T	D	No further work
-4896 A/B	Hammatt et al. 1994	Site complex	Temporary habitation, agriculture	L, M, P, D, T (tested in 1994)	C, D	Data Recovery/ Preservation
-4897 A/B/ C/D	Hammatt et al. 1994	Site complex	Agriculture	L, M, P, D, T	D	No further work
-4898	Hammatt et al. 1994	Mounds	Agriculture	L, M, P, D	D	No further work, as has been destroyed by bulldozing activities
-4900 A/B/ C	Hammatt et al. 1994	Wall and 2 sinkholes	Agriculture	L, M, P, D	D	No further work, as wall is in remnant condition and sinkholes have been destroyed by bulldozing activities
-6679	O'Hare et al. 2004	Canal	Plantation flood control	L, M, P, D	D	No further work
-6684	Designated in present study	Pavement with slab uprights	Temporary habitation	L, M, P, D, T	D	No further work
-6685	Designated in present study	Enclosure	Temporary habitation	L, M, P, D, T	D	No further work
-6686 A/B	Designated in present study	Mound complex	Agricultural clearing	L, M, P, D, T	D	No further work

SIHP Site #	Previously Identified?	Nature of Site	Posited Function	Work Accomplished	Significance	Recommendation
-6687	Designated in present study	Enclosure with upright	Possible shrine	L, M, P, D, T	D	Consultation with SHPD regarding Preservation
-6688	Designated in present study	Gilbert Trig Station	Geographic marker	L, M, P, D	D	Preservation
-6689	Designated in present study	Concrete flume	Agriculture (Sugar cane irrigation)	L, M, P, D	D	No further work
-9545	Lewis 1970 Sinoto 1976, Olson & James 1982, Hammatt et al. 1994	Sinkhole	Habitation	L, M, P, D, T (tested in 1976)	C, D	Preservation
-9546	Lewis 1970, Barrera 1975, Sinoto 1976, Hammatt et al. 1994	Wall	Ranching, animal enclosure	L, M, P, D	D	No further work
-9555	Barrera 1975, Sinoto 1976	Cist mound	Storage (?)	L, M, P, D, T	D	No further work
-9617 A/B	Sinoto 1976, Hammatt et al. 1994	Site complex	Temporary habitation	L, M, P, D, T	D	Preservation
-9633	Sinoto 1976, Hammatt et al. 1994	Cave	Burial	L, M, P, D, T	C, D, E	Preservation
-9714	Placed on National Register 1975	O.R.&L. right of way	Transportation	L, M, P, D	A, B, C, D	Preservation

L=Located with a GPS, M. = Mapped, P = Photographed, D=Described, T=Tested

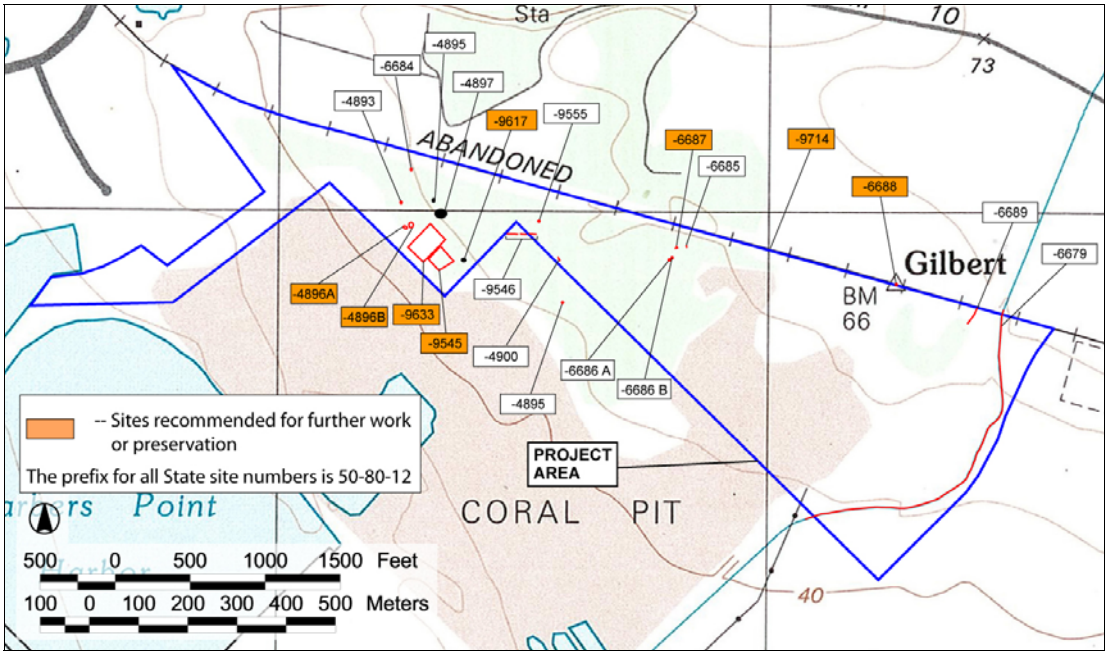

Figure 57. Map of the project area, showing location of sites recommended for further work or preservation

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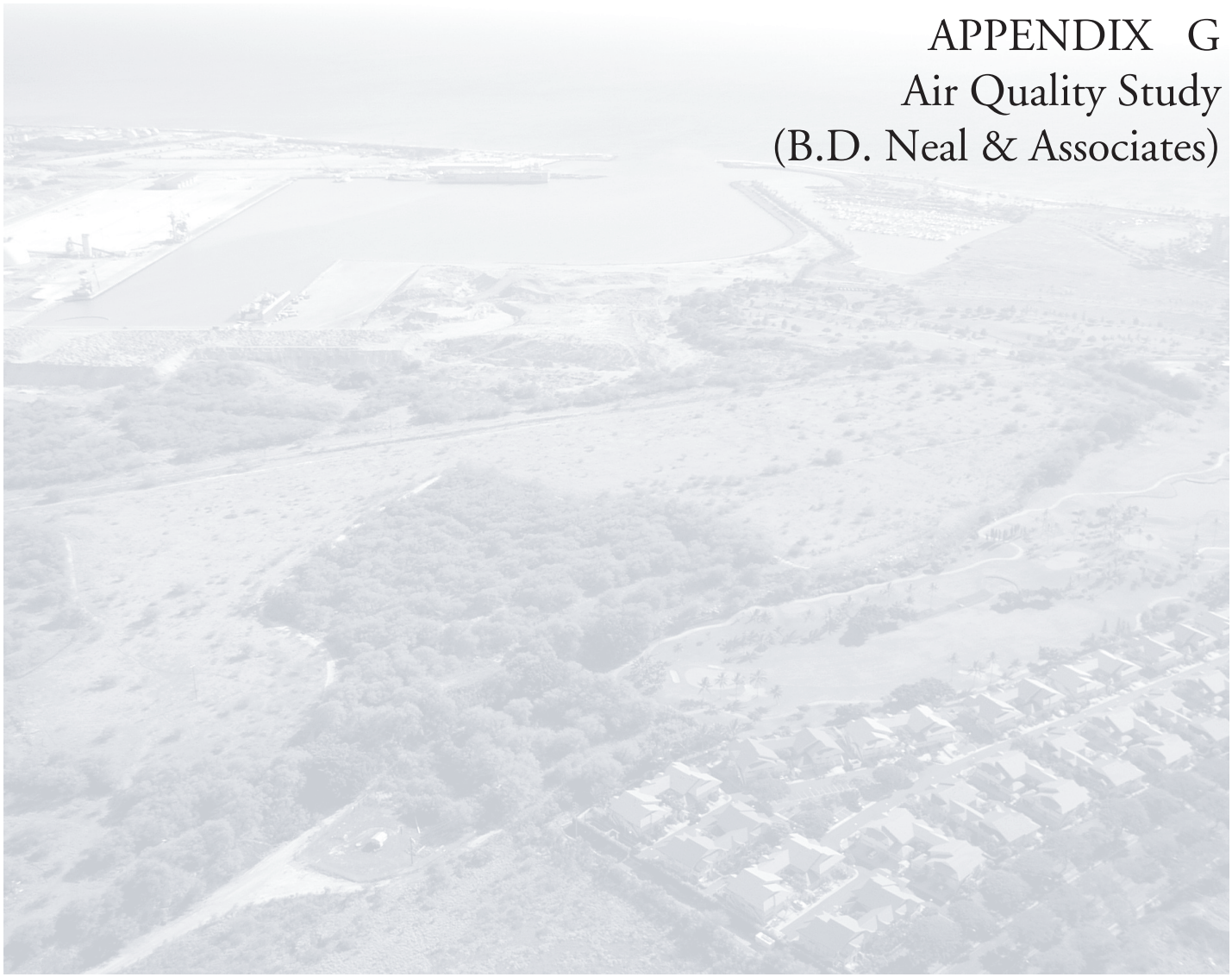

APPENDIX G
Air Quality Study
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AIR QUALITY STUDY

FOR THE PROPOSED

KAPOLEI WEST PROJECT

KAPOLEI, OAHU, HAWAII

Prepared for:

Helber Hastert & Fee, Inc.

March 2005

CONTENTS

Section		Page
1.0	Summary	1
2.0	Introduction	5
3.0	Ambient Air Quality Standards	5
4.0	Regional and Local Climatology	7
5.0	Present Air Quality	11
6.0	Short-Term Impacts of Project	15
7.0	Long-Term Impacts of Project	17
	7.1 Roadway Traffic	17
	7.2 Electrical Demand	29
	7.3 Solid Waste Disposal	29
8.0	Impacts on Project from Campbell Industrial Park	28
9.0	Conclusions and Recommendations	29
References		32

FIGURES

Figure	
1	Project Location Map

TABLES

Table	
1	Summary of State of Hawaii and National Ambient Air Quality Standards
2	Annual Wind Frequency for Honolulu International Airport
3	Air Pollution Emissions Inventory for Island of Oahu, 1993

TABLES(cont.)

Table	
4	Annual Summaries of Ambient Air Quality Measurements for Monitoring Stations Nearest Kapolei West Project
5	Estimated Worst-Case 1-Hour Carbon Monoxide Concentrations Along Roadways Near Kapolei West Project
6	Estimated Worst-Case 8-Hour Carbon Monoxide Concentrations Along Roadways Near Kapolei West Project
7	Estimated Indirect Air Pollution Emissions from Kapolei West Project Electrical Demand
8	Estimated Indirect Air Pollution Emissions from Kapolei West Project Solid Waste Disposal Demand

1.0 SUMMARY

Aina Nui Corporation is proposing to develop the West Kapolei Project at Kapolei, Oahu. The proposed project will consist of a total of 2,370 residential units, a 23-acre regional commercial area, a transit/mixed-use development on 16 acres, a 2-acre neighborhood commercial center, a golf course, an elementary school, 25 acres of public park facilities, and 47 acres of roads and open space. Development of the project is not expected to be completed and fully occupied until sometime after 2020. 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. Potential impacts on the project from nearby industrial sources are also examined.

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 Kapolei 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 will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, an air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are within both the state and the national ambient air quality standards. In the year 2020 without the project, carbon monoxide concentrations were predicted to remain largely unchanged despite an expected increase in traffic. This is because average motor vehicle emissions are expected to continue to decrease over time as older, more-polluting vehicles are retired. With the project in the year 2020, carbon monoxide concentrations were estimated to

increase slightly at the intersection of Kapolei Parkway and Kalaeloa Boulevard compared to the without-project case, while other locations would remain nearly unchanged. Worst-case concentrations should remain well within both national and state standards. Due to the small impact the project is expected to have, implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any impacts will likely be negligible. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts.

In evaluating the proposed project, it may be appropriate to consider not only impacts created by the project but also potential impacts on the project from nearby industrial sources. Due to the relatively close proximity of industries located at Campbell Industrial Park, occasional impacts on the project from emissions emanating from these facilities may occur in conjunction with coincidental occurrences of industry malfunctions and southerly winds, both of which are relatively infrequent events. Increased scrutiny by the Department of Health, an air quality task force mandated by the state legislature, and the modernization by some industrial park tenants should help to mitigate future impacts on the proposed project.

2.0 INTRODUCTION

The Aina Nui Corporation is proposing to develop the Kapolei West Project on 547 acres of vacant lands on the Waianae (west) side of the City of Kapolei on the island of Oahu (see Figure 1 for project location). The project would include lands along both sides of the future Kapolei Parkway from a short distance west of Kalaeloa Boulevard to the eastern boundary of the Ko Olina development area. The mauka borders of the project are formed by the H-1 Freeway and the Nanakai Gardens/Honokai Hale communities, with lands extending makai to or slightly makai of the former Oahu Railway and Land Company track alignment. The development will include 2,370 residential units on 138 acres, a regional commercial area on 23.2 acres, a transit/mixed-use development on 15.8 acres, a 2-acre neighborhood commercial area, a golf course occupying approximately 200 acres, about 25 acres of public park lands, an elementary school on 6 acres and other areas totaling 47 acres used for roads and open space. Construction of the project is expected to commence during 2008, and full development and occupancy is planned for sometime after 2020.

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. Potential impacts on the project from nearby air pollution sources are also discussed. Measures to mitigate impacts either by the project or on 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 at this time, it is expected that the new standards for particulate will be implemented by 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 broad Ewa Plain leeward of the Koolau Mountains.

Wind frequency data for Honolulu International Airport (HIA), which is located about 10 miles to the east of the project site, are given in Table 2. These data can be expected to be reasonably representative of the project area. 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 near coastal, leeward location results in a relatively moderate temperature profile compared to other locations around Oahu and the state. Based on more than 50 years of data collected at the former nearby Ewa Plantation, average annual daily minimum and maximum temperatures in the project 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.

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 Kapolei 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 radiational cooling. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The 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 ten years, while emissions of sulfur oxides, carbon monoxide and hydrocarbons probably have declined.

The H-1 Freeway, which borders the project site on 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 over portions the project site by the prevailing winds.

Several sources of industrial air pollution are located in the Campbell Industrial Park, which is located about 1.5 miles to the south at Barbers Point. 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 Kahe Generating Station is located about 3 miles to the northwest at Kahe Point. 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 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 near the project site. Emissions from both the 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. Long-range uses for the land have not yet been determined.

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 1999 through 2003. These are the most recent data that are currently available.

During the 1999-2003 period, sulfur dioxide was monitored by the State Department of Health at an air quality station located at Kapolei. 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 15 to 19 $\mu g/m^3$, while the annual second-highest 24-hour concentrations ranged from 5 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 also measured at the Kapolei monitoring station. Annual second-highest 24-hour PM-10 concentrations ranged from 29 to 129 $\mu g/m^3$ between 1999 and 2003. Average annual concentrations ranged from 14 to 19 $\mu g/m^3$. All values reported were within the state and national AAQS.

Carbon monoxide measurements were also made at the Kapolei monitoring station. The annual second-highest 1-hour

concentrations ranged from 1.2 to 2.0 mg/m^3. The annual second-highest 8-hour concentrations ranged from 0.6 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 7 to 9 $\mu g/m^3$, safely inside the state and national AAQS.

The nearest available ozone measurements were obtained at Sand Island (about 12 miles east of the project area). The second-highest 8-hour concentrations for 2002 and 2003 were 88 and 77 $\mu g/m^3$, respectively, 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, particulate matter, ozone and lead are currently being

met at the project site. 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, three scenarios were selected for the carbon monoxide modeling study: (1) year 2004 with present conditions, (2) year 2020 without the project, and (3) year 2020 with the

project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, several of the key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Kalaeloa Boulevard at Farrington Highway;
- Kapolei Parkway at Kamokila Boulevard;
- Kapolei Parkway at Kalaeloa Boulevard;
- Kapolei Parkway at Hanua Street;
- Kapolei Parkway at Road H;
- Aliinui Drive at Koio Drive
- Aliinui Drive at Olani Street.

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 three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 43.6% light-duty gasoline-powered automobiles, 43.6% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.4% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE6 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, one of the study intersections is unsignalized, Aliinui Drive at Olani Street. In the future, in accordance with the traffic report, this intersection along with

Aliinui Drive at Koio Drive and Kapolei Parkway at Road H were assumed to be unsignalized.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings (where applicable). All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6 based on assumed free-flow vehicle speeds corresponding to the posted speed limits (25 to 45 mph depending on location).

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all three scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability

categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2004. Although increased traffic is expected to occur within the project area within the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 5 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 2004 with existing traffic, year 2020 without the project and year 2020 with the project. The

locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2004) case was 4.5 mg/m^3. This was projected to occur during the morning peak traffic hour near the intersection of Kapolei Parkway and Kalaeloa Boulevard. Concentrations at other locations and times studied were 3.2 mg/m^3 or lower. All predicted worst-case 1-hour concentrations for the 2004 scenario were within both the national AAQS of 40 mg/m^3 and the state standard of 10 mg/m^3.

In the year 2020 without the proposed project, the highest worst-case 1-hour concentration was predicted to occur during the morning at the intersection of Kapolei Parkway and Hanua Street. A value of 3.9 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 2020 without project scenario ranged between 1.4 and 3.8 mg/m^3. Compared to the existing case, concentrations decreased somewhat or remained about the same. All projected worst-case concentrations for this scenario remained within the state and national standards.

Predicted 1-hour worst-case concentrations for the 2020 with project scenario were largely unchanged compared to the 2020 without project scenario. A maximum concentration of 4.4 mg/m^3 was predicted to occur during the morning peak hour at the intersection of Kapolei Parkway and Kalaeloa Boulevard. Other concentrations ranged between 1.7 and 3.4 mg/m^3, well within the state and federal standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [11] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 6. For the 2004 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the three locations studied ranged from 0.8 mg/m^3 at the Aliinui Drive/Olani Street intersection to 2.2 mg/m^3 at the Kapolei Parkway/Kalaeloa Boulevard intersection. The estimated worst-case concentrations for the existing case were within both the state standard of 5 mg/m^3 and the national limit of 10 mg/m^3.

For the year 2020 without project scenario, worst-case concentrations ranged between 0.8 and 2.0 mg/m^3, with the highest concentration occurring at Kapolei Parkway and Hanua Street. All predicted concentrations were within the standards.

For the 2020 with project scenario, worst-case concentrations remained nearly unchanged compared to the without project case, indicating minimal project impact. All predicted 8-hour concentrations for this scenario were within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The annual electrical demand of the project when fully developed is expected to reach approximately 42 million kilowatt-hours [12]. 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 22 tons per day [12]. 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 IMPACTS ON PROJECT FROM CAMPBELL INDUSTRIAL PARK

In addition to assessing the air quality impacts of the project on the surrounding area, the reverse problem of impacts of air pollution sources located in the surrounding area on the residents of the project is also of concern. For the this project, the issue of primary concern is the Campbell Industrial Park (CIP) located about 1.5 miles south of the project site. Several large industrial sources of air pollution are located at CIP including Applied Energy Systems (AES) Generating Station, Kalaeloa Partners Cogeneration Plant, the Chevron and BHP Refineries, H-Power and Hawaiian Cement. During the past few years, several incidents of acute air pollution levels have occurred in areas within and adjacent to CIP. Some of these incidents have been caused by upset conditions at the BHP and Chevron Refineries, while the source or sources of other incidents have never been identified.

As indicated in Section 4, the prevailing winds are in the northeast quadrant, which will carry emissions from CIP away from the project site more than 70 percent of the time. Winds from the south, which could carry emissions toward the site, occur less than about 5 percent of the time. While estimating specific air

pollution levels at the project site is beyond the scope of the present study, it is unlikely that concentrations exceed air quality standards during normal operations. Emissions during normal operations are regulated by the Hawaii Department of Health, and industry operators are required to demonstrate compliance with state and national air quality standards. Perhaps the greatest concern is the coincidence of industry malfunctions in conjunction with southerly-wind periods. Even if industry operators are very diligent in operating and maintaining their facilities, occasional malfunctions that result in air pollution incidents in nearby areas are probably unavoidable.

After several incidents over the past few years, the Department of Health has increased scrutiny of industries at CIP. Also, a task force mandated by the state legislature was formed to investigate recent air pollution incidents and to reduce future occurrences. In response to plant malfunctions that have caused the excessive release of air contaminants, several industries have begun modernization programs which are intended to improve operations.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive

areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After the proposed project is completed, any long-term impacts on air quality in the project area due to emissions from project-related motor vehicle traffic should be small. Worst-case concentrations of carbon monoxide should remain within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of waste materials generated by the project will likely be negligible based on the magnitudes of the estimated emissions compared to the current island-wide emissions. To further moderate any impacts, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters, water heater timers or possibly hot water on demand systems; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; movable, controlled openings for ventilation at opportune times; and possibly automated room occupancy sensors. Solid waste related air pollution could likely be reduced somewhat by the promotion of conservation and recycling programs within the proposed development.

Due to the relatively close proximity of industries located at CIP, occasional impacts on the project from emissions emanating from these facilities will probably be unavoidable. Such impacts may occur in conjunction with the coincidental occurrence of industry malfunctions and southerly winds, both of which are relatively infrequent events. Increased scrutiny by the Department of Health, a special task force mandated by the state legislature to assess and monitor emissions in the area, and the upgrade of some of the industries located at CIP, such as Chevron, should help to mitigate future impacts on areas adjacent to CIP.

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Figure 1 - Project Location Map

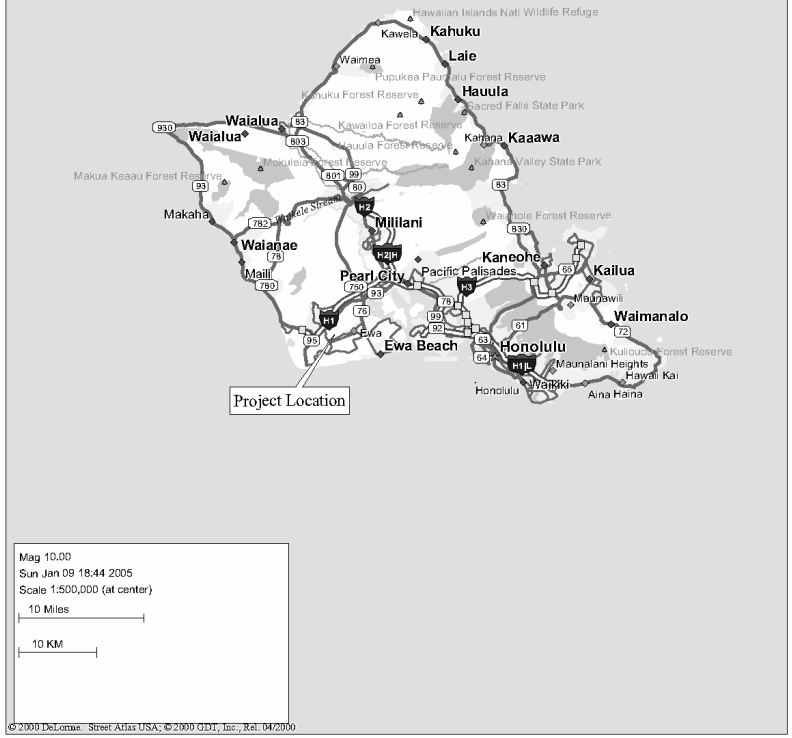


Table 1

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 KAPOLEI WEST PROJECT

Parameter / Location	1999	2000	2001	2002	2003
Sulfur Dioxide / Kapolei					
3-Hour Averaging Period:					
No. of Samples	2710	2505	2511	2420	2461
Highest Concentration ($\mu g/m^3$)	30	23	24	47	26
2nd Highest Concentration ($\mu g/m^3$)	17	18	15	19	19
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	360	362	359	344	351
Highest Concentration ($\mu g/m^3$)	6	6	7	9	9
2nd Highest Concentration ($\mu g/m^3$)	6	5	6	7	9
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	2	1	2	2	1
Particulate (PM-10) / Kapolei					
24-Hour Averaging Period:					
No. of Samples	362	356	352	351	343
Highest Concentration ($\mu g/m^3$)	129	148	121	55	72
2nd Highest Concentration ($\mu g/m^3$)	39	129	104	35	29
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	15	17	19	16	14
Carbon Monoxide / Kapolei					
1-Hour Averaging Period:					
No. of Samples	8395	8595	8577	8354	8559
Highest Concentration (mg/m^3)	1.5	2.5	2.3	2.2	2.2
2nd Highest Concentration (mg/m^3)	1.2	1.6	1.9	2.0	1.6
No. of State AAQS Exceedances	0	0	0	0	0
8-Hour Averaging Period:					
No. of Samples	1048	1076	1073	1044	n/a
Highest Concentration (mg/m^3)	0.6	1.0	1.6	1.8	0.8
2nd Highest Concentration (mg/m^3)	0.6	0.8	1.3	1.8	0.8
No. of State AAQS Exceedances	0	0	0	0	0
Nitrogen Dioxide / Kapolei					
Annual Average Concentration ($\mu g/m^3$)	7	9	8	9	9
Ozone / Sand Island					
8-Hour Averaging Period:					
No. of Samples	-	-	-	8549	8641
Highest Concentration (mg/m^3)	-	-	-	89	79
2nd Highest Concentration (mg/m^3)	-	-	-	88	77
No. of State AAQS Exceedances	-	-	-	0	0

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 1999 - 2003"

Table 5

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR KAPOLEI WEST PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario					
	2004/Present		2020/Without Project		2020/With Project	
	AM	PM	AM	PM	AM	PM
Kalaeloa Blvd. at Farrington Highway	2.3	3.0	2.5	2.1	2.5	2.1
Kapolei Parkway at Kamokila Blvd.	-	-	3.3	2.4	3.1	2.6
Kapolei Parkway at Kalaeloa Blvd.	4.5	3.2	3.8	2.5	4.4	2.9
Kapolei Parkway at Hanua Street	-	-	3.9	3.1	3.4	2.3
Kapolei Parkway at Road H	-	-	-	-	2.2	1.8
Aliinui Drive at Koio Drive	-	-	1.6	1.4	2.1	1.7
Aliinui Drive at Olani Street	1.6	1.0	2.2	1.6	2.3	1.6

Hawaii State AAQS: 10
National AAQS: 40

Table 6

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR KAPOLEI WEST PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	2004/Present	2020/Without Project	2020/With Project
Kalaeloa Blvd. at Farrington Highway	1.5	1.2	1.2
Kapolei Parkway at Kamokila Blvd.	-	1.6	1.5
Kapolei Parkway at Kalaeloa Blvd.	2.2	1.9	2.2
Kapolei Parkway at Hanua Street	-	2.0	1.7
Kapolei Parkway at Road H	-	-	1.1
Aliinui Drive at Koio Drive	-	0.8	1.0
Aliinui Drive at Olani Street	0.8	1.1	1.2

Hawaii State AAQS: 5
National AAQS: 10

Table 7

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM KAPOLEI WEST PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	13
Sulfur Dioxide	105
Carbon Monoxide	8
Volatile Organics	1
Nitrogen Oxides	46

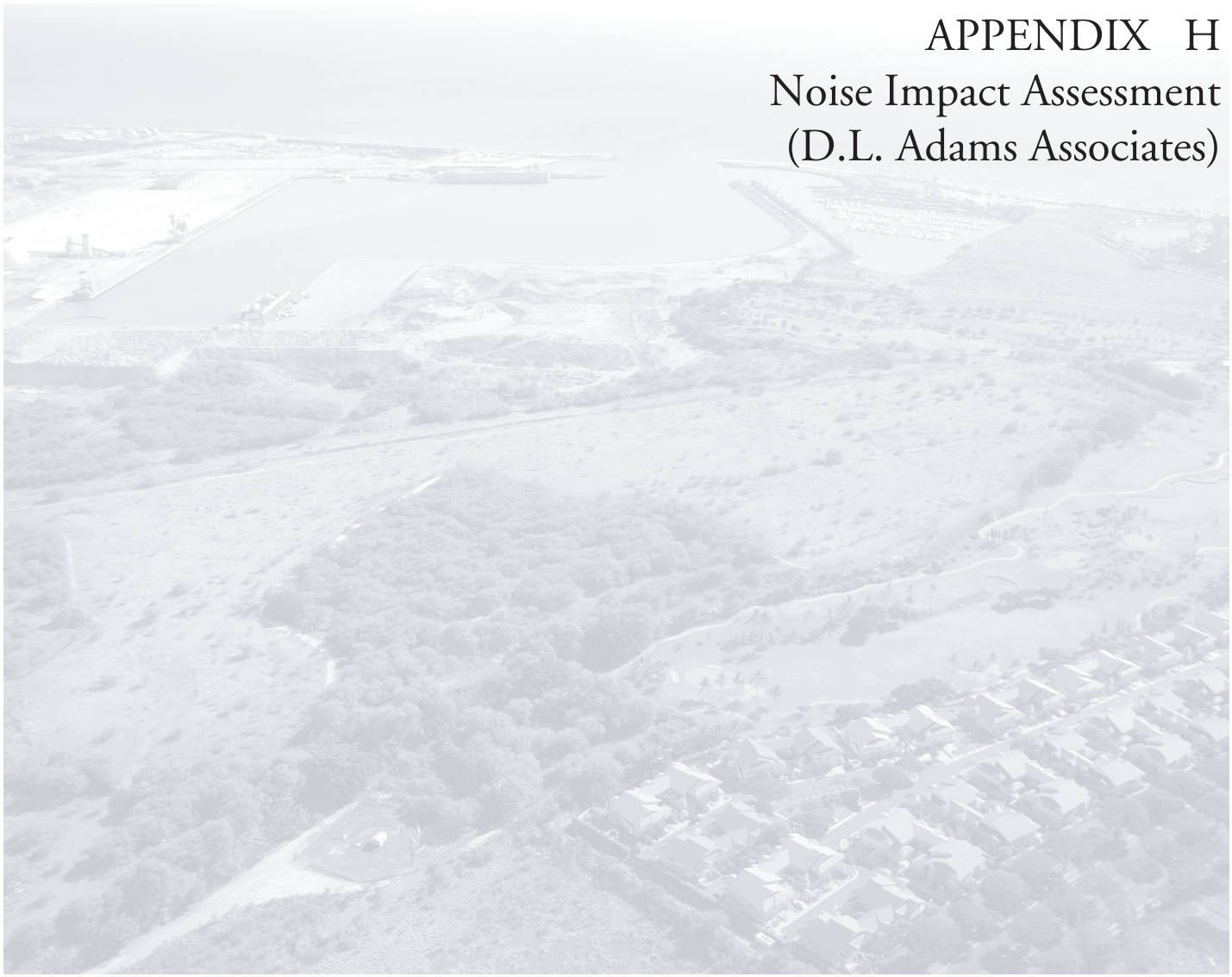
[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes electrical demand of 314 million kilowatt-hrs per year and low-sulfur oil used to generate power.

Table 8

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM KAPOLEI WEST PROJECT SOLID WASTE DISPOSAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	<1
Sulfur Dioxide	2
Carbon Monoxide	4
Volatile Organics	<1
Nitrogen Oxides	10
Lead	<1

[a]Based on U.S. EPA emission factors for municipal waste incinerators [2]. Assumes mass burn unit with 99 percent control of particulate emissions and solid waste disposal demand of 22 tons per day.



APPENDIX H
Noise Impact Assessment (D.L. Adams Associates)

D. L. ADAMS ASSOCIATES, LTD.
Consultants in Acoustics and Performing Arts Technologies

Environmental Noise Assessment Report
Kapolei West 100 Acre Petition

Kapolei, O'ahu, Hawaii

February 2005

DLAA Project No. 04-33

Prepared by: David L. Adams Associates, Ltd.
Kailua, O'ahu, Hawaii

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TABLE OF CONTENTS

Section Description **Page**

1.0 Executive Summary 1
2.0 Project description 2
3.0 Noise Standards 2
4.0 Existing Acoustical Environment 5
5.0 Potential Noise Impact Due to the Project 6
6.0 Noise Impact Mitigation 8
7.0 References 10

Tables

1 FAA Land Use Compatibility Chart
2 HDOT Airports Division Land Use Compatibility Chart
3 Predicted Traffic Noise Levels With and Without the Project

Figures

1 Maximum Permissible Sound Levels for Various Zoning Districts
2 FHWA Recommended Sound Levels Based on Land Use
3 Map of Project Area and Noise Measurement/Prediction Locations
4 Graph of Measured Noise Levels
5 Typical Sound Levels From Construction Equipment

Appendices

Appendix A Acoustical Terminology
Appendix B Photographs at Project Site

1.0 EXECUTIVE SUMMARY

1.1 The Kapolei West 100 Acre Petition project is proposed to offer residential lots, a golf course, and other land development near Kapolei, Hawaii. The development includes the 100-acre Petition Area and the adjacent 372 acre property. The existing site is undeveloped land.

1.2 Continuous ambient noise levels were measured at 150 feet south of the H-1 freeway. The hourly Equivalent Sound Level ($L_{eq(h)}$) generally ranged between 55 dBA and 72 dBA, depending on the time of day and traffic volume on the H-1 freeway. The dominant noise source is vehicular traffic on the H-1 freeway, but other noises include aircrafts, wind, birds, and crickets.

1.3 All homes that are 300 feet or more from the H-1 freeway satisfy the FHWA noise criteria. Homes that are between 100 feet and 300 feet of the H-1 freeway will require noise mitigation. No homes should be built within 100 feet of the H-1 freeway.

1.4 All homes that are 300 feet or more from the H-1 freeway satisfy the HUD noise criteria for an "acceptable" rating. Homes that are between 100 feet and 300 feet of the H-1 freeway will require noise mitigation. No homes should be built within 100 feet of the H-1 freeway.

1.5 Vehicular traffic noise in the area is expected to increase due to the project. However, the increase in noise level due to project generated traffic is expected to be 2 dB or less for all major connecting roads, which is not a significant noise impact. This analysis includes year 2020 traffic volume projections with and without the project.

1.6 Noise from aircraft operations at the Kalaeloa Airport and the Honolulu International Airport were considered. The Kapolei West 100 Acre Petition project site is outside of the L_{dn} 55 airport noise contours for both airports. Therefore, no noise impact was found for aircraft noise at the project site.

1.7 During the construction phase of the project, typical construction noises will be audible in the area. Noise from construction activities must comply with State Department of Health noise regulations as specified for construction activities.

1.8 After construction is complete, noise generated from stationary mechanical equipment on the project site must meet the State of Hawaii noise regulations.

2.0 PROJECT DESCRIPTION

The planned Kapolei West 100 Acre Petition project proposes to add residential lots, a golf course, parks, and commercial development near Kapolei on the Island of O'ahu, Hawaii. The residential lots will be mixed within and around the golf course, and adjacent to the neighboring Ko'Olina golf course and resort development. The development area begins near the Farrington Highway and H-1 Freeway merge, and continues along the H-1 freeway corridor to the Kalaeloa Boulevard off-ramp. The entire development is on the makai side of the H-1 freeway.

During construction, the project site will be closed to the public. Typical construction equipment will be on-site throughout the construction of the new land development.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 State of Hawaii, Community Noise Control

The State of Hawaii Community Noise Control Rule [Reference 1] defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to stationary noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc., and equipment related to agricultural, construction, and industrial activities. These 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. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 2]. 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.

3.3 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 3], which are listed in Figure 2. For example, Category B, defined as picnic and recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67dBA and a maximum interior L_{eq} of 52 dBA. These limits are viewed as design goals, and all projects meeting these limits are deemed in conformance with FHWA noise standards. Calculation of traffic noise levels should be conducted using the Federal Highway Administration's Traffic Noise Model, 1978 [Reference 4].

3.4 Hawaii Department of Transportation (HDOT)

The HDOT has adopted FHWA's design goals for traffic noise exposure in its noise analysis and abatement policy [Reference 5]. According to the policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15 dB.

3.5 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 Hawaii Department of Transportation (HDOT), Airports Division

The State of Hawaii, Department of Transportation, Airports Division has adopted noise restrictions that similar to the FAA's, but more strict [Reference 8]. Similar to the FAA, HDOT expresses land use compatibility guidelines based on yearly day-night average sound levels, L_{dn}, due to aircraft operations. In most cases, the HDOT states maximum noise limits that are 5 dB lower than the FAA. For example, the HDOT 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, HDOT 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 HDOT 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 HDOT 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.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Continuous long-term ambient noise level measurements were conducted at one (1) location, as shown on Figure 3. The noise measurements were conducted between January 6, 2005 and January 12, 2005. In addition, short term noise measurements and traffic counts were conducted at the same location on January 6, 2005. The purpose of the short-term measurements and traffic counts was to calibrate the traffic noise model prediction software.

4.1 Noise Measurement Procedure

Long-Term Noise Measurements
The microphone was mounted on a tripod, approximately 5' above grade. A windscreen covered the microphone during the entire measurement period. The sound level meter was secured in a weather resistant case.

Continuous, hourly, equivalent sound levels, L_{eq}, were recorded during the measurement period. 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.

Short-Term Noise Measurements
The microphone and sound level meter was mounted on a tripod, approximately 5' above grade. A windscreen covered the microphone during the entire measurement period.

An approximate 30-minute equivalent sound level, L_{eq}, was measured. The 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.

4.2 Noise Measurement Location

The measurement location was positioned on the north side of the project area, near the H-1 freeway, 150 feet south of the edge of pavement on the H-1 freeway and approximately 450 feet west of the high voltage utility power lines. In this area, the H-1 freeway has 24-foot wide double lanes (each direction) separated by a 22-foot wide median. The noise measurement location is shown in Figure 3.

4.3 Noise Measurement Results

The results from the long-term noise measurements are graphically presented in Figure 4, which shows the measured equivalent sound level, L_{eq}, and the 90% exceedance level, L_{90}, in A-weighted decibels (dBA) as a function of the measurement date and time.

The sound levels are relatively dynamic and depend significantly on the vehicular traffic patterns on the H-1 Freeway. The hourly L_{eq} noise levels generally range from 55 dBA during the low traffic times to approximately 72 dBA during peak hour traffic times. The hourly L_{90} ranges from 45 dBA to 70 dBA. The average day-night level, L_{dn} was 70 dBA for the measurement period. The dominant and secondary noise sources are described below:

Noise Sources

Dominant:	Vehicular traffic on H-1 freeway
Secondary:	Occasional aircraft flyovers, wind, birds, crickets, and other industrial activities in the Campbell Industrial Park

4.4 Kalaeloa Airport and Honolulu International Airport Noise Contours

The project is in the vicinity of the Kalaeloa Airport and several miles west of Honolulu International Airport. Therefore, the project site was assessed for aircraft noise using airport noise contour maps. The Kalaeloa Master Plan completed in November 1998 [Reference 9] includes year 2020 projections of airport operations and noise contour maps for three airport alternates. Also included in the airport noise contour maps is the affect of the Honolulu International Airport operations. The Kapolei West 100 Acre Petition project is well outside of the Ldn noise contours for all three alternates. A complete description of the Kalaeloa Airport alternates can be found in the Kalaeloa Master Plan.

5.0 POTENTIAL NOISE IMPACTS DUE TO THE PROJECT

5.1 Project Construction Noise

Development of project areas will involve excavation, grading, and other typical construction activities during construction. The various construction phases of the project may generate significant amounts of noise. The surrounding residences may be impacted by the construction noise due to their proximity to the project. 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 5.

5.2 Projection of Noise Levels Due to the Project

The new land development will incorporate stationary mechanical equipment that is typical for residential housing, commercial buildings, etc. Expected mechanical equipment may include air handling equipment, condensing units, etc. Noise from this mechanical equipment and other equipment must meet the State noise rules, which stipulate maximum permissible noise limits at the property line. These noise limits are 55 dBA during the daytime hours (7:00 am to 10:00 pm) and 45 dBA during the nighttime hours (10:00 pm to 7:00 am) for residential areas. For commercial areas, the noise limits are 60 dBA during the day and 50 dBA during the night.

5.3 Compliance with FHWA/HDOT Land Use Noise Limits and HUD Noise Guidelines

Noise from vehicular traffic on the H-1 freeway is the primary noise source in the vicinity of the planned development. Using the FHWA noise prediction model [Reference 4] and future traffic volumes provided by the Traffic Consultant, new homes should be built at least 300 feet from H-1. The traffic projections include a complete build-out of the project in the year 2020. Homes within 300 feet of H-1 exceed the FHWA maximum noise limit of 67 dBA for peak hour traffic volumes.

The HUD “acceptable” maximum noise limit of 55 L_{dn} will be satisfied for all homes 300 feet, or more, from H-1. With regards to aircraft noise, the entire project site is outside of the L_{dn} 65 airport noise contour and therefore meets HUD’s “acceptable” rating for aircraft noise.

5.4 Projection of Project Generated Vehicular Traffic Noise

The Kapolei West land development project will provide housing for many residents and some commercial business, which will increase vehicular traffic in the area. The increase in traffic noise along the H-1 corridor will not significantly increase due to the project. Year 2020 projections of traffic volumes along the H-1 corridor indicate an increase in traffic noise of less than 1 dB can be expected, which is not a significant noise impact.

Vehicular traffic along other roads in the area will also increase due to the project. However, year 2020 projections with and without the project show the noise level is expected to increase by 2 dB or less on all primary connecting roads, such as Aliinui Drive and Hanua Street due to the project.

Table 3 shows the predicted traffic noise levels with and without the project. The table also includes the resulting increases in traffic noise and increases in traffic noise level due to the project for the H-1 freeway, Aliinui Drive and Hanua Street. The noise prediction locations are shown in Figure 3. No noise impact was found regarding project generated vehicular traffic noise.

5.5 Compliance with FAA and HDOT Airports Division Guidelines

The Kapolei West 100 Acre Petition project site is outside of the 55 L_{dn} noise contour. Therefore, the project will not be impacted by aircraft noise.

6.0 NOISE IMPACT MITIGATION

6.1 Mitigation of Construction Noise

In cases where construction noise exceeds, or is expected to exceed the State’s "maximum permissible" property line noise levels [Reference 1], a permit must be obtained from the State DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit noise levels in excess of the "maximum permissible" levels.

In order for the State DOH to issue a construction noise permit, the Contractor must submit a noise permit application to the DOH, which describes the construction activities for the project. Prior to issuing the noise permit, the State DOH may require action by the Contractor to incorporate noise mitigation into the construction plan. The DOH may also require the Contractor to conduct noise monitoring or community meetings inviting the neighboring residents and business owners to discuss construction noise. The Contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engine machines, using properly tuned and balanced machines, etc. However, the State DOH may require additional noise mitigation, such as temporary noise barriers, or time of day usage limits for certain kinds of construction activities.

Specific permit restrictions for construction activities [Reference 1] are:

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels ... before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."
>
> “No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels... before 9:00 a.m. and after 6:00 p.m. on Saturday."
>
> “No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The use of hoe rams and jack hammers 25 lbs. or larger, high pressure sprayers, chain saws, and pile drivers must be restricted to 9:00 a.m. to 5:30 p.m., Monday through Friday.

The DOH noise permit does not limit the noise *level* generated at the construction site, but rather the *times* at which noisy construction can take place. Therefore, noise mitigation for construction activities should be addressed using project management, such that the time restrictions within the DOH permit are followed.

6.2 Mitigation of the Kapolei West 100 Acre Petition 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]. Noisy equipment should be located away from neighbors and the residential units, as much as is practical. Enclosed mechanical rooms may be required for some equipment.

6.3 Mitigation of H-1 Freeway Noise

All homes that are 300 feet or more from the H-1 freeway meet the FHWA and HUD criteria and do not need noise mitigation. However, any homes within 300 feet of the H-1 freeway will require some type of noise mitigation to meet the criteria. Potential noise mitigation solutions may include:

- Upgraded exterior windows
- Air-Conditioning
- Sound barrier wall or earth berm along H-1

The specific noise mitigation treatments used will depend on the precise location and grade elevation of the new homes. Any homes built between 100 feet and 300 feet from the H-1 freeway will require that some form of noise mitigation be incorporated into their design. No homes should be built within 100 feet of the H-1 freeway, even if noise mitigation treatments are planned.

7.0 REFERENCES

1. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.

2. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.

3. *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.

4. *Federal Highway Administration's Traffic Noise Model,* FHWA-RD-77-108; U.S. Department of Transportation, December 1978.

5. *Noise Analysis and Abatement Policy,* Department of Transportation, Highways Division, State of Hawaii, June 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 1, 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. *Kalaeloa Airport Master Plan,* State of Hawaii Department of Transportation, Airports Division, November 1998.

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					
	< 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 requrements should be evaluated for the specific land use, interior acoustical requirements, and properties of the aircraft noise events. NLR requirements should not be based soley 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

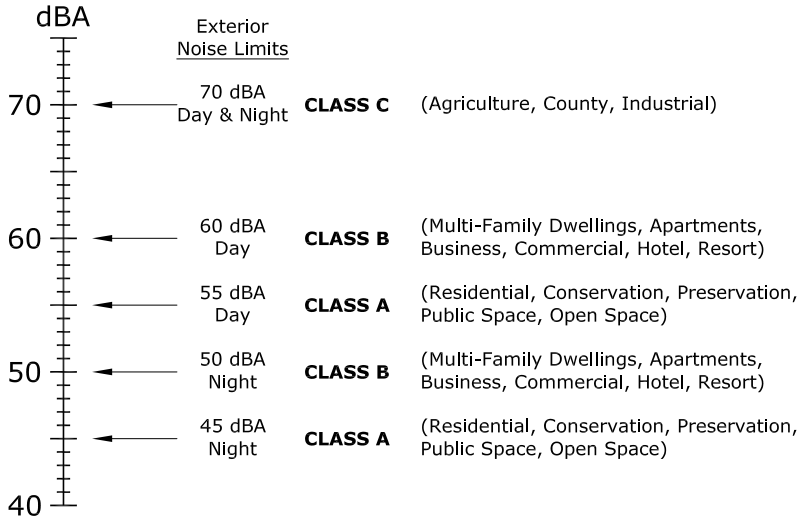
TABLE 3
Predicted Traffic Noise Levels With and Without the Project and Resulting Increases Due to the Project

Noise levels shown in the table are based on peak-hour traffic volumes, and are expressed in A-weighted decibels (dBA).

	Location 1* (H-1 Freeway)		Location 2* (Aliinui Dr)		Location 3* (Hanua St)	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**
Existing (Calculated)	61.5	62.0	59.7	59.7	N/A	N/A
Future Without Project (2020)	66.6	66.7	63.6	64.5	65.9	68.3
Future With Project (2020)	66.6	67.0	65.0	66.3	67.6	69.6
Future Increase Without Project (2020)	5.1	4.7	3.9	4.8	N/A	N/A
Future Increase With Project (2020)	5.1	5.0	5.3	6.6	N/A	N/A
Future Increase Due to Project (2020)	**0.0**	**0.3**	**1.4**	**1.8**	**1.7**	**1.3**

* Location 1 - 300 feet south of H-1 Freeway
Location 2 - 50 feet south of Aliinui Drive
Location 3 - 100 feet west of Hanua Street

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, County, Industrial	70 dBA (Exterior)	70 dBA (Exterior)



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Hawaii Maximum Permissible Sound Levels for Various Zoning Districts

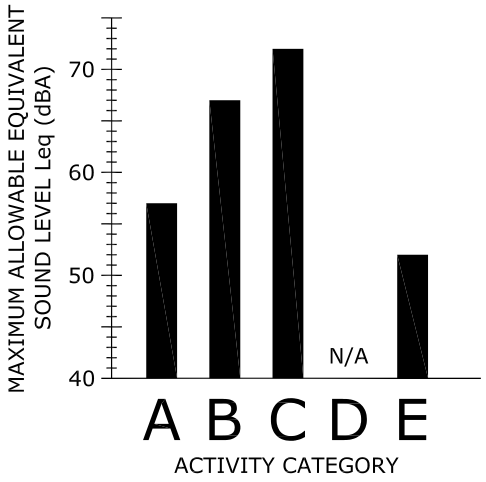
Kapolei West 100 Acre Petition

not to scale

Figure No 1

Date	Project No.	Drawn By
February 2005	04-33	TRB

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, ACHOOLS, 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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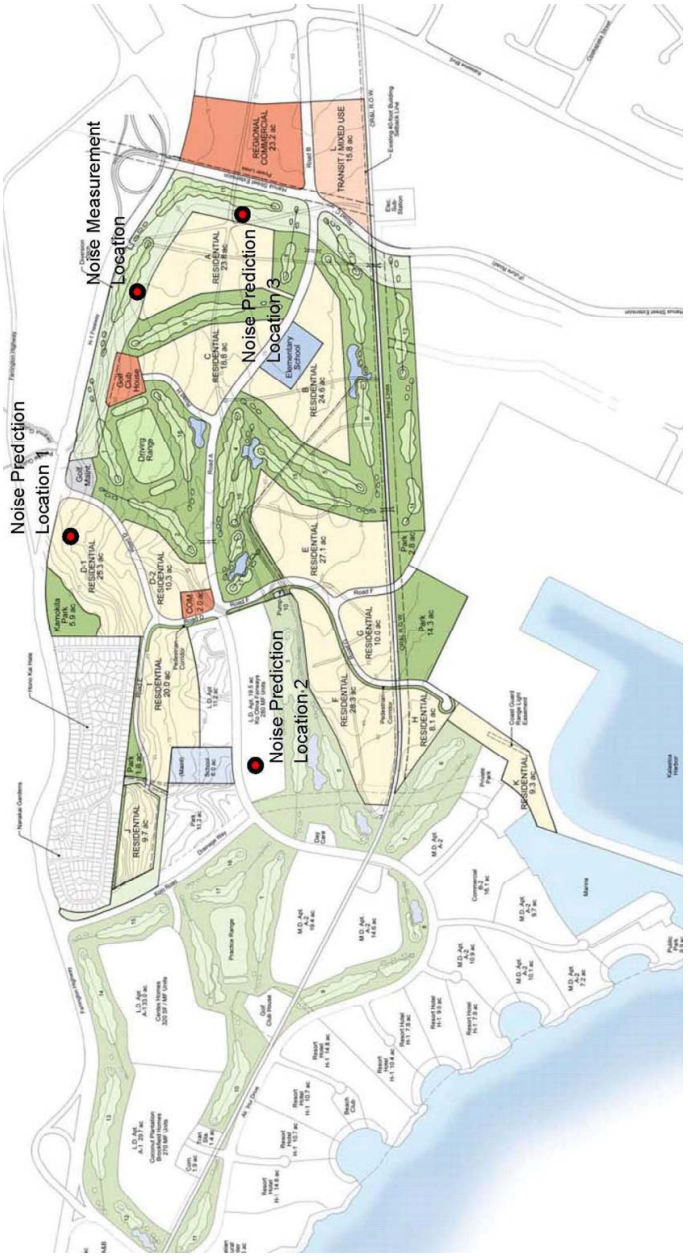
Federal Highways Administration Recommended Equivalent Hourly Sound Levels Based on Land Use

Kapolei West 100 Acre Petition

not to scale

Date: February 2005 | Project No.: 04-33 | Drawn By: TRB

Figure No 2



Noise Measurement & Prediction Locations

Kapolei West 100 Acre Petition

not to scale

Date: February 2005 | Project No.: 04-33 | Drawn By: TRB

Figure No 3

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Graph of Long Term Noise Measurements

Kapolei West 100 Acre Petition

not to scale

Date February 2005

Project No. 04-33

Drawn By TRB

Figure No 4

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NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

Typical Sound Levels from Construction Equipment

Kapolei West 100 Acre Petition

not to scale

Date February 2005

Project No. 04-33

Drawn By TRB

Figure No 5

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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.

Equivalent Sound Level

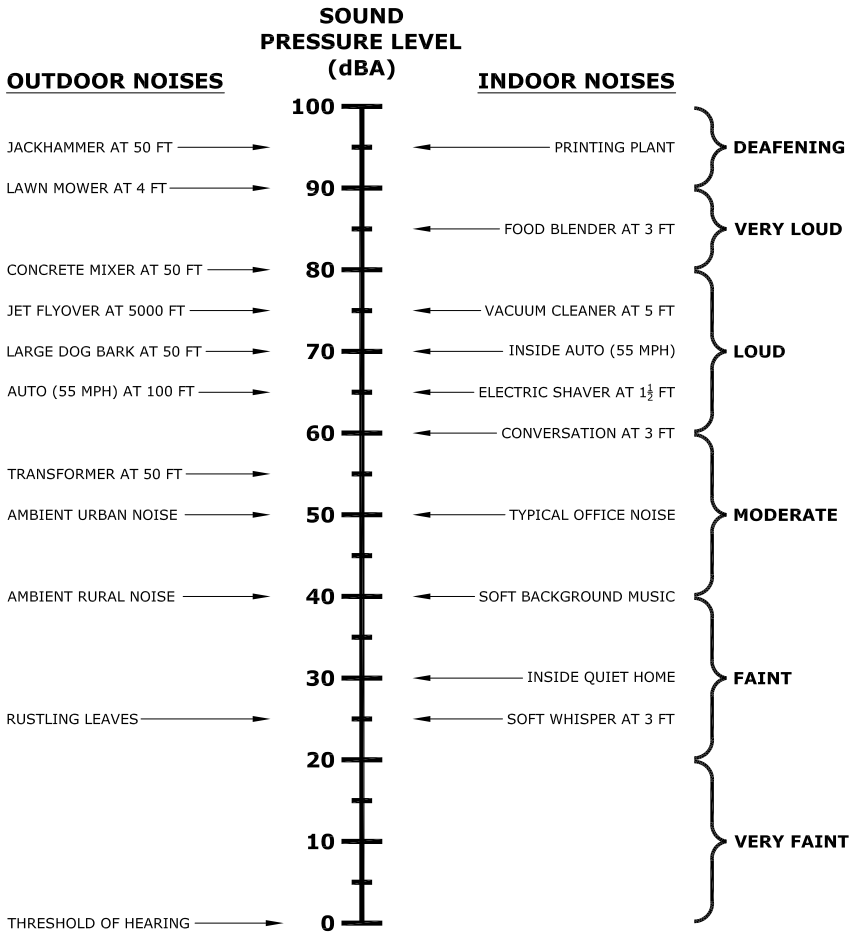
The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. 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.

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.



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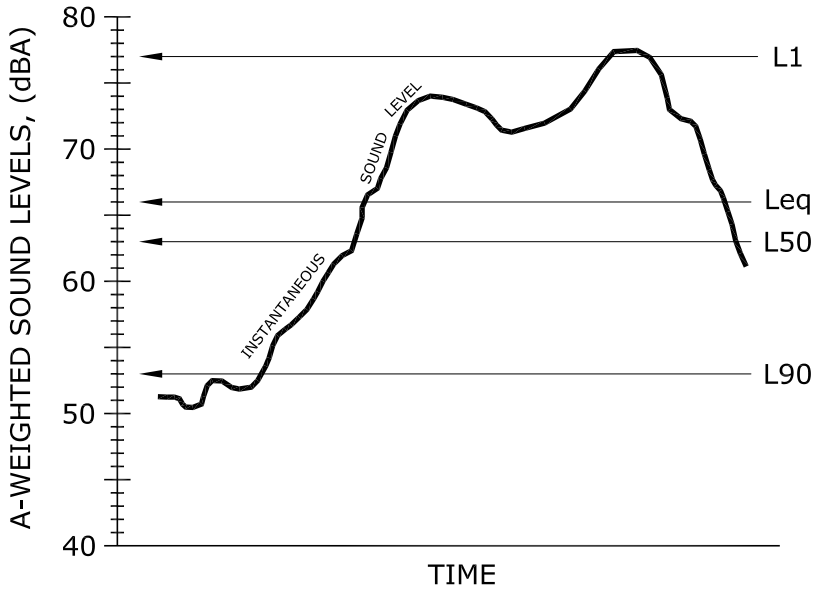
Common Outdoor/Indoor Sound Levels

Kapolei West 100 Acre Petition

not to scale

Date	Project No.	Drawn By
February 2005	04-33	TRB

Figure No A-1



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Example Graph of Equivalent Sound Level and Statistical Sound Levels

Kapolei West 100 Acre Petition

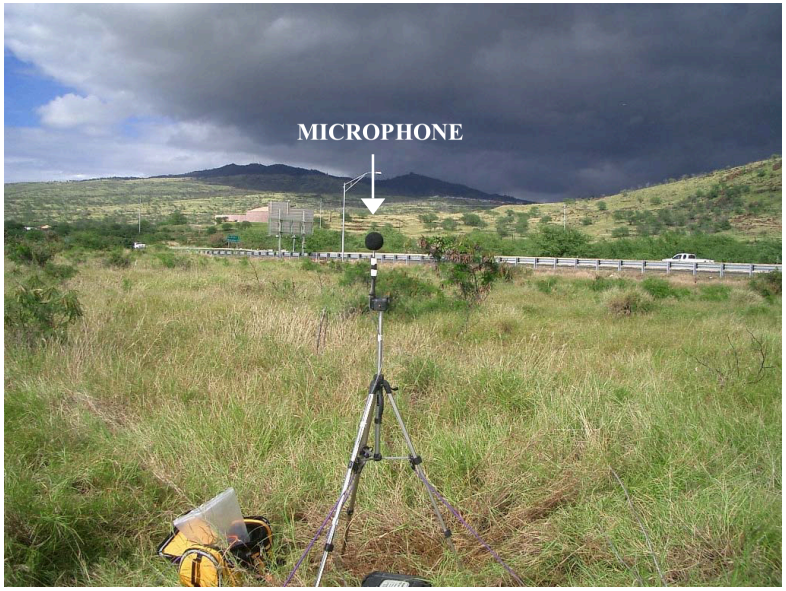
not to scale

Date	Project No.	Drawn By
February 2005	04-33	TRB

Figure No
A-2

APPENDIX B

Photographs at Project Site



Location 1

Microphone mounted on tripod. H-1 freeway in the distance. Camera pointed northwest.



Location 1

Microphone mounted on tripod. H-1 freeway in the distance. Camera pointed north.



Location 1

Microphone mounted on tripod. H-1 freeway in the distance. Camera pointed northeast.



Location 1

Microphone mounted on tripod. Honolulu Advertiser building in the distance. Camera pointed southeast.



APPENDIX I
Market Assessment
(Mikiko Corporation)

MIKIKO
CORPORATION

MARKET ASSESSMENT FOR RESIDENTIAL USES AT THE PROPOSED KAPOLEI WEST

ISLAND OF OAHU

Prepared for:
Helber Hastert & Fee, Planners

FINAL REPORT

May 21, 2004

Market Assessment for Residential Uses at the Proposed Kapolei West

Table of Contents

Executive Summary

Project and Study Background 4
Mikiko Corporation Study Objectives 4
Overview of Project Recommendations 5
Report Organization 8
Report Conditions 8

Report Text

Chapter 1 – Project Characteristics and Study Approach 11
Chapter 2 – Economic and Demographic Trends 14
Chapter 3 – Housing Supply and Demand Indicators 20
Chapter 4 – Comparison Developments 25
Chapter 5 – Conclusions for Kapolei West 31

Exhibits

Exhibit 1-1: Kapolei West Project Location 40
Exhibit 1-2: Kapolei West Development Concept Plan 41
Exhibit 1-3: Central and West Oahu Districts, Island of Oahu 42

Exhibit 2-1: Resident Population – Island of Oahu, Comparison of Four Estimates and Projections, 2000 to 2025 43
Exhibit 2-2: Projected Resident Population for Ewa, Central-West Oahu and Island of Oahu, 2000 to 2009 44
Exhibit 2-3: Projected Population by Age Group, 2000 to 2009 45
Exhibit 2-4: Increase in Population by Age Group, 2000 to 2009 46
Exhibit 2-5: Population Distribution by Age Group, 2000 to 2009 47
Exhibit 2-6: Projected Number of Households in Ewa, Central-West Oahu and Island of Oahu, 2000 to 2009 48
Exhibit 2-7: Projected Households by Age of Head, 2000 to 2009 49
Exhibit 2-8: Increase in Households by Age of Head, 2000 to 2009 50
Exhibit 2-9: Household Distribution by Age of Head, 2000 to 2009 51
Exhibit 2-10: Households by Household Income – 2004 Estimate 52
Exhibit 2-11: Labor Force Trends – Honolulu County, 1990 to 2003 53

Exhibit 2-12: Visitor Arrivals to the State of Hawaii and Island of Oahu, 1998 to 2004 54
Exhibit 2-13: Average Occupancy for State and Oahu Visitor Accommodations, 1998 to 2004 55
Exhibit 2-14: Average Room Rate for State and Oahu Visitor Accommodations, 1998 to 2004 56

Exhibit 3-1: Private Residential Building Permits, Island of Oahu, 1993 to 2003 ... 57
Exhibit 3-2: Median Sales Prices of Housing – Honolulu County, 1987 to 2004 ... 58
Exhibit 3-3: Developer Unit Sales – Island of Oahu and Ewa Development Plan Area, 1999 to 2003 59
Exhibit 3-4: Ewa Development Plan and Other Sustainable Communities Plan Areas 60
Exhibit 3-5: Planned Residential Development Projects with State Land Use Entitlements or Exemption, Ewa Development Plan Area, as of May 2004 61
Exhibit 3-6: Ewa DP District Projected New Housing Unit Supply, Planned Developments with State Land Use Entitlement or Exemption, as of May 2004 63
Exhibit 3-7: Island of Oahu Projected New Residential Housing Unit Supply, Planned Developments with State Land Use Entitlements or Exemption, as of May 2004 64
Exhibit 3-8: Island of Oahu Resident Housing Unit Projected Supply and Demand, 2000 to 2025 65

Exhibit 4-1: Characteristics of Selected Golf-Front Single-Family Residential Projects 66
Exhibit 4-2: Median Sales Prices for Selected Golf-Front Single-Family Projects, 2000 to 2004 67
Exhibit 4-3: Current Owner Place of Residence for Selected Golf-Front Single-Family Projects, Based on Tax Bill Address 68
Exhibit 4-4: Characteristics of Selected Multifamily Residential Projects 69
Exhibit 4-5: Median Sales Prices for Selected Multifamily Projects, 2000 to 2004 71
Exhibit 4-6: Current Owner Place of Residence for Selected Multifamily Projects, Based on Tax Bill Address 73

Exhibit 5-1: Projected Market Mix for Kapolei West by Site and Area 74
Exhibit 5-2: Resort Residential Developer Product Sold in Ko Olina Resort, 2002 and 2003 75
Exhibit 5-3: Projected Residential Unit Sales Absorption at Kapolei West, 2006 to 2025 76

MARKET ASSESSMENT FOR RESIDENTIAL USES AT THE PROPOSED KAPOLEI WEST

Executive Summary

Executive Summary

This section relates the study background, objectives and an executive summary of the market assessment for the proposed Kapolei West on Oahu. The subsequent materials offer a more detailed presentation of the findings and analyses on which these conclusions are based.

Project and Study Background

Aina Nui Corporation, an affiliate of the Estate of James Campbell, has initiated a planning and entitlement process to develop Kapolei West (also "the Project" or "Subject"), an area formerly known as Ko Olina Phases II, III and IV. The Project encompasses some 535 acres, of which about 162 acres (the former Ko Olina Phase III) are designated Agricultural by the State Land Use Commission (LUC) and about 373 were granted Urban designation by the LUC in 1991.

Kapolei West is in the Ewa Judicial District and in the City and County of Honolulu (City) Ewa Development Plan area. The Ewa DP is currently undergoing a five-year review, and drafts of the current new plan show the Urban areas of the Subject as 2,900 residential units, as well as golf and commercial land uses. The Agricultural areas are shown as 1,800 Low Density Apartments.

As currently proposed, 234 acres of the total area would be designated for residential uses, and these areas would accommodate 2,370 residential units. Kapolei West would include both resort second home and primary residential developments, as well as an 18-hole championship golf course, commercial developments, transit station, park and other open spaces.

Helber Hastert & Fee, Planners (HHF) is preparing materials to support Aina Nui's efforts to entitle the site.

Mikiko Corporation Study Objectives

HHF engaged Mikiko Corporation (MC) to support these efforts by preparing two reports:

1) **Market Assessment -** Describing the market support these efforts by describing the market support for residential product types proposed for Kapolei West, including:

   - ❑ Evidence of demand and competitive supply
   - ❑ Assessment of appropriate buyer markets, pricing, and anticipated sales absorption

2) **Economic and fiscal impact assessment** – An assessment of the economic and fiscal impacts of the Project in terms of employment, population, personal income and State and County government operating expenditures.

The economic and fiscal impact assessment report will be provided in a separate document.

Overview of Project Recommendations

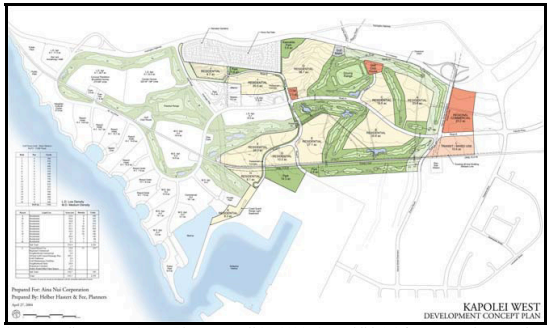
Development Concepts

Kapolei West is in a transitional location, bridging the resort second home and visitor attractions of Ko Olina Resort to its west, and the primary residential community of Kapolei to its east. Within the Project, two thematic areas are seen to reflect this transition (see map on next page):

- ❑ **Eastern lands** – Consisting of lands closest to the City of Kapolei, this area is seen as an extension of the primary residential community and urban center at Kapolei. This area includes Sites A, B, C, D and E of the land use plan, all of which would offer golf frontage. It also encompasses Site L, an area proposed to be set-aside for transit/mixed use development, including multifamily residential.

- ❑ **Western lands** – Consisting of lands closest to and adjacent to the Ko Olina Resort and Golf Course, this area is seen as a transition from the vacation and second home environment of Ko Olina, to the primary residential uses to the east. This area includes residential Sites F, G, H, I, J and K. All of these sites offer golf frontage and/or golf and ocean views. Site K is a long and narrow site that also fronts on the Ko Olina Marina.

Proposed Roads D and F largely delineate the two areas.



Source: Helber Hastert & Fee, Planners, April 27, 2004. See Exhibit 1-2 for a copy at larger scale.

Buyer Market Mix, Unit Densities and Number of Units

Considering site characteristics, the Project development concept and other study findings, a summary development plan for the Subject was prepared as follows:

Summary Development Plan for Residential Uses at Kapolei West

	Sites	Acres	Average (range) units/acre	No. units	Projected market mix[1]
Eastern lands	A, B, C, D, E & L	149.0[2]	8.9 (8, 10 & 15 – the latter on transit site L)	1,320	85% primary residents; 15% nonresidents
Western lands	F, G, H, I, J & K	85.4	12.3 (7, 18 & 1 – the latter on Marina-front site K)	1,050	31% primary residents; 69% nonresidents
Total		**234.4**[2]	**10.1**	**2,370**	**61% primary residents; 39% nonresidents**

Source: Mikiko Corporation, 2004

Market Demand Factors

- **Primary residential market** - The study estimated a 2005 deficit of nearly 16,300 housing units, representing a sizeable pent-up demand for homes island-wide. This is based on the estimated and projected number of households on Oahu, in comparison to the number of resident housing units, with adjustments to exclude those held for vacation or occasional use and a vacancy factor of 5%.

  Considering projected population growth on Oahu and a trend to smaller households, there is anticipated to be a need for 73,800 more housing units over the ensuing 20 years. In contrast, major residential developments for which State Land Use Commission (LUC) entitlement is in place represent only about 35,400 more homes approved for development[3].

  Assuming all of the 35,400 LUC-approved units are developed and sold by 2025, that all are kept in primary residential use, and adding a vacancy allowance, current approved plans represent a further shortfall of some 40,300 units between 2005 and 2025. Including the pre-existing pent-up demand of 16,300, the study finds that

[1] "Nonresidents" defined as those purchasing a unit for other than primary residential or retirement purposes. Also referred to herein as resort, second, or retirement homebuyers. The majority of this group is expected to have primary residences on the West Coast or other mainland U.S.

[2] Acreage shown is net of 5.8 acres on site L that are allocated to transit purposes. The remaining 10 acres of the site would be a mixed-use development, including residential and commercial uses.

[3] Excludes entitled units on the Urban portion of the Subject.

current development approvals are approximately 56,600 units short of Oahu's residential development needs to 2025.

With its proximity to the Second City of Kapolei and within the targeted Ewa Development Plan (DP) area, the Subject is seen as a logical site upon which to address a portion of this important need. If approved, the primary resident units to be sold at Kapolei West could represent a solution for about 2% to 5% of the unplanned needs in the Ewa DP area in the 2006 to 2020 period.

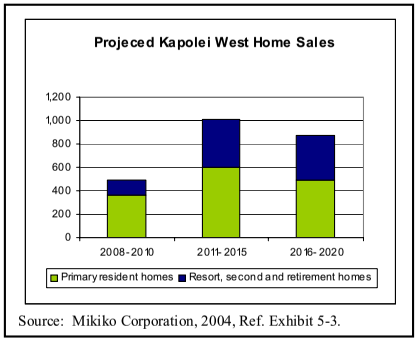
- **Nonresident market** – The nonresident market also exhibits strong underlying demand. In 2002 and 2003, Ko Olina closed an average of 116 resort residential unit sales each year. This occurred despite having only one project on the market in the first year, and it occurred alongside robust Ko Olina timeshare and Waikiki resort condominium marketing and sales. In 2004, additional residential units have been offered on a lottery basis at Ko Olina, and all have been claimed rapidly upon their offering.

  Going forward, the demand for resort residential units in the Ko Olina area could be even stronger, considering:

  - The U.S. and other offshore markets are just beginning to recognize Oahu as a destination for quality golf resort second, vacation or retirement homes,
  - The aging of the U.S. baby boom means that the nation's largest generation is moving into the age group historically most associated with resort, second and vacation home purchases, and
  - Stock market instability and the tragic events of September 2001 have led to renewed investor focus on U.S. real estate, and Hawaii is reportedly perceived as a safe location for such investment.

Projected Sales Absorption

Assuming the first units could be available for sale by 2008, and considering the above factors together, absorption of the 2,370 units proposed for development at Kapolei West could be expected to occur within 13 years, or by 2020. This would represent an average sales velocity of 112 units per year for the primary resident housing units, and 71 per year for the nonresident units.



Source: Mikiko Corporation, 2004, Ref. Exhibit 5-3.

Projected Supportable Unit Pricing (2004 dollars)

	Multifamily units	Single-family units
Primary resident housing	$300,000 to $400,000	$450,000 to $550,000
Nonresident housing[4]	$450,000 to $550,000	$650,000 to $800,000
Transit site (L)	$250,000 to $300,000	NAP
Marina-front site (K)	NAP	$1 million +

NAP – Not applicable. Source: Mikiko Corporation, 2004

Six single-family and ten multifamily golf resort and primary residential projects in Hawaii were visited and surveyed in order to determine their development characteristics, market performance, and supportable pricing. After analysis of these market findings and of the Subject's site characteristics, development concept and the density assumptions presented before, the residences at Kapolei West are estimated to support typical sales prices as shown.

Report Organization

The attached materials are organized in two parts, as follows:

- ***Part I: Report Text*** – Explanation of the study analyses and conclusions, in five subsections:

  1. Project Characteristics and Study Approach
  2. Economic and Demographic Trends
  3. Housing Supply and Demand Factors
  4. Comparison Developments
  5. Conclusions for Kapolei West

- ***Part II: Exhibits*** – Presentation of findings on which the conclusions are based.

Report Conditions

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

MC has no responsibility to update this report or any of the underlying data for events and circumstances occurring after April 15, 2004, the date of substantial completion of primary data collection.

This report is for the planning purposes of Aina Nui, HHF and their consultants, as well as for public disclosure of the nature of the Project pursuant to seeking State and County land entitlements. It is not to be used for solicitation of investment or any other third party purposes.

This report does not offer an appraisal of the Subject, nor should it be construed as an opinion of value for the Project.

MARKET ASSESSMENT FOR RESIDENTIAL USES AT THE PROPOSED KAPOLEI WEST

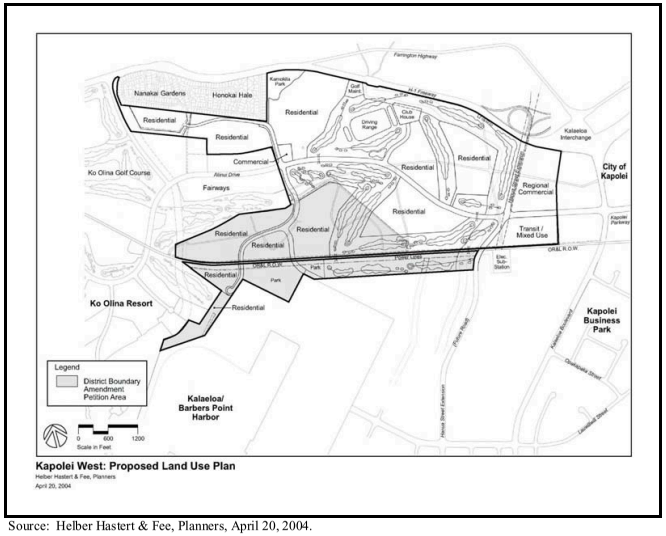
Report Text

1 – Project Characteristics and Study Approach

Project and Site Characteristics

The proposed Kapolei West development is located in the Ewa District, east of and adjacent to the existing Ko Olina Resort and Marina, and west of the City of Kapolei.

The site includes some 535 acres, of which 224 are designated solely for residential uses. Another approximately 10 acres within a 16-acre transit/mixed use site are also intended for residential purposes. In addition, the Project would include an 18-hole championship golf course, commercial facilities, a transit station, park and other open spaces.



Source: Helber Hastert & Fee, Planners, April 20, 2004.

Market Study Resources and Approach

In undertaking this study, data were gathered from primary sources, such as interviews and site visits, as well as from secondary sources such as published information and proprietary databases. The major secondary sources of information used in this study included:

- **SMS, Inc.** – "Hawaii Housing Policy Study, 2003," August 28, 2003. This report was prepared by SMS Research & Marketing Services, Inc. for a consortium including the City and County of Honolulu (City), Department of Housing and Community Services; the housing departments of the other three Hawaii counties; and the State of Hawaii, Housing and Community Development Corporation of Hawaii. It included a statewide survey of 4,856 households[3].

- **Claritas, Inc.** – Claritas is a division of the VNU Precision Marketing Group, Inc., a leading provider of geodemographic market research information to government and industry throughout the U.S. Claritas derives its information from the U.S. Bureau of the Census, State and local governmental planning and forecasting entities, its proprietary Business-Facts ® database and other sources. In April 2004, MC engaged Claritas to prepare various economic and demographic reports, estimates and projections for the Subject area and its environs[4].

- **Hawaii Information Services** – HIS, previously referred to as MLS Hawaii, Inc., is a private Hawaii-based vendor that maintains a database on real property within the State, including information on closed sales transactions. This database contains information gathered from the various County Tax Assessors' Offices, the State Bureau of Conveyances, and the Department of Land Utilization. Mikiko Corporation (MC) conducted a number of searches and analyses of information obtained form this database.

- **U.S. Bureau of the Census and other** U.S. federal, Hawaii State, and Honolulu City and County agencies and departments, as cited herein.

Geographic Areas of Analysis

Much of the economic and demographic data presented herein is organized by County Subdivision or Judicial District (hereinafter, "District.") The Subject falls within the Ewa District, a large area extending from approximately H-3 in the east, to the Wahiawa area in

[3] Subsequent references to "SMS" refer to this August, 2003 report unless otherwise stated.

[4] Subsequent references to "Claritas" refer to this source unless otherwise stated.

the north, and partway up the Waianae coast to the west. The Ewa, Wahiawa and Waianae Districts together are areas sometimes referred to as Central and West Oahu. Within these areas, the Ewa District includes most of the developing master-planned residential communities of the island. Ongoing or recently completed communities within the Ewa District include the Villages of Kapolei, Ewa by Gentry, Kunia, Mililani Mauka and Waikele.

As used in this report, "Central-West" refers to the Ewa, Waianae and Wahiawa Districts combined.

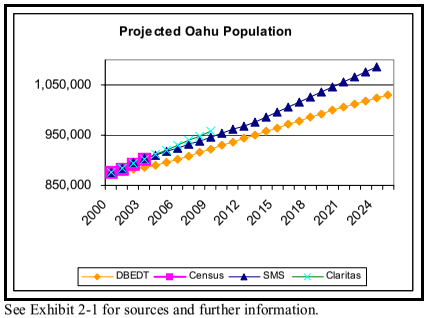
2. Economic and Demographic Trends

Resident Population Trends

Projected Oahu Population

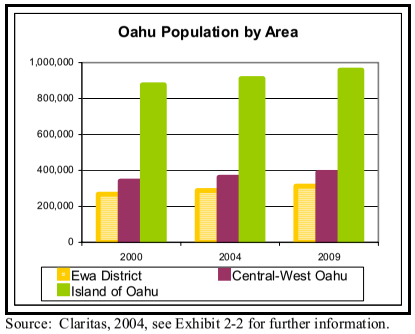
Oahu recorded 876,156 residents at the U.S. Census in 2000. Four sources are considered in estimating how population has grown since then, and how it is likely to grow over the next two decades.

The U.S. Census, SMS and Claritas show similar results in the early years of their projections, since they were all prepared or updated within the last 12 months and thus had the benefit of the 2000 Census enumeration and subsequent surveys. SMS's projection provides the only long-term outlook of the three, with a projected 1,085,949 residents island-wide in 2024.



See Exhibit 2-1 for sources and further information.

The State of Hawaii, Department of Business, Economic Development and Tourism (DBEDT) also offers a long-term projection, however, this series was last updated in 2000, without the benefit of the 2000 Census results at the time. Even so, the difference between the SMS and the DBEDT projections for 2024 is only 6%.



Source: Claritas, 2004, see Exhibit 2-2 for further information.

Population by Area

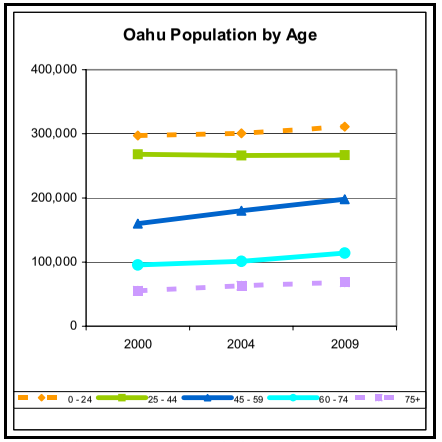
Population outlook for areas within the island is only available to 2009. Central-West already houses some 40% of the island's population, and Claritas expects this share to grow. The Ewa District has the majority of the Central-West population, and is also anticipated to increase in share.

Population by Age Group

Oahu's largest age group is those under 25. However, the next largest age groups are the 25 to 44 and the 45-59 age groups, both prime markets for home buying.

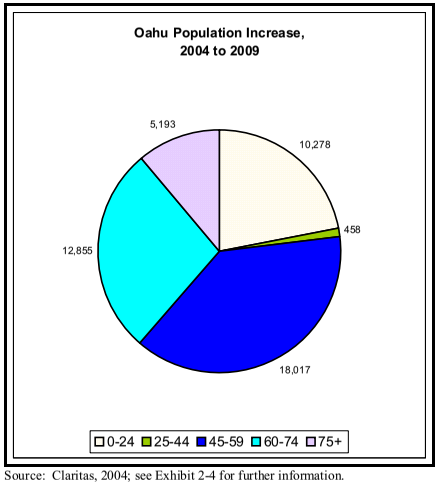
Together, these two groups include nearly 450,000 persons in 2004.

The most rapidly increasing group is expected to be the 45- to 59-year olds, followed by the 60- to 74-year olds. This reflects the baby boomer generation moving into and through their 50s and 60s. In contrast, the 25 to 44 age group on Oahu is anticipated to see almost no increase between 2004 and 2009.



Source: Claritas, 2004; see Exhibit 2-3 for further information.

Number of Households



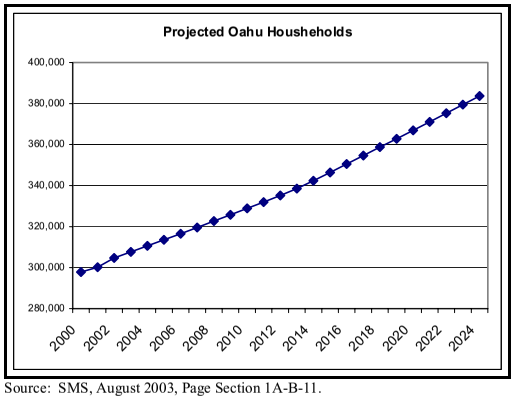
Source: Claritas, 2004; see Exhibit 2-4 for further information.

Both SMS and Claritas prepared estimates or projections of Oahu's households in 2004 and 2009. In 2004, Claritas estimated Oahu had 300,269 households, while SMS estimated 310,659. For 2009, Claritas estimated 318,709 vs. SMS' 325,810. The two sources differ by 3% and 2%, respectively, in 2004 and 2009.

Long-term Projection of Households

SMS projected Oahu households to 2024, utilizing the projected population figures shown previously and assuming a continuation of the trend towards smaller households. The projection shown assumes the

average Oahu household declines from 2.94 persons in 2000, to 2.83 in 2024.

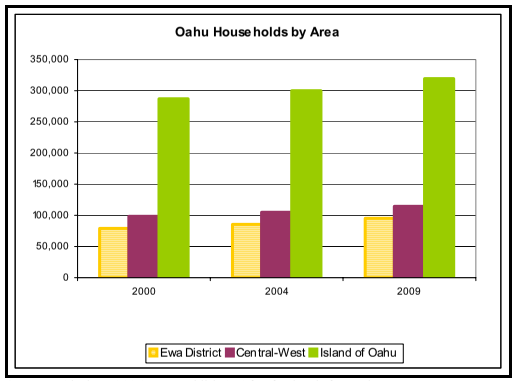


Source: SMS, August 2003, Page Section 1A-B-11.

Claritas' projections do not go beyond 2009, but do offer greater detail by area and other characteristics, as presented in the following sections.

Households by Area

Claritas estimates 35% of Oahu's households lived in the Central-West area in 2004, and that the majority of Central-West households were in the Ewa District. Oahu households are expected to continue to increase more rapidly than population due to declining average household size.

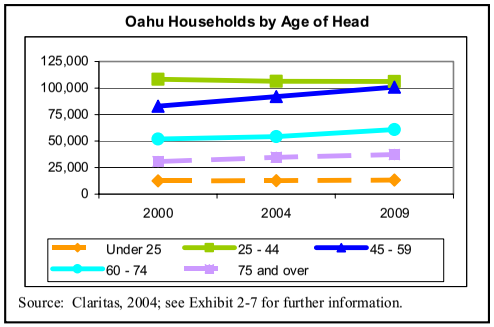


Source: Claritas, 2004; see Exhibit 2-6 for further information.

By 2009, Oahu is projected to have some 318,700 households, with 36% of those located in Central-West.

Oahu Households by Age Group

Household heads tend to be older than the population as a whole. The biggest group on Oahu is currently householders ranging from 25 to 44; however the number of households headed by those aged 45 to 59 is increasing most rapidly. This group's size is anticipated to approach the 25 to 44 age group by 2009.

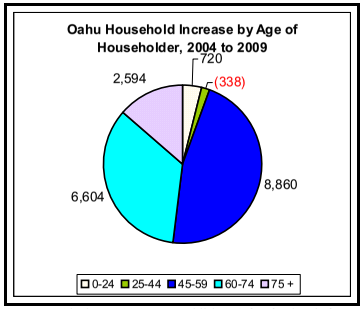


Source: Claritas, 2004; see Exhibit 2-7 for further information.

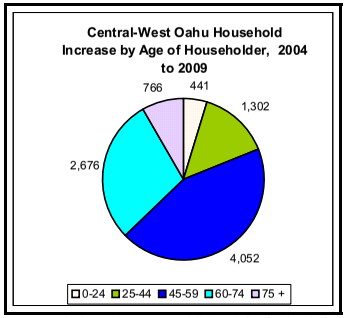
Over the next five years, there could be dramatic growth in the numbers of households headed by persons in their prime home-buying years.

For the island as a whole, the combination of population growth, aging, and a trend towards smaller households could lead to 8,860 more households headed by persons aged 45 to 59, and 6,600 more by those aged 60 to 74, within the next five years. There could be a decline in the number of households headed by those aged 25 to 44, as shown on the chart to the right.

Within Central and West Oahu, the pattern of change is expected to be similar, but with their relatively younger population compared to the island as a whole, these areas would still see increases in young households (householders aged 25 to 44), and relatively less increase in the 60 to 74 year-old householder group, as shown below.



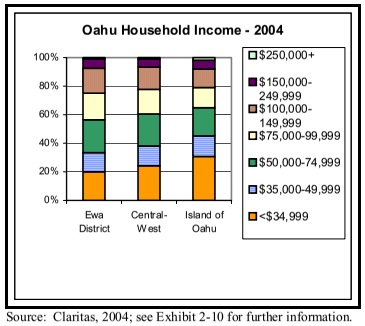
Source: Claritas, 2004; see Exhibit 2-8 for further information.



Source: Claritas, 2004; see Exhibit 2-8 for further information.

Households by Income

Compared to the island as a whole, the Ewa District in particular and Central-West in general show a higher household income profile. Claritas estimates the median 2004 household income is approximately $68,000, $63,000 and $56,000 for Ewa, Central-West and the island of Oahu, respectively.



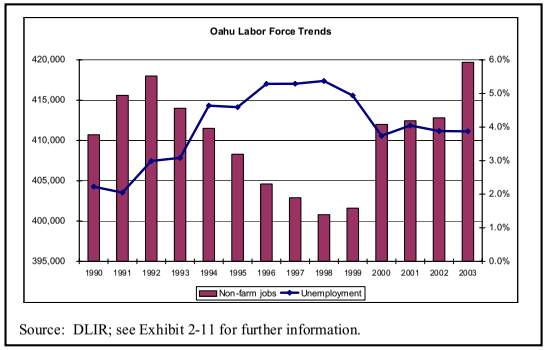
Source: Claritas, 2004; see Exhibit 2-10 for further information.

The Ewa and Central-West areas also show relatively fewer households with incomes below $49,999, and greater shares with incomes between $50,000 and $149,999.

Employment Trends and Outlook

Labor Force Trends

The State of Hawaii, Department of Labor and Industrial Relations (DLIR) reports Honolulu civilian unemployment at 3.2% in April 2004[5]. This is down from the County annual averages of 3.9% to 4.0% in the 2001 to 2003 period, and significantly down from the 4.6% to 5.4% range exhibited from 1994 to 1998.



Source: DLIR; see Exhibit 2-11 for further information.

Oahu has been adding jobs since 1998, and has supported annual increases in the number of employed persons since 2001.

Oahu Visitor Industry Trends

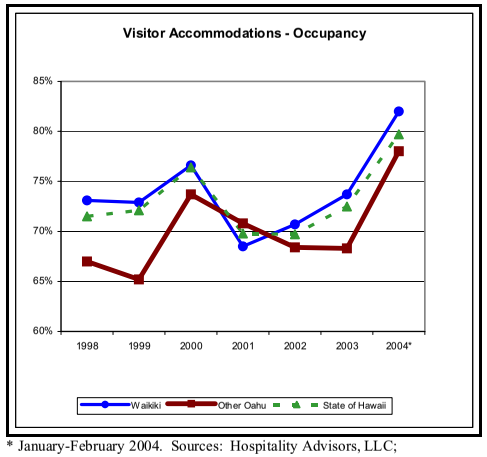
In 2003, Oahu welcomed 4.1 million visitors, of whom 59% were domestic and 41% international.

Oahu's domestic arrivals have slowed since the late 1990s, as more visitors are able to travel to the Neighbor Islands without first stopping in Honolulu. International arrivals are also down, reflecting a statewide trend.

Hotel occupancies, however, are up significantly since 2001, reflecting the longer lengths of stay and slight declines in the visitor room inventory in Waikiki.

[5] Not seasonally adjusted, for civilian labor force. See www.state.hi.us/dlir/rs/loihi

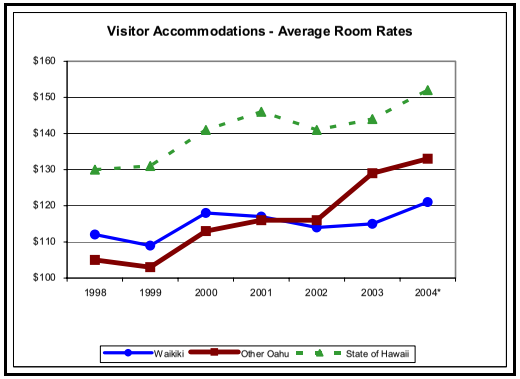
For the first two months of 2004, average occupancies were 82% in Waikiki, and 78% elsewhere on Oahu (principally at Ko Olina and Kuilima Resorts.)



* January-February 2004. Sources: Hospitality Advisors, LLC; PricewaterhouseCoopers LLP; see Exhibit 2-13 for further information.

These figures were comparable to the statewide trend, which showed an average of 80% for the period.

Likewise, room rates have been on an upswing since about 2002, with an average achieved rate of $121 in Waikiki and $133 elsewhere on Oahu in early 2004. Due to its predominance of older facilities without extensive resort amenities, Oahu's visitor properties tend to be priced below their Neighbor Island counterparts; hence the average Oahu rates are below those seen for the state as a whole.



* January-February 2004. Sources: Hospitality Advisors, LLC; Pricewaterhouse Coopers LLP; see Exhibit 2-13 for further information.

3. Housing Supply and Demand Indicators

Historical Supply Conditions

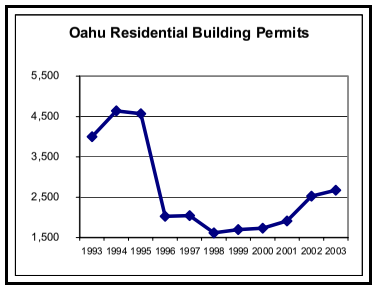
2004 Inventory

Oahu has some 331,200 housing units in 2004, of which 91% are estimated to be occupied, according to Claritas. Among occupied units, 55% were owner-occupied and 45% renter-occupied.

About 34% of the island's housing units are located in Central-West Oahu, representing about 113,700 units, according to Claritas. Of these, 93% are believed to be occupied. Among those occupied units, 63% are owner-occupied and 36% renter-occupied.

Residential Building Permits

Oahu residential permitting plunged from 1995 to 1996, as the effects of the collapsing real estate "bubble" of the late 1980s and early 1990s were finally realized. However, despite a fully recovered market, residential permitting has risen materially only since about 2001.



Source: City & County of Honolulu; see Exhibit 3-1 for further information.

In 2003, some 2,670 new residential building permits were obtained on Oahu, according to the City and County. This compares to more than 4,500 per year in 1994 and 1995.

Market Trends

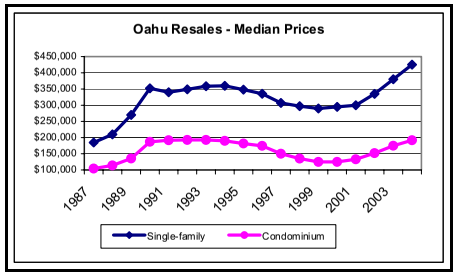
Oahu Home Resales

Rapidly rising home prices reflect the relatively limited production of new housing, combined with strong labor market conditions and highly favorable financing conditions in recent years.

Sales recordations of existing homes during the first four months of 2004 showed a median single-family price of $425,000 and a median condominium[6] price of $192,000.

[6] Defined by the Honolulu Board of Realtors as duplexes, townhomes and other multifamily units having common areas.

Residential sales velocity has also shown dramatic increases. Between January and April 2004, 3,642 existing homes were sold on Oahu, 13.1% more than during the same period last year. The number of homes resold on Oahu has shown nearly consistent increases every year since 1995.

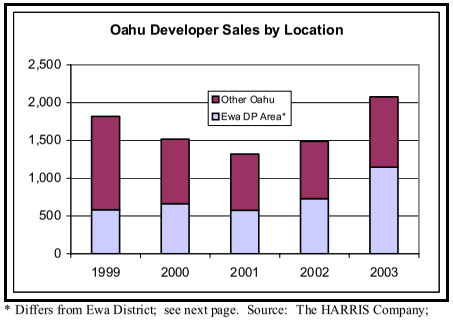


* Year-to-date as of April 30, 2004. Source: Honolulu Board of Realtors; see Exhibit 3-2 for further information.

Leeward Home Resales

In Leeward Oahu, an area defined by the Honolulu Board of Realtors to include the Subject property and much of the Ewa District, the median priced single-family home sold for $340,000 in the first four months of 2004, while the median-priced condominium unit sold for $170,000. These both represent 22% increases over the corresponding periods in 2003.

Also in the Leeward area, sales are up 17.2% for single-family units and 19.9% for condominium units so far this year[7].



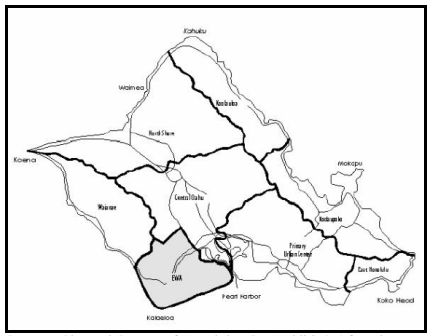
* Differs from Ewa District; see next page. Source: The HARRIS Company; see Exhibit 3-3 for further information.

Developer Unit Sales by Area

Developer-built homes are likewise showing rapid sales absorption and rising prices. Oahu recorded an estimated 2,077 new home sales in 2003, representing an average annual change of 3.4% since 1999.

Considering only Ewa, developer sales are up 18.4% per annum since 1999, to a total of 1,147 units closed in 2003. This represents 55% of new homes sold on Oahu in the year, up from 583 in 1999.

[7] Honolulu Board of Realtors, "April 2004 Monthly Statistical Report," May 3, 2004.

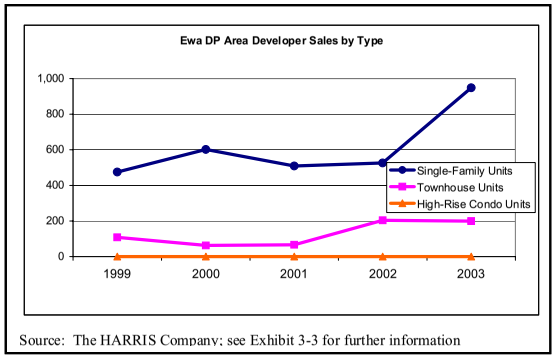


Source: City and County of Honolulu. See Exhibit 3-4 for a larger scale copy.

These data are based on classification of HARRIS Company data into the City's Ewa Development Plan (DP) area, which is a smaller region than the Ewa Judicial District referred to earlier[8]. The map below highlights the Ewa and other DP or Sustainable Community Plan areas of Oahu.

Ewa Developer Unit Sales by Type

In the Ewa DP, most developer sales were single-family units. This reflects a preference at the entry level of the market for small-lot, detached single-family homes in lieu of attached townhomes.



Source: The HARRIS Company; see Exhibit 3-3 for further information

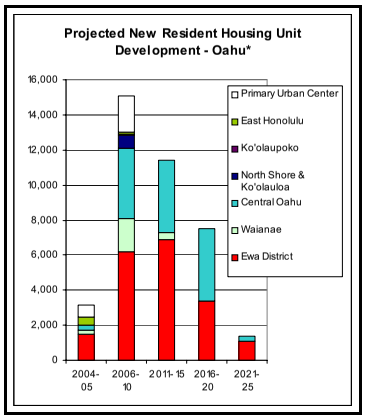
Housing Supply Outlook

Planned Communities in Ewa

MC conducted a detailed review of planned residential development projects within the Ewa DP area. This survey addressed projects of 100 units or more for which State Land Use Commission (LUC) designation Urban is in place, and/or for which the landowner may be exempt from LUC governance.

Excluding the Subject, approximately 20,000 units of State-entitled future development were identified at 16 sites. This figure is slightly lower than that quoted by the City in its draft documents for the Ewa DP 5-Year Review, which is now underway. This is because in several cases, stated developer plans were less than their entitlements.

[8] The Ewa District as defined earlier includes all of the Ewa, and most of the Central Oahu DP areas, as well as portions of the Primary Urban Center (see Page 2 and Exhibits 1-3 and 3-4.)



* Planned developments with State Land Use Urban designation or exemption as of May 2004. Source: Mikiko Corporation, 2004; see Exhibit 3-7 for further information.

This 20,000 inventory represents 19,000 resident housing units, and about 900[9] nonresident housing units. The latter is expected to be targeted at the resort, second home and offshore retirement home markets, not at primary residential buyers.

Projected Oahu Housing Development

Combining the data on Ewa DP resident housing projects with information for the rest of the County shows some 38,500 resident housing units with LUC approval at this time.

Based on information provided by developers and landowners and on historical absorption rates of similar products in the area, buildout of these entitled units could occur as follows:

Summary of Supply and Demand Factors

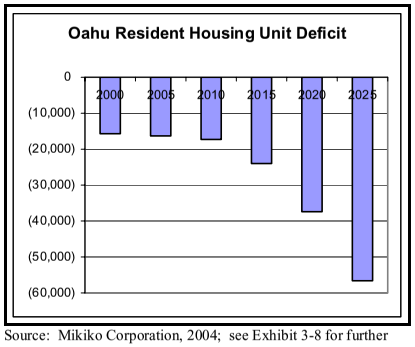
The SMS study also inventoried Oahu housing units, with consideration for vacancy factors and those units that are in nonresident use. After comparing available resident housing units to the number of households, SMS estimated a pent-up demand of some 15,700 homes in 2000 and 16,300 in 2005.

In addition, SMS projects that Oahu households will increase from about 297,900 in 2000, to 383,700 in 2024, as depicted previously on Page 4. By 2025, the island could have some 387,400 households, assuming average household size remains constant at the 2.83 projected by SMS for 2024[10].

[9] Based on the estimated 885 remaining developable residential units at Ko Olina.

[10] 2025 figure interpolated from SMS projections, which go to 2024 only.

These projections suggest a need to house some 73,800 more households over the 20-year period from 2005 to 2025, in addition to the 2005 pent-up demand for 16,300 housing units.



Source: Mikiko Corporation, 2004; see Exhibit 3-8 for further information.

Overlaying this future need with the projected future residential developments, and making allowance for vacancies, it appears that without further State entitlement of major housing developments, Oahu's shortage of primary resident housing units could increase to about 56,600 by 2025.

4 - Comparison Developments

Selection Criteria

MC visited and/or interviewed representatives at 16 recently developed single- and multifamily projects. The purpose of this survey was to evaluate their development characteristics, product types and market performance.

Projects were selected for comparison with preference for those sharing the following characteristics with the Subject:

- ❑ Location in Ewa DP area.
- ❑ Location in a master-planned community that includes a golf course.
- ❑ Golf- but not ocean frontage.
- ❑ For those without golf frontage, golf or distant ocean views, and or/other amenity frontage.
- ❑ Some in primary residential communities, some in golf resort communities.
- ❑ First product sales within the last 10 years, with preference for those developed more recently.

Single-Family Products

Project Characteristics

Surveyed single-family developments included:

1. **Kula Lei**, a 199-unit neighborhood at Ewa by Gentry.
2. **Hu`elani**, a 101-unit, gated single-family detached condominium project in Ewa by Gentry.
3. **A`eloa**, a 332-unit project in the Villages of Kapolei.
4. **Palms at Kekuilani**, a 186-unit project in the Villages of Kapolei.

5. **Kapolei Knolls**, a 425-unit project on a hill with views of the Kapolei Golf Course and the Ewa coastline.

6. **The Estates at Ko Olina Kai**, the 60 single-family units of the 324-unit overall project now underway at Ko Olina Resort.

All of the single-family comparison properties are located on Oahu. Five of the six are golf-front. The first five listed above are in primary residential communities, while Ko Olina Resort is considered primarily a resort/second home community.

Key characteristics are summarized by community type as follows:

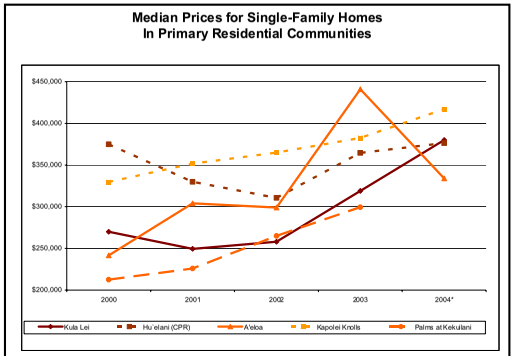
Category/ number of projects	Average (range) units per gross acre	Average lot size (sf)
Golf resort community/1	6.0*	<= 6,500
Primary residential communities/5	7.0 (5.6 to 8.7)	4,400

* Estates of Ko Olina. Density refers to project as a whole, including its multifam component; data not available for single-family portion only.
Source: Mikiko Corporation, 2004; see Exhibit 4-1 for further information.

Median Sales Prices

As in other market groups, prices at the selected single-family projects have also escalated rapidly.

In the primary residential market, the typical price for a unit with 1,400 to 1,800 square feet was close to $400,000 in early 2004. This is a substantial increase from the range in 2000, when median prices for three of the five sampled projects were between $200,000 and $300,000.



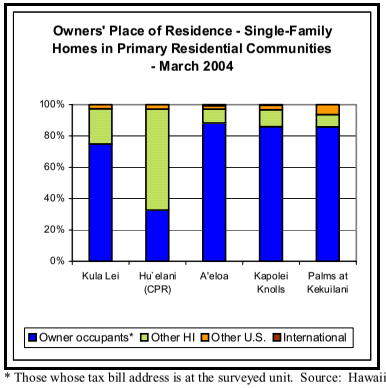
* Recorded sales as of March 31, 2004. See Exhibit 4-2 for further information.

The apparent drop in 2004 price at A`eloa is considered an anomaly of sample size. Between January 1 and March 31, 2004, only 5 homes had recorded at A`eloa compared to 10 to 25 sales per year in the prior full years.

Unfortunately, the only golf resort project in the sample has not yet recorded any sales. Offering prices for the Estates at Ko Olina Kai begin in the mid-$900,000's, more than twice the range of units at golf-front projects in primary residential communities. Other single-family golf resort projects now marketing in the state are generally priced even higher, and are often at highly coveted oceanfront sites, making them not comparable.

Buyer Origins

Ownership records at four of the five single-family primary community comparison projects show 75% to 88% of current owners live at the project. Another 8% to 23% of owners receive their tax bills at another address in Hawaii, suggesting that they may live at the property (and be receiving bills at the office, for example), or that they are investor-buyers who may be renting the unit. About 3% to 6% of owners show a tax bill address out of state, suggesting that these units are investments, second homes or part-time residences.



* Those whose tax bill address is at the surveyed unit. Source: Hawaii Information Service; see Exhibit 4-3 for further information.

The fifth project, Hu`elani, shows relatively more owners whose tax bill addresses is in Hawaii but not at the project. It is possible that the condominiumization and gating of this project encourages investor-buyers. However, project representatives indicated they were not aware of any vacant or rented units. Thus, many of these may also be primary residents who are receiving their tax bills somewhere other than at home. Together, owner-occupants and other Hawaii residents represent 97% of Hu`elani owners, a statistic similar to those for the other projects sampled.

Multifamily Products

Project Characteristics

Ten multifamily projects were surveyed. Those in golf-resort communities included:

1. **The Coconut Plantation**, a 270-unit development within Ko Olina Resort that includes flats and townhomes.

2. **Villas at Ko Olina Kai**, the 264-unit multifamily component of this mixed use development at Ko Olina Resort. All of the multifamily units are located on interior areas of the project site.

3. **Kai Lani**, a 116-townhome project in Ko Olina Resort that recently sold out and is now in resales.

4. **Ko Olina Fairways**, a 280-townhome project, and the earliest residential development in Ko Olina Resort.

5. **Waikoloa Colony Villas**, a 168-unit, 6-plex development in a golf-front location at Waikoloa Beach Resort on the island of Hawaii.

6. **Na Hale O Keauhou**, an 84-unit, 6-plex development at Keauhou Resort on the island of Hawaii that offers ocean views.

7. **Wailea Fairway Villas**, a 118-unit stacked flat and townhome development at a golf-front site at Wailea Resort, Maui.

The three primary residential multifamily projects surveyed are all located on Oahu:

8. **The Colony at the Peninsula**, a 96-unit, 4-story project within this new neighborhood in Hawaii Kai.

9. **Mariners Place,** a 126-unit project on an interior site within Ocean Pointe.

10. **Ke Noho Kai,** 131 townhomes in Increments 1 to 4 of this mixed use project in Ocean Pointe. The site fronts on a planned golf course site but currently offers only interior views.

Key characteristics of the multifamily projects are summarized by community type as follows:

Category/ number of projects	Average (range) units per gross acre	Range of unit sizes (net interior sf)
Golf resort communities/7	9.5* (6.0 to 14.4)	847 to 1,834
Primary residential communities/3	16.2** (15.3 to 17.1)	823 to 1,700

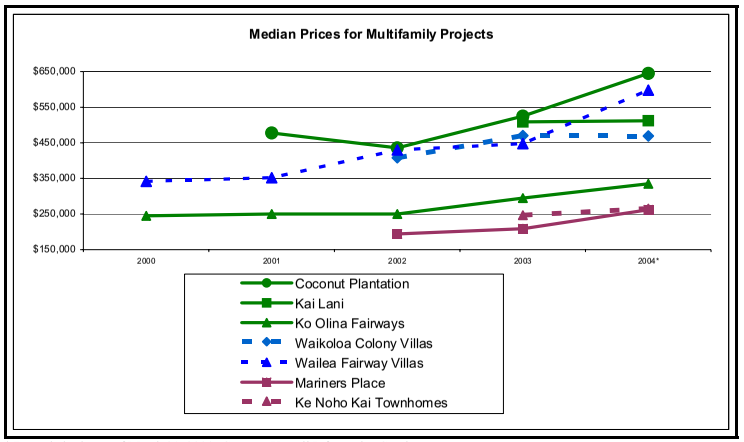
* Excludes the Estates at Ko Olina Kai, since figures are not available for the multifamily component alone.
** Excludes The Colony, for which site area data are not available.
Source: Mikiko Corporation, 2004; see Exhibit 4-4 for further information.

Median Sales Prices

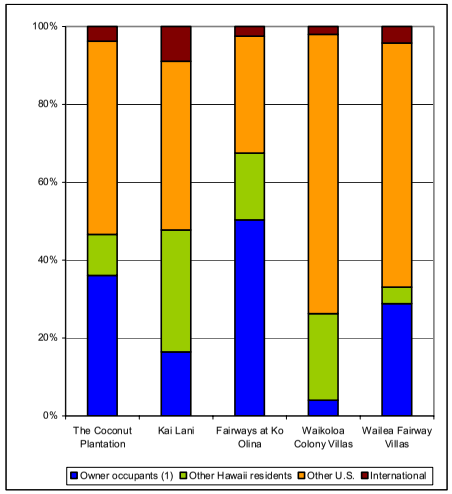
Median sales prices for the surveyed multifamily projects have risen rapidly in recent years, wherever sufficient inventory has been available.

The only two showing declines from 2003 to early 2004 are Kai Lani and Waikoloa Colony Villas, both of which have been completing their initial developer sales and have had remnant units to close this year.

Excluding the older Ko Olina Fairways, there is a clear distinction between the resort products, which are now clustered between $450,000 and $650,000, and the primary residential community products, which were showing prices between $260,000 and $265,000 in early 2004.



* Recorded sales as of March 31, 2004. Source: Hawaii Information Service; see Exhibit 4-5 for further information.

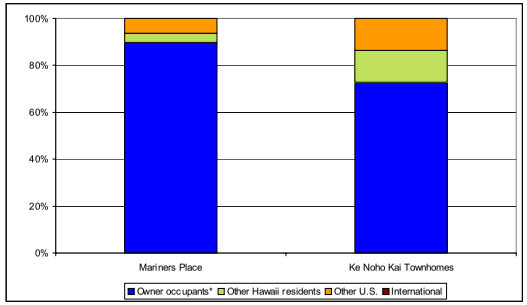


* Those whose tax bill address is at the surveyed unit. Source: Hawaii Information Service; see Exhibit 4-6 for further information.

Buyer Origins

Excluding the Fairways at Ko Olina, the five resort comparison projects show about 4% to 36% of current owners live at the project. The Fairways shows 50%. Mainland and international-resident owners represent around 33% (Fairways) to 74% (Wailea Fairway Villas) of current owners.

The two multifamily projects within the primary residential community Ocean Pointe show dramatically different owner profiles. Owner-occupants represent at least 73% to 90% of owners, while U.S. mainland residents represent 14% and 6%, respectively. Neither project showed any evidence of international ownership at the time of the data search.



* Those whose tax bill address is at the surveyed unit. Source: Hawaii Information Service; see Exhibit 4-6 for further information.

5 - Conclusions for Kapolei West

This section presents the study conclusions for Kapolei West in terms of its:

- Development concepts
- Buyer market mix, densities and number of units
- Market demand factors
- Sales absorption and pricing

Development Concepts

Kapolei West is in a transitional location, bridging between the resort second home and visitor attractions of Ko Olina Resort to its west, and the primary residential community and city of Kapolei to its east.

Within Kapolei West, the development sites can also be seen in two thematic areas.

Primary Resident-Oriented Areas

East of proposed roads D and F, residential development is seen to be mostly oriented to a primary residential market. These areas will offer golf-frontage and ready access to major thoroughfares of the region, but mostly golf- and interior-project views (with the exception of site D, where the site's slope may offer ocean views).



Source: Helber Hastert & Fee, Planners, April 27, 2004. See Exhibit 1-1 for copy at larger scale.

The eastern area of the Subject would include Sites A, B, C, D and E. It would also include Site L, an area separated from the rest of the Project by a planned regional connector road. Site L is planned to be set-aside as a potential future transit station with residential and commercial uses to be developed in conjunction.

Resort/Second Home-Oriented Areas

Sites to the west of proposed Roads D and F will offer ocean and/or Ko Olina Resort, Golf Course and Marina views. Along portions of its western end, the Subject property also fronts on the existing Ko Olina Golf Course. Site K extends makai to touch the Ko Olina Marina.

These characteristics lend a leisure and vacation appeal to this end of the property. Thus, the western end of the Subject, encompassing Sites F, G, H, I, J and K, is proposed to be developed with particular consideration for retiree and resort/second homebuyer market segments.

Buyer Market Mix, Densities and Number of Units

Buyer Market Mix

Assessment of the Project's buyer market mix considers the above locational factors, as well as the study findings regarding ownership at the selected comparison properties.

To review, at the primary residential community projects sampled, owner-occupants represented:

- 75% to 88% of owners among single-family projects (excluding Hu`elani), all of which were golf-front and
- 73% to 90% of owners at the sampled multifamily projects for which data was available.

Within the golf resort communities sampled, owner-occupants represented:

- 16% to 50% of owners at the projects within Ko Olina (16% to 36% if the older Fairways is excluded), and
- 4% to 29% of owners at the neighbor island projects for which data was available.

The balance was typically other Hawaii residents at the primary residential communities. Some of these owners could be owner-occupants and some may be investors. Up to 14% of owners at the multifamily projects in primary communities were U.S. mainland residents.

At the golf resort communities, the majority of owners typically resided on the U.S. mainland. These represented between 43% and 72% of owners at the multifamily projects, excluding the Fairways at Ko Olina (which showed 30%.) Foreign residents represented 2% to 9% of owners at the multifamily golf resort projects.

Based on these findings, the Project's buyer market mix is projected to be approximately as follows:

	Eastern lands	Western lands	Overall
Primary residents	75% to 90%	25% to 45%	61%
Non-resident buyers*	10% to 25%	55% to 75%	39%
Total	**100%**	**100%**	**100%**

* Resort, second home and/or retiree markets, likely to come from the West Coast or other mainland U.S.
Source: Mikiko Corporation, 2004; see Exhibit 5-1 for further information.

Gross Unit Densities

At the eastern end of the site, Helber Hastert & Fee Planners (HHF) proposes gross unit densities to range from 8 to 10 units per acre, as shown in Exhibit 5-1. This would be at or below the densities observed at the selected comparison properties within primary residential communities, which ranged from 5.6 to 8.7 per acre for single-family projects, and 15.3 to 17.1 per acre for the multifamily projects. (See also Exhibits 4-1 and 4-4, with summaries on Pages 11 and 13.)

The residential components of development at the transit/mixed use site at L are proposed at 15 units per acre, a density consistent with those observed at the comparison primary residential multifamily projects.

At the western end of the Subject, Sites F, G and H are planned for development at up to 18 units per acre. Such densities would allow building heights that could maximize view opportunities across Ko Olina Resort, Golf Course and Marina, as well as of the sunset and ocean.

Sites I and J are located in an area of greater slope, which is most conducive to lower-density single-family or attached to development. HHF proposes development at up to 7 units per acre at these sites. This is well within the densities observed at the sampled golf

resort projects, which averaged less than 6 per acre at the single-family comparison property, and 9.5 per acre at the sampled multifamily projects.

The Marina-front Site K has a long and narrow configuration and is seen to accommodate just a few very unique residences, at an average density of 1 unit per acre.

Number of Units

The proposed densities result in a total potential development of 2,370 units, as shown in Exhibit 5-1. Among these, about 1,320 could be on the eastern lands and generally oriented towards primary residents, and 1,050 could be on the western lands and generally oriented towards resort/second home buyers.

Proposed Number of Units at Kapolei West

	Eastern lands	Western lands	Overall
Primary resident homes	1,110	340	1,450
Non-resident homes	210	710	920
Total	**1,320**	**1,050**	**2,370**

Source: Helber Hastert & Fee, Planners and Mikiko Corporation, 2004; see Exhibit 5-1 for further information.

Market Demand Factors

Primary Resident Market Demand

As shown in Section 3, Oahu exhibits a strong pent-up demand for primary resident housing, with an estimated 15,700 shortfall in 2000 anticipated to grow to about 16,300 by 2005 (see Page 10 and Exhibit 3-8).

In addition, the demand for household formation after 2005 is expected to outpace new housing production throughout the subsequent 20 years, based on lands that hold LUC approval or for which the owner is exempt. If no more lands were granted LUC approval on Oahu, the shortage could represent 37,400 units by 2020, or about 56,600 by 2025.

Considering the Ewa DP area's historical 55% share of the island market for new housing, the Ewa DP area deficit is estimated at 9,520 units in 2010, or 13,200 by 2015, as shown in Exhibit 5-3.

If granted entitlements, the approximately 1,450 primary resident housing units at the Subject would represent a solution for about 4% to 5% of the otherwise unmet demand for primary housing in Ewa over the 2005 to 2015 period, and even less thereafter. Its location in the rapidly developing Ewa DP area makes it a logical area to provide new housing.

Based on sales closings demonstrated by other communities in the Ewa District, Kapolei West is anticipated to support a sales velocity averaging about 120 units per year during its marketing period.

Nonresident Market Demand

With only one project available for sales closings in 2002 and two in 2003, Ko Olina has sold an average of 116 units per year over the two years. The Ko Olina Kai Estates and Villas also held a pre-sales lottery in March 2004, and took reservations for all units offered, including 48 single-family units priced from the $900,000s and multifamily units priced from the mid-$400,000s.

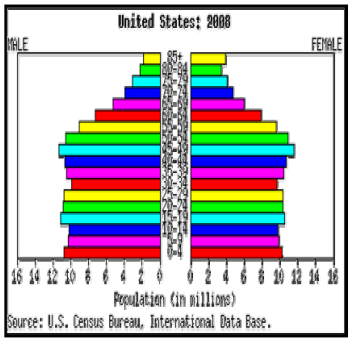
These strong sales reflect an untapped demand and still emerging market for resort, second and retirement homes at Oahu golf resorts outside of Waikiki, targeted at offshore buyers. The remarkable Ko Olina sales performance also occurred simultaneously with robust timeshare sales at Ko Olina, and visitor-oriented condominium sales in Waikiki.

Future sales within Ko Olina are expected to be stronger than this historical benchmark because:

- **Oahu is a growing market -** The golf resort residential market on Oahu remains largely untapped. Historically, golf resort residential development has been mostly on the neighbor islands, but Ko Olina has served to publicize Oahu. Further, many neighbor island resort projects are beginning to record extraordinarily high prices that many potential buyers can no longer afford.

- **More persons in prime buying years -** Over the next 20 years, the Oahu and U.S. populations will grow rapidly in the age groups that generate the most second home sales: those aged 45 to 59, and 60 to 74. This was shown for Oahu in the diagram on Page 4, and is a phenomenon shared nationwide. Thanks to the aging of the U.S. baby boom, the numbers of households within these age groups will be at unprecedented highs throughout the years of the Project's marketing.

The adjacent chart shows the age distribution of the U.S. population in 2008, the anticipated date of first marketing for Kapolei West. Note the bulge in population in the 45 to 54 age groups in that year. This, of course, will be reflected in the 50 to 59 age groups in 2013 and the 55 to 64 age groups in 2018.



- **Focus on U.S. real estate** – The stock market instability of the early 2000s, combined with the tragic events of September 2001 appear to have led to a renewed focus on real estate investment among Americans. To date, Hawaii is also seen by such investors as a relatively safe location for visiting and investing.

Considering these factors, the future Ko Olina area market for nonresident housing is seen to have the potential to increase 20% or 30% over the next 15 to 20 years. Thus, compared to the historical benchmark of 116 units sold per year in 2002-2003, future area sales could be expected to represent up to 150 units per year during the period of project marketing.

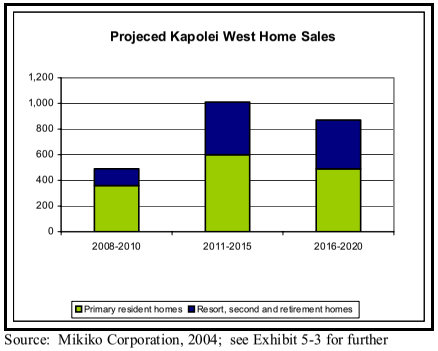
As an average figure during the projection period, Ko Olina area nonresident housing sales are estimated to represent 125 units per year, as shown in Exhibit 5-3.

Within this Ko Olina area market, Kapolei West is likely to capture only a small share in its earliest years of marketing, when Ko Olina Resort and Marina will still have resort products available on prime sites. However, after about 2011, Kapolei West could be expected to capture the majority of the potential area demand.

Sales Absorption and Pricing

Projected Absorption and Selling Period

Exhibit 5-3 summarizes the projected residential unit sales absorption at Kapolei West. Assuming the first units are available for sales closings in 2008, both the primary resident and nonresident housing units are projected to be fully absorbed within 13 years, or by 2020.



Source: Mikiko Corporation, 2004; see Exhibit 5-3 for further information.

This would represent an average sales velocity of 112 units per year for the primary resident housing units, and 71 units per year for the nonresident housing units.

The projected sales absorption is summarized by period as shown in the chart.

Projected Supportable Pricing

Considering prices achieved at the selected comparable projects (Exhibits 4-2 and 4-6), projected supportable unit pricing for Kapolei West is estimated as follows:

Projected Supportable Unit Prices at Kapolei West (2004 Dollars)

	Multifamily units	Single-family units
Primary resident housing	$300,000 to $400,000	$450,000 to $550,000
Nonresident housing	$450,000 to $550,000	$650,000 to $800,000
Transit site (L)	$250,000 to $300,000	NAP
Marina-front site (K)	NAP	$1 million +

NAP – Not applicable. Source: Mikiko Corporation, 2004.

This assessment considers the following:

- **Multifamily resident housing units** are positioned above the sampled projects at Ocean Pointe, since the latter do not yet have a golf course.

- **Single-family resident housing units** are positioned similar to or slightly higher than current resale prices at the Villages at Kapolei golf-front sites. This is in consideration of the greater prestige associated with the Project's proximity to Ko Olina Resort and the ocean.

- **Multifamily nonresident housing units** are priced in a range similar to that exhibited at current Ko Olina Resort multifamily projects, but below the Wailea Resort and Keauhou Resort project comparisons.

- **Single-family nonresident housing units** are priced below those now offered at Ko Olina Kai due to their greater distance from the resort and exclusion from its amenity privileges.

Special consideration was given to the unique products proposed on two sites:

- **The transit/mixed use site –** multifamily units here were priced similar to sales recordings at Mariners Place and Ke Noho Kai at Ocean Pointe, and at the low end of asking prices at the mid-rise Colony at the Peninsula, in Hawaii Kai.

- **The Marina-front site –** single-family units here are expected to be $1 million+ properties, depending on specific attributes of individual lots, as yet to be determined. Key considerations would include lot size, access, configuration, water frontage and views and the size and quality of home to be built on each.

MARKET ASSESSMENT FOR RESIDENTIAL USES AT THE PROPOSED KAPOLEI WEST

Exhibits

Exhibit 1-2: Kapolei West Development Concept Plan

Exhibit 1-1: Kapolei West Project Location

Exhibit 1-3: Central and West Oahu Districts, Island of Oahu

Ewa, Waianae and Wahiawa County Subdivisions

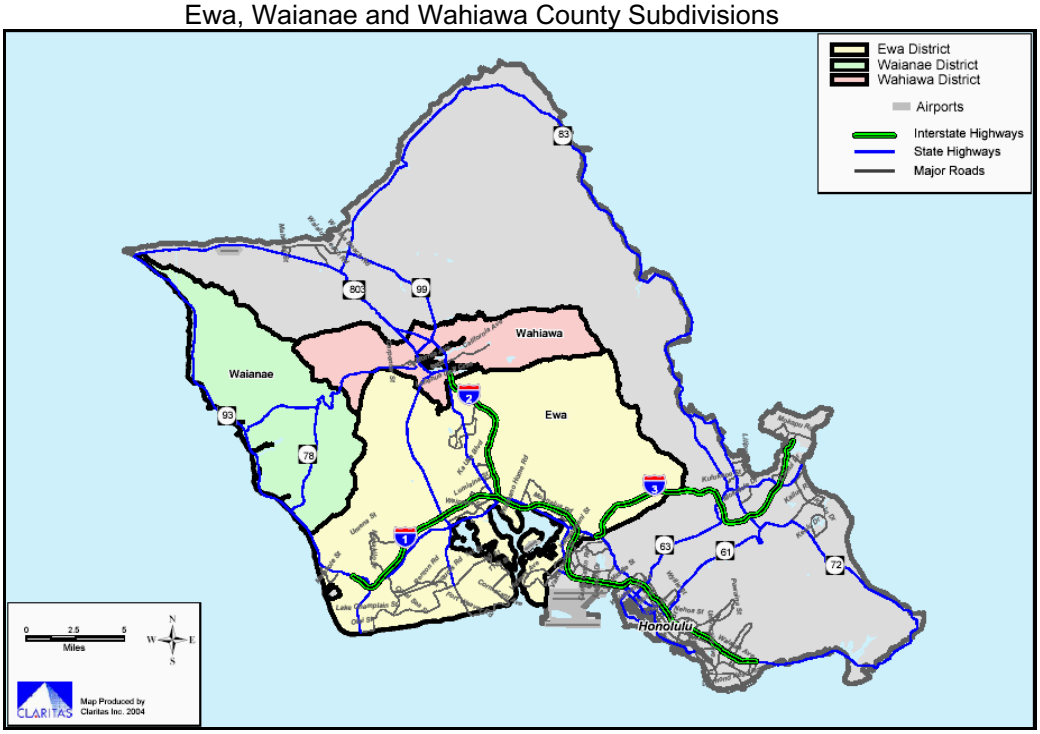
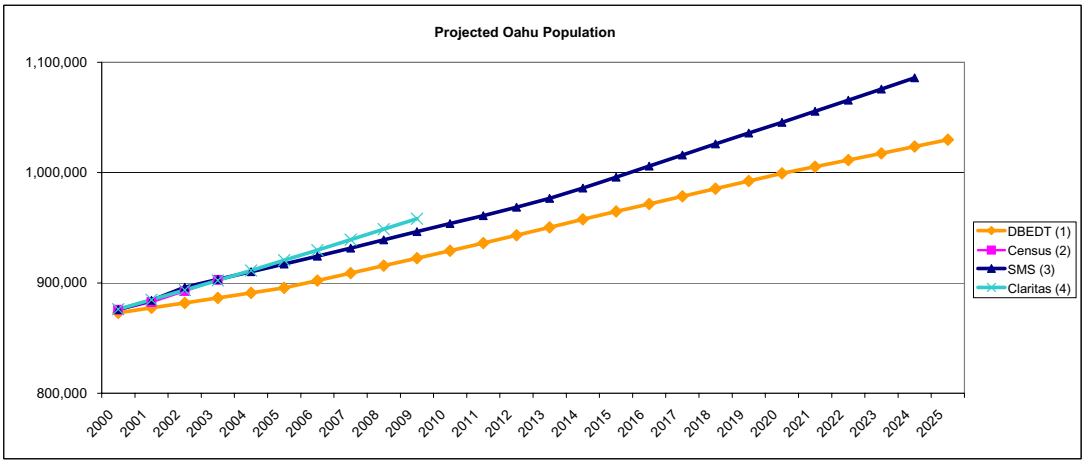


Exhibit 2-1: Resident Population - Island of Oahu

Comparison of Four Estimates and Projections

2000 to 2025

	Date prepared	2000	2001	2002	2003	2004	2005	2010	2015	2020	2025
DBEDT[1]	*2000*	872,900	877,400	881,900	886,400	891,000	895,600	929,200	964,800	999,400	1,029,800
US Census[2]	*2000-03*	875,654	882,550	892,562	902,704						
SMS[3]	*2003*	875,881	884,176	896,019	903,187	910,232	917,150	953,765	995,881	1,045,645	
Claritas[4]	*2004*	876,156	884,800	893,600	902,400	911,333	920,500				



[1] State of Hawaii, Department of Business, Economic Development and Tourism, Research and Economic Analysis Division, "Population and Economic Projections for the State of Hawaii to 2025," (DBEDT 2025 Series), February 2000. Projections for 2000 and 5-year increments thereafter to 2025; figures interpolated in-between. The same figures are reported as General Plan policy by the City in Department of Planning and Permitting, "Annual Report on the Status of Land Use on Oahu: Fiscal Year 2002," July 2003 (Table I-2.)

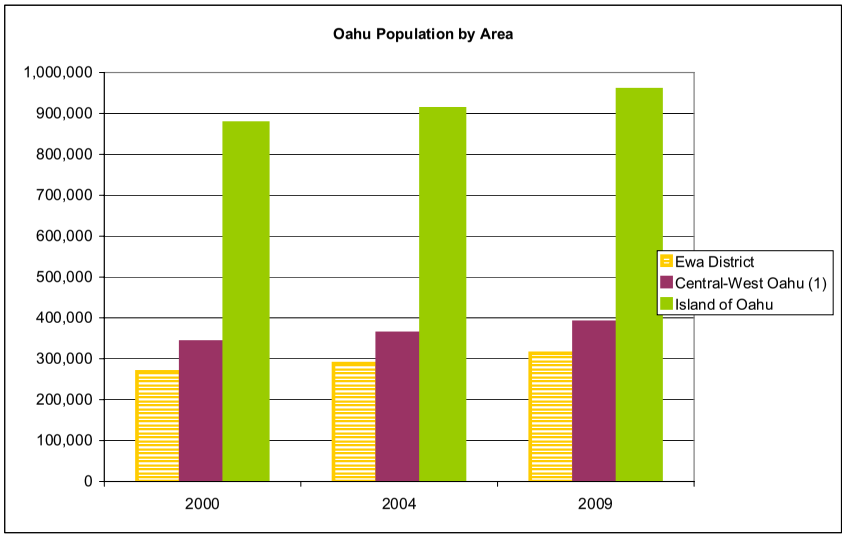
[2] US Census Bureau, Population Estimates Program, as reported at http://factfinder.census.gov/, May 12, 2004. Figures reflect July 1 estimates for each year, as shown.

[3] SMS, Inc., "Hawaii Housing Policy Study, 2003," August 2003, Page Section IA-B-11. Estimates prepared for 2000 to 2002; projections for each year thereafter to 2024.

[4] Claritas, Inc., May 7, 2004. Census enumeration for 2000; estimate for 2004; projection for 2009, with figures interpolated in between.

Exhibit 2-2: Projected Resident Population for Ewa, Central-West Oahu and Island of Oahu
2000 to 2009

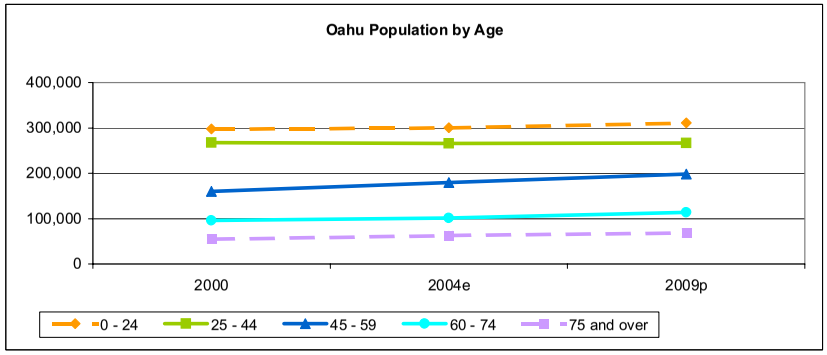
	2000	2004	2009	Average annual % increase 2000 - 2004	Average annual % increase 2004 - 2009
Population:					
Ewa District	268,331	288,229	313,245	1.8%	1.7%
Central-West Oahu[1]	340,817	362,142	389,525	1.5%	1.5%
Island of Oahu	876,156	911,333	958,134	1.0%	1.0%
As a percentage of Oahu:					
Ewa District	30.6%	31.6%	32.7%	--	--
Central-West Oahu[1]	38.9%	39.7%	40.7%	--	--



[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.
Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-3: Projected Population by Age Group
2000 to 2009

	2000	2004	2009	Average annua % increase 2000 - 2004	Average annua % increase 2004 - 2009
Ewa District:					
Under 25 years	97,389	102,004	109,509	1.2%	1.4%
25 - 44 years	88,086	91,177	94,915	0.9%	0.8%
45 - 59 years	46,730	54,317	61,416	3.8%	2.5%
60 - 74 years	25,414	27,786	32,694	2.3%	3.3%
75 years and over	10,710	12,946	14,712	4.9%	2.6%
Median Age	33.57	34.60	35.29	0.8%	0.4%
Central-West Oahu[1]:					
Under 25 years	130,925	135,233	143,077	0.8%	1.1%
25 - 44 years	109,061	111,571	114,757	0.6%	0.6%
45 - 59 years	56,297	65,281	73,756	3.8%	2.5%
60 - 74 years	31,049	33,798	39,545	2.1%	3.2%
75 years and over	13,485	16,261	18,389	4.8%	2.5%
Median Age	32.29	33.41	34.23	0.9%	0.5%
Island of Oahu:					
Under 25 years	297,400	300,692	310,970	0.3%	0.7%
25 - 44 years	267,902	266,165	266,623	-0.2%	0.0%
45 - 59 years	159,944	179,961	197,978	3.0%	1.9%
60 - 74 years	95,647	101,252	114,107	1.4%	2.4%
75 years and over	55,263	63,263	68,456	3.4%	1.6%
Median Age	35.73	36.93	37.81	0.8%	0.5%

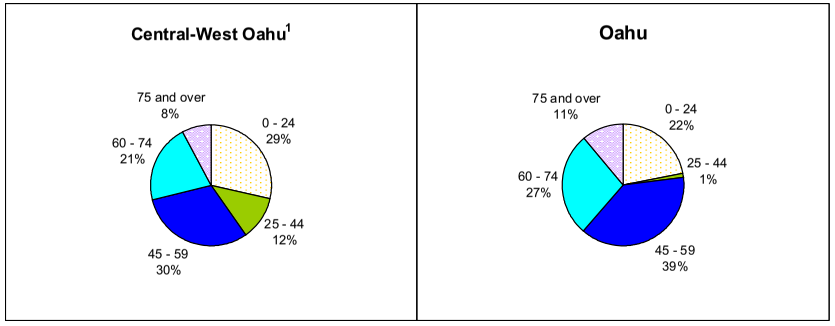


[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.
Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-4: Increase in Population by Age Group
2000 to 2009

	2000 - 2004	2004 - 2009
Ewa District:		
Under 25 years	4,615	7,505
25 - 44 years	3,091	3,738
45 - 59 years	7,587	7,099
60 - 74 years	2,372	4,908
75 years and over	2,236	1,766
Central-West Oahu[1]:		
Under 25 years	4,308	7,844
25 - 44 years	2,510	3,186
45 - 59 years	8,984	8,475
60 - 74 years	2,749	5,747
75 years and over	2,776	2,128
Island of Oahu:		
Under 25 years	3,292	10,278
25 - 44 years	(1,737)	458
45 - 59 years	20,017	18,017
60 - 74 years	5,605	12,855
75 years and over	8,000	5,193

Population Increase, 2004 to 2009

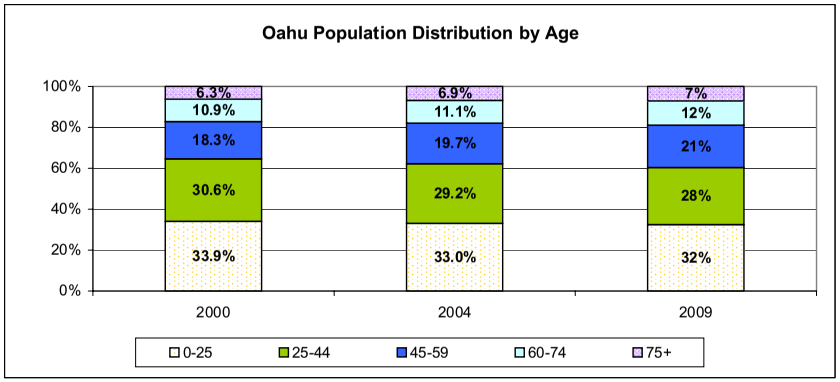


[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.

Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-5: Population Distribution by Age Group
2000 to 2009

	2000	2004	2009
Ewa District:			
Under 25 years	36%	35%	35%
25 - 44 years	33%	32%	30%
45 - 59 years	17%	19%	20%
60 - 74 years	9%	10%	10%
75 years and over	4%	4%	5%
Total	100%	100%	100%
Central-West Oahu[1]:			
Under 25 years	38%	37%	37%
25 - 44 years	32%	31%	29%
45 - 59 years	17%	18%	19%
60 - 74 years	9%	9%	10%
75 years and over	4%	4%	5%
Total	100%	100%	100%
Island of Oahu:			
Under 25 years	34%	33%	32%
25 - 44 years	31%	29%	28%
45 - 59 years	18%	20%	21%
60 - 74 years	11%	11%	12%
75 years and over	6%	7%	7%
Total	100%	100%	100%

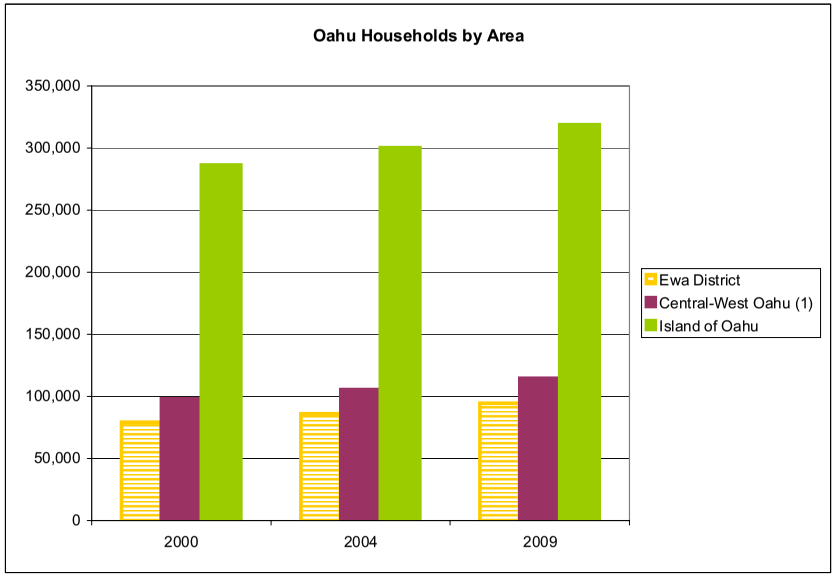


[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.

Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-6: Projected Number of Households in Ewa, Central-West Oahu and Island of Oahu
2000 to 2009

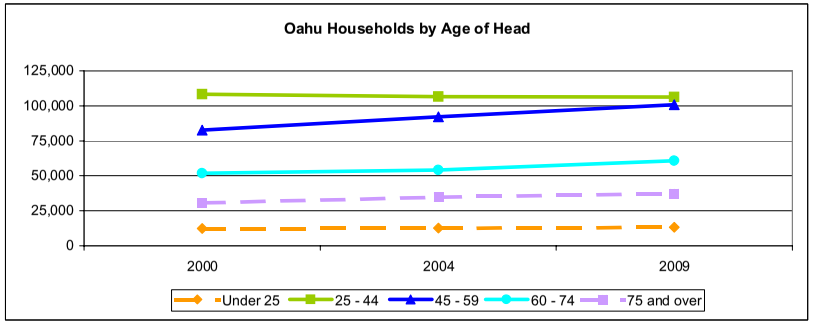
	2000	2004	2009	Averaege annual % increase 2000 - 2004	2004 - 2009
Number of households:					
Ewa District	79,289	86,044	94,537	2.1%	1.9%
Central-West Oahu[1]	98,159	105,421	114,660	1.8%	1.7%
Island of Oahu	286,450	300,269	318,709	1.2%	1.2%
As a percentage of Oahu:					
Ewa District	27.7%	28.7%	29.7%	--	--
Central-West Oahu[1]	34.3%	35.1%	36.0%	--	--



[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.
Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-7: Projected Households by Age of Head
2000 to 2009

	2000	2004	2009	Average annua % increase 2000 - 2004	2004 - 2009
Ewa District:					
Under 25 years	2,894	3,103	3,502	1.8%	2.4%
25 - 44 years	35,382	36,571	38,257	0.8%	0.9%
45 - 59 years	23,372	26,931	30,454	3.6%	2.5%
60 - 74 years	12,847	13,816	16,107	1.8%	3.1%
75 years and over	4,794	5,624	6,217	4.1%	2.0%
Median Age	45.80	46.75	47.61	0.5%	0.4%
Central-West Oahu[1]:					
Under 25 years	4,297	4,502	4,943	1.2%	1.9%
25 - 44 years	43,520	44,284	45,586	0.4%	0.6%
45 - 59 years	28,155	32,265	36,317	3.5%	2.4%
60 - 74 years	15,893	16,994	19,670	1.7%	3.0%
75 years and over	6,295	7,377	8,143	4.0%	2.0%
Median Age	45.61	46.71	47.70	0.6%	0.4%
Island of Oahu:					
Under 25 years	12,491	12,646	13,366	0.3%	1.1%
25 - 44 years	108,389	106,498	106,160	-0.4%	-0.1%
45 - 59 years	82,796	92,084	100,944	2.7%	1.9%
60 - 74 years	51,956	54,274	60,878	1.1%	2.3%
75 years and over	30,818	34,767	37,361	3.1%	1.4%
Median Age	48.72	49.80	50.74	0.5%	0.4%

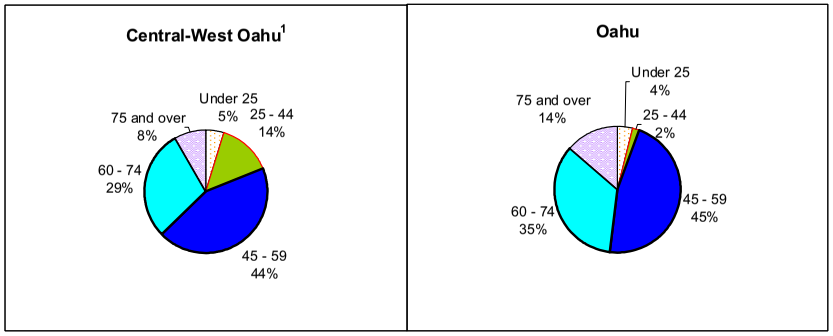


[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.
Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-8: Increase in Households by Age of Head
2000 to 2009

	2000 - 2004	2004 - 2009
Ewa District:		
Under 25 years	209	399
25 - 44 years	1,189	1,686
45 - 59 years	3,559	3,523
60 - 74 years	969	2,291
75 years and over	830	593
Central-West Oahu[1]:		
Under 25 years	205	441
25 - 44 years	764	1,302
45 - 59 years	4,110	4,052
60 - 74 years	1,101	2,676
75 years and over	1,082	766
Island of Oahu:		
Under 25 years	155	720
25 - 44 years	(1,891)	(338)
45 - 59 years	9,288	8,860
60 - 74 years	2,318	6,604
75 years and over	3,949	2,594

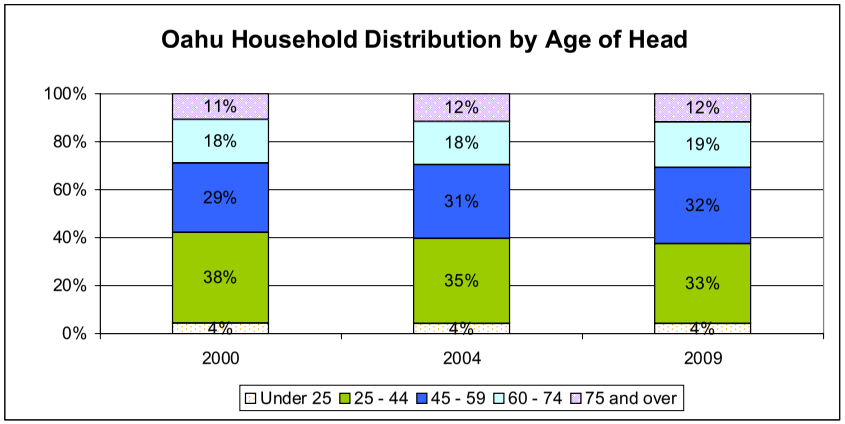
Household Increase, 2004 to 2009



[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.
Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-9: Household Distribution by Age of Head
2000 to 2009

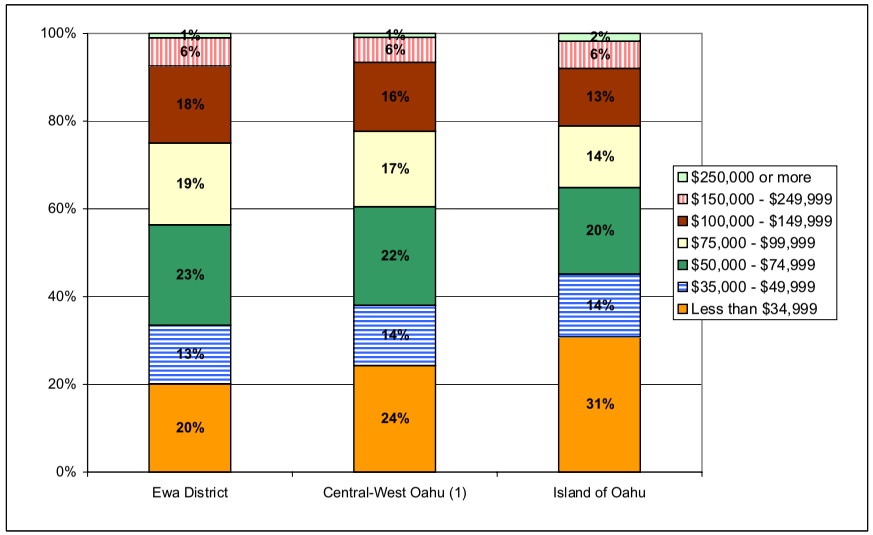
	2000	2004	2009
Ewa District:			
Under 25 years	4%	4%	4%
25 - 44 years	45%	43%	40%
45 - 59 years	29%	31%	32%
60 - 74 years	16%	16%	17%
75 years and over	6%	7%	7%
Total	100%	100%	100%
Central-West Oahu[1]:			
Under 25 years	4%	4%	4%
25 - 44 years	44%	42%	40%
45 - 59 years	29%	31%	32%
60 - 74 years	16%	16%	17%
75 years and over	6%	7%	7%
Total	100%	100%	100%
Island of Oahu:			
Under 25 years	4%	4%	4%
25 - 44 years	38%	35%	33%
45 - 59 years	29%	31%	32%
60 - 74 years	18%	18%	19%
75 years and over	11%	12%	12%
Total	100%	100%	100%



[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.
Source: 2004 Claritas, Inc., May 7, 2004.

Exhibit 2-10: Households by Household Income - 2004 Estimate

	Ewa District	Central-West Oahu[1]	Island of Oahu
Median household income	**$68,058**	**$63,327**	**$56,161**
Number of households, by income -			
Less than $34,999	17,266	25,592	92,399
$35,000 - $49,999	11,516	14,488	43,154
$50,000 - $74,999	19,715	23,694	59,172
$75,000 - $99,999	16,024	18,106	42,253
$100,000 - $149,999	15,118	16,558	39,334
$150,000 - $249,999	5,538	6,006	18,592
$250,000 or more	868	978	5,365
Total	**86,045**	**105,422**	**300,269**

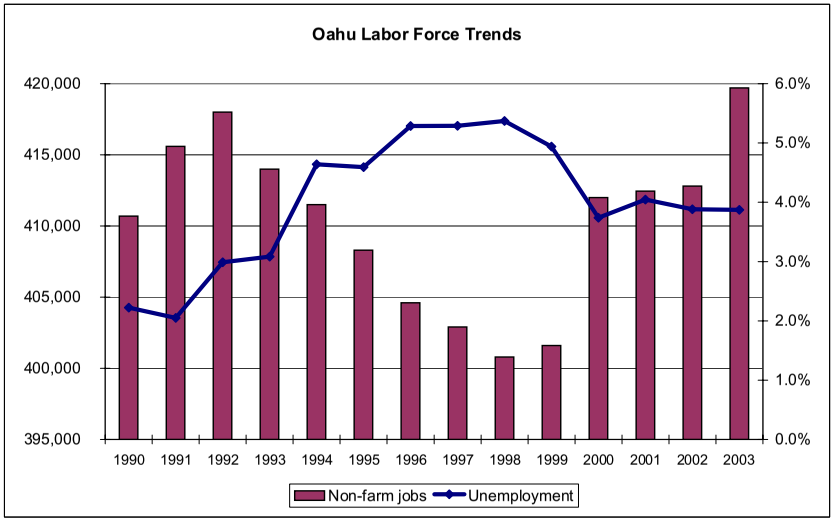


[1] Defined as the Ewa, Waipahu and Waianae County Subdivisions or Judicial Districts.

Source: 2004 Claritas Inc., May 7, 2004.

Exhibit 2-11: Labor Force Trends - Honolulu County
1990 to 2003

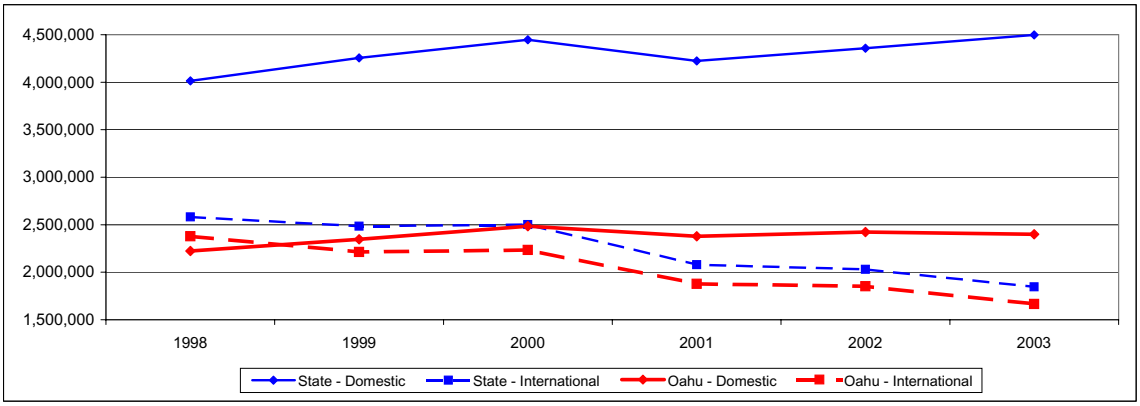
	Civilian labor force	Employed persons	Non-farm wage & salary jobs	Percent unemployment
1990	402,300	393,300	410,700	2.2%
1991	419,850	411,250	415,600	2.0%
1992	423,350	410,700	418,000	3.0%
1993	426,400	413,250	414,000	3.1%
1994	420,350	400,850	411,500	4.6%
1995	418,150	398,950	408,300	4.6%
1996	429,350	406,650	404,600	5.3%
1997	433,800	410,850	402,900	5.3%
1998	433,800	410,500	400,800	5.4%
1999	430,200	408,950	401,600	4.9%
2000	421,200	405,450	412,000	3.7%
2001	419,000	402,050	412,450	4.0%
2002	412,100	396,050	412,800	3.9%
2003	436,450	419,550	419,700	3.9%



Source: Computed by Hawaii State Department of Business, Economic Development & Tourism from the Hawaii State Department of Labor & Industrial Relations, monthly rounded data.
As referenced in: www.hawaii.gov/dbedt/qser/0304

Exhibit 2-12: Visitor Arrivals to the State of Hawaii and Island of Oahu
1998 to 2004

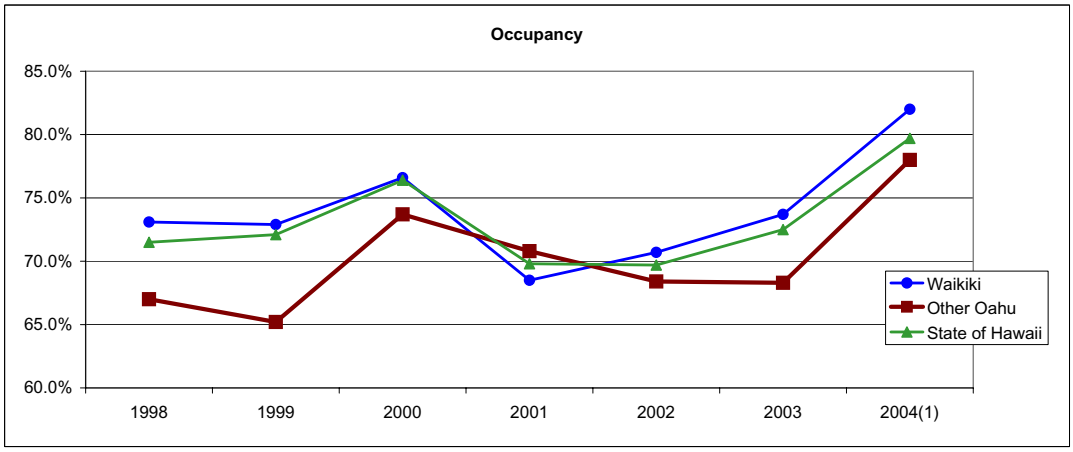
	1998	1999	2000	2001	2002	2003	2004[1]
State:							
Domestic	4,014,140	4,255,621	4,446,936	4,224,321	4,358,850	4,498,655	1,118,985
International	2,581,650	2,485,416	2,501,659	2,079,469	2,030,208	1,846,554	500,604
Total	6,595,790	6,741,037	6,948,594	6,303,790	6,389,058	6,345,209	1,619,589
Island of Oahu:							
Domestic	2,222,551	2,347,040	2,485,058	2,379,285	2,423,169	2,400,161	598,952
International	2,379,283	2,213,101	2,234,186	1,878,250	1,852,908	1,666,097	447,208
Total	4,601,834	4,560,142	4,719,244	4,257,536	4,276,077	4,066,258	1,046,160



[1] Year to date through the month of March.
Source: Department of Business, Economic Development and Tourism.

Exhibit 2-13: Average Occupancy for State and Oahu Visitor Accommodations
1998 to 2004

	1998	1999	2000	2001	2002	2003	2004[1]
Waikiki	73.1%	72.9%	76.6%	68.5%	70.7%	73.7%	82.0%
Other Oahu	67.0%	65.2%	73.7%	70.8%	68.4%	68.3%	78.0%
Island of Oahu	72.3%	71.9%	76.2%	68.8%	70.5%	73.1%	81.5%
State of Hawaii	71.5%	72.1%	76.4%	69.8%	69.7%	72.5%	79.7%



[1] Year to date as of February 2004.
Source: Hospitality Advisors, LLC, "Hawai'i Hotel Flash Report," annual. (PricewaterhouseCoopers LLP 1998-1999).

Exhibit 2-14: Average Room Rate for State and Oahu Visitor Accommodations
1998 to 2004

	1998	1999	2000	2001	2002	2003	2004[1]	Compound annual % change 1998-2003
Waikiki	$ 112	$ 109	$ 118	$ 117	$ 114	$ 115	$ 121	0.5%
Other Oahu	$ 105	$ 103	$ 113	$ 116	$ 116	$ 129	$ 133	4.2%
Island of Oahu	$ 111	$ 108	$ 118	$ 117	$ 114	$ 116	$ 123	0.9%
State of Hawaii	$ 130	$ 131	$ 141	$ 146	$ 141	$ 144	$ 152	2.1%

[1] Year to date as of February 2004.
Source: HospitalityAdvisors, LLC, "Hawai'i Hotel Flash Report," annual. (PricewaterhouseCoopers LLP 1998-1999).

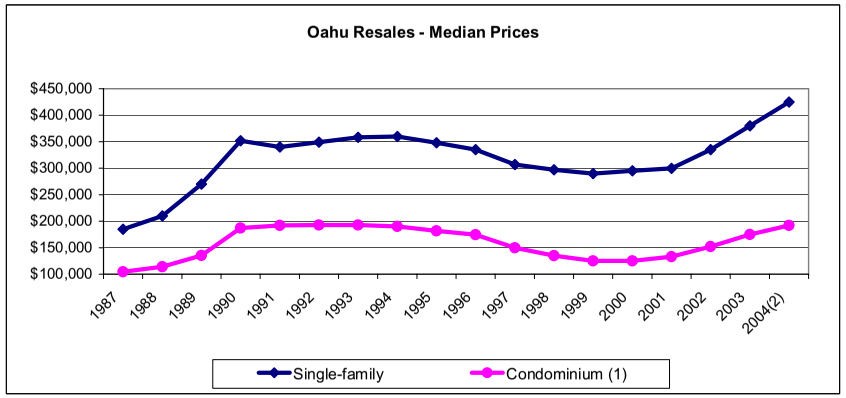
Exhibit 3-1: Private Residential Building Permits, Island of Oahu
1993 to 2003

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual
1993	554	992	1,545	908	3,999
1994	613	1,385	1,261	1,380	4,639
1995	1,581	923	1,580	482	4,566
1996	532	260	885	347	2,024
1997	195	980	532	337	2,044
1998	423	334	497	361	1,615
1999	468	479	334	415	1,696
2000	352	469	382	527	1,730
2001	466	595	497	353	1,911
2002	296	553	807	867	2,523
2003	682	785	576	630	2,673

Source: City & County of Honolulu Building Department, as referenced in http://www.hawaii.gov/dbedt/qser/0304/

Exhibit 3-2: Median Sales Prices of Housing - Honolulu County
1987 to 2004

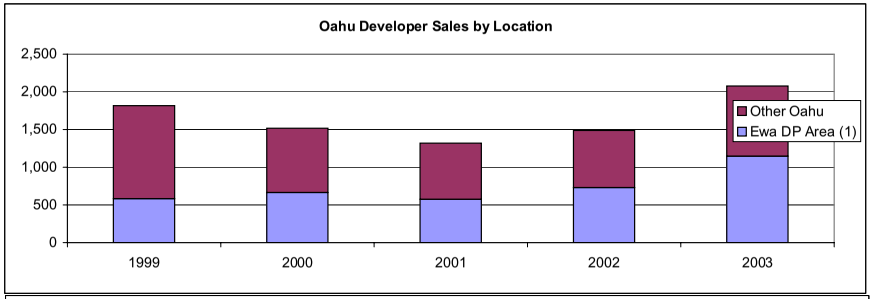
	Single-family	Condominium[1]
1987	$185,000	$104,500
1988	$210,000	$114,000
1989	$270,000	$135,500
1990	$352,000	$187,000
1991	$340,000	$192,000
1992	$349,000	$193,000
1993	$358,500	$193,000
1994	$360,000	$190,000
1995	$348,000	$181,800
1996	$335,200	$174,500
1997	$307,000	$150,000
1998	$297,000	$135,000
1999	$290,000	$125,000
2000	$295,000	$125,000
2001	$299,900	$133,000
2002	$335,000	$152,000
2003	$380,000	$175,000
2004[2]	$425,000	$192,000

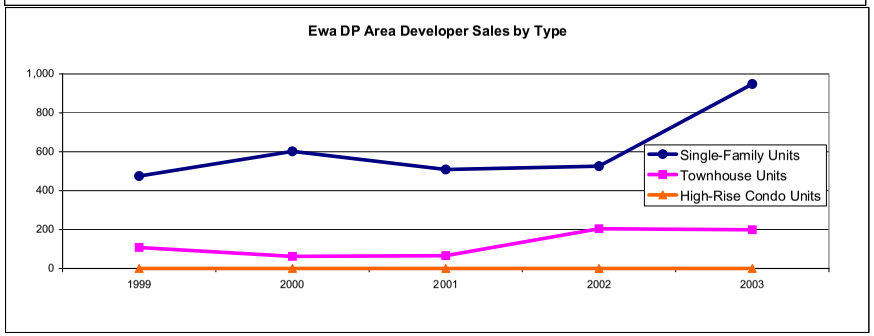


Note: Resales only; residential units that are entered in the Multiple Listing Service.
[1] Includes duplexes, townhomes and other multifamily units with common areas.
[2] Year-to-date as of April 30, 2004.
Source: Honolulu Board of Realtors, Research Department, as referenced in http://www.hawaii.gov/dbedt/qser/0304/e_08.xls and "April 2004 Monthly Statistical Report Residential Resale Activity on Oahu," May 3, 2004,

Exhibit 3-3: Developer Unit Sales - Island of Oahu and Ewa Development Plan Area
1999 to 2003

	1999	2000	2001	2002	2003	Average annual	Average annual % change[2]
Island of Oahu:							
Single-family units	926	1,118	1,026	1,132	1,697	1,180	16.4%
Townhouse units	290	195	229	312	359	277	5.5%
High-rise condominium units	601	204	64	44	21	187	-56.8%
	1,817	**1,517**	**1,319**	**1,488**	**2,077**	**1,644**	**3.4%**
Ewa DP area[1]:							
Single-family units	475	602	509	526	948	612	18.9%
Townhouse units	108	62	66	204	199	128	16.5%
High-rise condominium units	0	0	0	0	0	0	NAP
Total	**583**	**664**	**575**	**730**	**1,147**	**740**	**18.4%**
As % of island	***32%***	***44%***	***44%***	***49%***	***55%***	***45%***	





[1] Approximated by the Ewa, Kapolei and West Oahu (Ko Olina) areas, as defined by The Harris Company.
[2] Annually compounded average percent change, from earliest to latest year for which data is available.
Source: The HARRIS Company, figures represent units reported by developers to have closed escrow and recorded.

Exhibit 3-5: Planned Residential Development Projects with State Land Use Entitlement or Exemption

Ewa Development Plan Area, as of May 2004

Project	Developer or Owner	No. of units	Estimated first occupancy	Residential product mix	Entitlement status	Comment
Kapolei West - Subject (includes "Kapolei LDA")	Aina Nui Corporation (Campbell Estate)	2,370	2008	SF & TH	Urban & Ag; not zoned	Shown as Subject and because majority of site is Urban.
Makaiwa Hills I and II	Aina Nui Corporation (Campbell Estate)	3,066	2009 - 2025	Emphasis on SF	Urban; not zoned	Includes limited neighborhood commercial.
City of Kapolei (Campbell)	Campbell Estate	1,000	INA	May seek BMX zoning	Urban; not zoned	Mauka of "City of Kapolei" (Mehana) site being developed by Schuler.
Palehua East B (Makakilo buildout 1/3)	Castle & Cooke	270	Construction start 5/04; occupancy 4Q05+	SF detached, min. 5,000 s.f. lots	Entitled	Acreage shown is net developable; 83 additional acres of gully lands to be deeded to community as open space.
Makakilo build-out 2/3	Finance Realty/ others	250	On-going	Mostly TH	Entitled	Ocean Ridge, Kai Nani & other by Schuler (170+ units); 64 units underway by Pacific Housing Alliance.
Palehua East C & D (Makakilo buildout 3/3)	Finance Realty, as managing partner of limited partnership	700	Indefinite	INA	75% of planned units entitled.	Acreage shown is net; another 120 acres are in gully.
Ewa by Gentry	Gentry Homes	1,300	On-going	SF condo & SF detached	Entitled	Unit count is net remaining as of 12/03; acreage from EDP.
Gentry Ewa Makai (prev. "Fairways" and Laulani")	Gentry Homes	1,865	2005+	SF condo & SF detached	Entitled	Zoning approval obtained 4/2004. Targeting buildout by 2014.
Ocean Pointe (prev. "Ewa Marina")	HASEKO (Ewa), Inc.	3,650	On-going	SF detached & TH	Entitled	4,850 maximum units per Unilateral, of which c. 1,200 are built.
Ko Olina Resort & Marina	Ko Olina Development LLC	885	As soon as marketable	SF, TH & medium-density MF	Zoned	5 remaining residential sites zoned A-1 (11 ac) and A-2 (49 ac).
Mehana (also "Kapolei Makai" or "City of Kapolei - Schuler")	Schuler Homes	1,148	Construction start 2007; occupancy 2008+	SF & MF (50%/50%)	Urban; not zoned	30% affordable housing condition. Targeting buildout in 8-10 years.

Exhibit 3-4: Ewa Development Plan and Other Sustainable Communities Plan Areas

Source: City and County of Honolulu, Planning Department, "Ewa Development Plan," August 1997 (revised May 2000,) as referenced at: http://honoluludpp.org/planning/Ewa/Ewa1.pdf

Exhibit 3-5: Planned Residential Development Projects with State Land Use Entitlement or Exemption, Con't.

Ewa Development Plan Area, as of May 2004

Project	Developer or Owner	No. of units	Market timing	Product mix	Entitlement status	Comment
East Kapolei area	State of Hawaii (DLNR/UH)	4,000	Indefinite	Apartments; MF-affordable & MF-market	Urban; not zoned	State commitment to campus in question; DLNR recently took control back from HCDCH & passed to UH.
Villages of Kapolei (Village 8)	State of Hawaii (HCDCH/DHHL)	327	Construction start 2004; occupancy 2006+	SF; possibly some self-help	Entitled	Last village at Villages of Kapolei; Minimum 5,000 s.f. lots. DHHL just completed Village 6 with 150 units.
Unnamed	State of Hawaii (DHHL)	500	Construction start 2006; occupancy 2007+	Unknown	Not Urban but DHHL exempt	Minimum 5,000 s.f. lots. EDP shows as up to 1,600 units at this site.
Unnamed	State of Hawaii (DHHL)	240	2010 +/-	Indefinite	INA but DHHL exempt	Site recently obtained in settlement of claims with State.
Ewa Villages	City and County of Honolulu - landowner	667	2004+	Discussing an assisted living center by St. Francis	Entitled	Tenney, Renton, and Varona Villages plus surrounding areas. City expects to use nonprofits or other entities to develop.
Total/average - including Kapolei West		**22,238**				
Total/average - excluding Kapolei West		**19,868**				

Note - Exhibit shows net remaining units and acreage to be developed at each masterplanned project. Figures shown based on stated owner or developer plans within entitlement restrictions, wherever information is available. Figures may vary from those presented in the City's Ewa Development Plan.

INA - Information not available; EDP - Ewa Development Plan and related materials (see source reference below); SF - Single-family; MF - Multifamily; SLUC - State Land Use Commission

Sources: City and County of Honolulu, Ewa Development Plan (1997) and various draft materials related to its 5-year review (2004); Helber Hastert Fee Planners; Aina Nui Corporation; Wilbur Smith Associates," Kapolei Traffic Impact Study"; internet research; Pacific Business News; Honolulu Advertiser; interviews with landowners, developers & consultants, public documents.

Exhibit 3-6: Ewa DP District Projected New Housing Unit Supply

Planned Developments with State Land Use Entitlement or Exemption
As of May 2004

Market orientation/ Project	Developer or Owner	2004 - 2005	2006 - 2010	2011 - 2015	2016 - 2020	2021 - 2025	Total projected units
Primary resident-oriented:							
Makaiwa Hills I and II	Aina Nui Corporation	0	500	1,250	1,250	66	3,066
City of Kapolei (Campbell)	Campbell Estate	0	300	700	0	0	1,000
Palehua East B (Makakilo buildout 1/3)	Castle & Cooke	60	210	0	0	0	270
Makakilo build-out 2/3	Finance Realty	200	50	0	0	0	250
Palehua East C & D (Makakilo buildout 3/3)	Finance Realty	0	80	400	220	0	700
Ewa by Gentry	Gentry Homes	600	700	0	0	0	1,300
Gentry Ewa Makai	Gentry Homes	0	800	1,065	0	0	1,865
Ocean Pointe	HASEKO (Ewa), Inc.	500	1,250	1,250	650	0	3,650
Mehana	Schuler Homes	0	450	698	0	0	1,148
UH West Oahu Campus area	State of Hawaii (DLNR)	0	500	1,250	1,250	1,000	4,000
Villages of Kapolei (Village 8)	State of Hawaii (HCDCH/DHHL)	0	327	0	0	0	327
Unnamed	State of Hawaii (DHHL)	0	500	0	0	0	500
Unnamed	State of Hawaii (DHHL)	0	0	240	0	0	240
Ewa Villages	City and County of Honolulu	100	567	0	0	0	667
Total primary residential market (rounded)		**1,500**	**6,200**	**6,900**	**3,400**	**1,100**	**19,000**
Non-resident/ second-home oriented:							
Ko Olina Resort & Marina	Ko Olina Development LLC	100	600	185	0	0	885
Total non-resident-oriented market (rounded)		**100**	**600**	**200**	**0**	**0**	**900**

Source: Based on information presented in Exhibit 3-5. Excludes Kapolei West.

Exhibit 3-7: Island of Oahu Projected New Resident Housing Unit Supply

Planned Developments with State Land Use Entitlement or Exemption
As of May 2004

Market orientation/ Development Plan District	2004 - 2005	2006 - 2010	2011 - 2015	2016 - 2020	2021 - 2025	Total projected units	Comment
Ewa District	1,500	6,200	6,900	3,400	1,100	19,000	See Exhibit 3-6 for detail. Excludes Subject.
Waianae	200	1,900	400	0	0	2,500	Majority are DHHL projects.
Central Oahu	300	4,000	4,100	4,100	300	12,800	Includes Koa Ridge and Waiawa (Castle & Cooke), both of which require zoning.
North Shore & Ko'olauloa	0	730	0	0	0	730	Includes Laie Affordable Housing and Kahuku Village (C&C of Hon.)
Ko'olaupoko	0	80	0	0	0	80	Manor at Mahinui.
East Honolulu	450	100	0	0	0	550	Most Hawaii Kai.
Primary Urban Center	700	2,100	0	0	0	2,800	Majority are high rise; includes Waikiki.
Total resident housing units (rounded)	**3,200**	**15,100**	**11,400**	**7,500**	**1,400**	**38,500**	

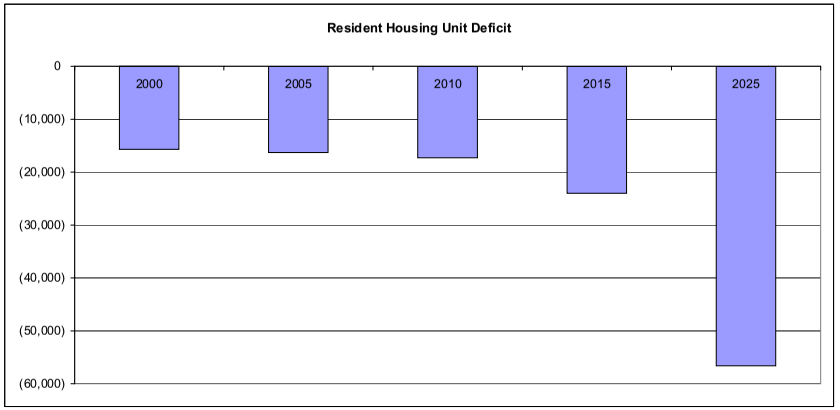
Note: May include units to be directed at nonresident housing market.

Sources: Interviews with Chief and various members, City and County of Honolulu, Department of Planning and Permitting, Plans & Zone Change Branch, May 13-19, 2004; C&C of Honolulu, DPP, "Annual Report on the Status of Land Use on Oahu: Fiscal Year 2002," July 2003; interviews with developers and landowners; Exhibit 5-2.

Exhibit 3-8: Island of Oahu Resident Housing Unit Projected Supply and Demand

2000 to 2025

	Reference	2000	2005	2010	2015	2020	2025	Total/ average, 2006-2025[1]
Demand (households):								
Number	SMS[1]	297,919	313,555	328,884	346,393	366,893	387,373	
Change since prior date -								
Total (rounded)		--	15,600	15,300	17,500	20,500	20,500	73,800
Average annual		--	3,120	3,060	3,500	4,100	4,100	3,690
Supply (resident housing units):								
Estimated/projected RHU	SMS[2]	282,219	297,191					
Entitled new developments, 2006-25:	Exhibit 3-7							
Development since prior date				15,100	11,400	7,500	1,400	35,400
Less vacancy allowance	5%			-755	-570	-375	-70	-1,770
Net available resident housing units (rounded)		282,200	297,200	311,500	322,300	329,400	330,700	
Change since prior date -								
Total		--	15,000	14,300	10,800	7,100	1,300	33,500
Average annual		--	3,000	2,860	2,160	1,420	260	1,680
Resident housing unit surplus (deficit):								
At prior date shown		INA	(15,700)	(16,300)	(17,300)	(24,000)	(37,400)	
Net surplus (deficit) in RHU production since prior date		INA	(600)	(1,000)	(6,700)	(13,400)	(19,200)	
By end of column date		(15,700)	(16,300)	(17,300)	(24,000)	(37,400)	(56,600)	



INA = Information not available.

[1] Excludes some of figures shown in 2005 column since some represent change from 2001 to 2005.

[2] SMS, Inc., "Hawaii Housing Policy Study 2003," Page Section 1A-B-11, August 2003. Study shows projections through 2024. 2025 figures estimated based on same rate of population growth projected by SMS for 2022-2023 and 2023-2024 (0.95%) and same average household size as projected for 2024 (2.83 persons). SMS projections of resident housing units (2000 and 2005) are net of vacant and non-resident units.

Exhibit 4-1: Characteristics of Selected Golf-Front Single-Family Residential Projects

Type/Location/Project	Developer	Date first marketed/ first recordations	Sales status	Number of units	Gross acres	Units per acre	Range of lot sizes/ median or av. sq. ft.	Range of unit sizes (net interior sq. ft.)	Primary view orientation/ frontage	Unit types	Comments
Golf resort communities:											
Ko Olina (Oahu) -											
Estates at Ko Olina Kai[1]	Destination Properties (Centex)	Mar-04 [2]	Pre-sales lottery, Phase 1 sold 3/04	60	33.0	6.0	INA <= 6,500	1,879 to 2,229	Ko Olina Golf Club/ all SF located on the site's perimeter	3/2; 3/3; 4/3	See also MF exhibit. Phase I = 48 SF units
		Average or range, golf resort communities[1]		**60**	**33.0**	**<=6.0**	**<=6,500**	**1,879 to 2,229**			
Primary residential communities:											
Ewa by Gentry (Oahu) -											
Kula Lei	Schuler Homes	1996	Resales	199	25.2	7.9	3,750 to 10,115/ 3,868	1,092 to 1,871	Coral Creek Golf Course frontage/interior	3/2; 3/2.5; 4/3	
Hu`elani	Gentry Homes Ltd.	1999	On-going	101	14.9	6.8	INA	1,444 to 1,934 1,826	Coral Creek Golf Course frontage/interior	2/2.5; 3/2; 3/2.5; 3/3	SF detached condo; gated; rec center with pool
Kapolei (Oahu) -											
A'eloa	Watt Homes	Ph1 Mar-94 Ph2 May-95	Resales	332	54.6	6.1	3,580 to 8,388/ 4,831	1,116 to 2,338	Kapolei Golf Course frontage/ interior	3/2; 3/25; 4/2.5; 4/3.5	Excludes affordable housing component
Kapolei Knolls 1&2	Schuler Homes	Jun-98	On-going	425	75.2	5.6	5,000 to 14,665/ 5,645	1,226 to 2,327	Kapolei Golf Course view/ interior	3/2; 3/2.5; 3/3; 4/2.5; 4/3; 5/3	Acreage includes 2.2 ac. neighborhood park
Palms at Kekuilani	Kekuilani Development Co./HFDC (Stanford Carr)	Jan-94	Resales	186	21.4	8.7	2,241 to 4,859/ 3,242	990 to 1,786	Kapolei Golf Course frontage/ interior	Cluster; 2/2; 3/2; 3/2.5; 4/2.5, few zero lot line	Sold out May 1996
		Average or range, primary residential communities, rounded		**249**	**38.3**	**7.0**	**4,400**	**990 to 2,338**			

INA = Information not available.

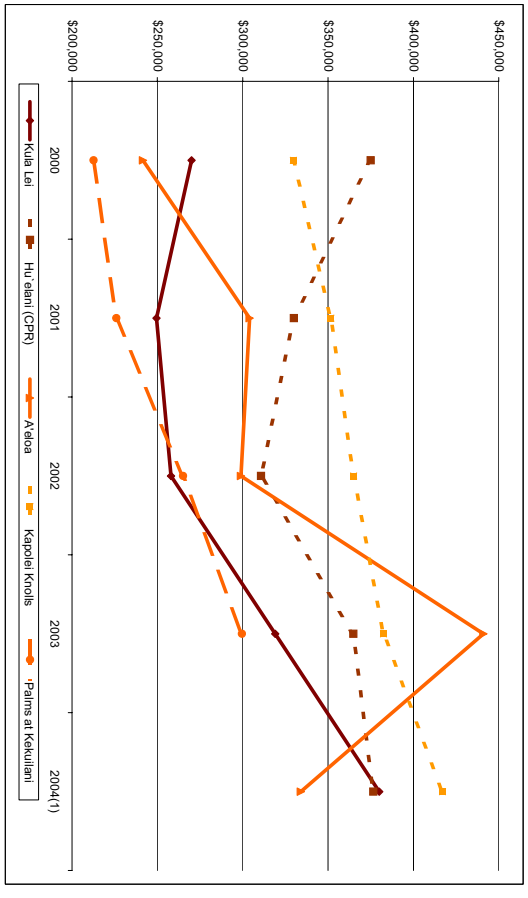
[1] Gross acres and units per acre refer to project as a whole including its multifamily elements; data not available for single-family areas only but can be inferred from lot sizes

[2] Over 300 reservations were taken for Phase 1, which totals 132 homes (48 single-family and 84 multifamily.) First phase to be completed by 1Q 2005. Amenities include rec center, free-form pool, spa

Sources: Interviews with respective developers, planners, & marketing agents; site visits; project planning and marketing materials; Internet research; Hawaii Real Estate Commission; Hawaii Information Service.

Exhibit 4-2: Median Sales Prices for Selected Golf-Front Single-Family Projects 2000 to 2004[1]

Project	2000	2001	2002	2003	2004[1]	Annual % change[2]	Average unit size[3]
Golf resort communities:							
Ko Olina -							
Estates at Ko Olina Kai[4]	NAP	NAP	NAP	NAP	$950,000+[5]	NAP	2,100
Primary residential communities:							
Ewa by Gentry -							
Kula Lei	$270,000	$249,500	$258,000	$319,000	$380,000	11%	1,426
Hu`elani (CPR)[6]	$374,900	$329,900	$310,662	$364,699	$376,399	0%	1,830
Weighted average	**$294,208**	**$287,020**	**$294,863**	**$343,143**	**$376,656**	**8%**	
Kapolei -							
A'eloa	$241,550	$304,000	$299,000	$441,000	$334,000	10%	1,698
Kapolei Knolls	$329,622	$351,615	$365,000	$382,500	$417,029	7%	1,738
Palms at Kekuilani	$212,500	$225,900	$265,000	$299,450	$385,000	12%	1,401
Weighted average	**$303,315**	**$328,162**	**$336,280**	**$377,803**	**$398,979**	**9%**	



NAP = Not applicable.

[1] Recorded sales as of March 31, 2004.

[2] Annually compounded average percent change, from earliest to latest year for which data is available.

[3] Based on information available for all recorded sales in sample: January 1, 2000 to February 29, 2003, or on March 2003 offerings.

[4] No recorded sales as of February 2004. Average unit size based on model offerings.

[5] Reported base list prices from mid-$900,000s.

[6] Single-family detached condominium project. Average unit size based on model offerings.

Sources: Hawaii Information Service, interviews with developers and brokers.

Exhibit 4-3:

Current Owner Place of Residence for Selected Golf-Front Single-Family Projects

Based on tax bill address

Project	Owner occupants[1]	Other Hawaii residents	Other U.S.	International	Total
Primary residential communities:					
Ewa by Gentry -					
Kula Lei	149	45	5	0	199
Hu`elani (CPR)	34	67	3	0	104
Average	**92**	**56**	**4**	**0**	**152**
Kapolei -					
A'eloa[2]	287	29	7	2	325
Kapolei Knolls	244	31	8	1	284
Palms at Kekuilani[3]	151	14	11	0	176
Average	**227**	**25**	**9**	**1**	**262**

Place of Residence of Owners of Single-Family Homes in Selected Primary Residential Communities

1 Those whose tax bill address is at the surveyed unit, based on ownership records of March 31, 2004.
2 Total does not equate to 332 units as there were seven unknown tax bill addresses within the sample.
3 Total does not equate to 178 units as there were two unknown tax bill addresses within the sample.
Source: Hawaii Information Service

Exhibit 4-4:

Characteristics of Selected Multifamily Residential Projects

Type/Location/Project	Developer	Date first marketed/ first recordations	Sales status	Number of units	Gross acres	Units per acre	Range of unit sizes (net interior sq. ft.)	Primary view orientation/ frontage	Configuration	No. of stories
Golf resort communities:										
Ko Olina Resort (Oahu) -										
The Coconut Plantation	Brookfield Homes	May-04	Developer sales	270	29.7	9.1	1,093 to 1,834	Ko Olina Golf Club/ lagoon/interior	Flats, 2,3,4 and 6-plex townhomes; 2/2, 2+den/2, 3/2.5; 3+den/3	1 & 2
Villas at Ko Olina Kai[1]	Destination Properties (Oertex)	Mar-04	Pre-sales lottery, Phase 1 03/04	264 (another 60 are SF)	33.0	8.0	1,202 to 1,695	Site fronts on Ko Olina Golf Club, but MF buildings are in interior locations of site	6-plex; stacked flats; 2/2, 3/2, 3/3; 2-story	2
Kai Lani	One Keahole Partners (Armstrong/ A&B)	Feb-03	Resales	116	11.3	10.3	1,244 to 1,320	Preservation/ open/ some distant ocean views/interior	30 buildings; 4-plex townhomes, 2-3 bedrooms	2
Ko Olina Fairways	Fairways Hawaii, LLC (Horita)	Jul-95	Resales	280	19.5	14.4	847 to 1,264	Ko Olina Golf Club/interior	Townhomes; 2/2, 3/2, 3/2.5	2
Waikoloa Beach Resort (Hawaii) -										
Waikoloa Colony Villas	Stanford Carr Development, LLC	Dec-02	Developer sales	168	22.0	7.6	1,236 to 1,699	Golf; King's Trail; luxury resort residential	6-plex; 2/2, 2/2.5, 3/2.5	2
Keauhou Resort (Hawaii) -										
Na Hale O Keauhou	CMI Group	Apr-04	Presales lottery	84	13.9	6.0	1,404 to 1,704	Ocean & interior views	14, 6-plexes; 2/2.5, 3/2.5, 3/3	2
Wailea Resort (Maui) -										
Wailea Fairway Villas	SCD Wailea Fairway LLC	Sep-98	Resales	118	12.4	9.5	949 to 1,568	Golf; resort residential; ocean view	23 5-plex and 1 3-plex; stacked flat townhomes; 2/2 & 3/3	2
Average or range, golf resort communities[2]				**186**	**18.1**	**9.5**	**847 to 1,834**			

[1] Gross acres and units per acre refer to project as a whole including its single-family elements; data not available for multifamily areas only.
[2] Gross acres and units per acre exclude Estates at Ko Olina Kai.

Exhibit 4-4: Characteristics of Selected Multifamily Residential Projects (Cont'd.)

Type/Location/Project	Developer	Date first marketed/ first recordations	Sales status	Number of units	Gross acres	Units per acre	Range of unit sizes	Primary view orientation/ frontage	Configuration	No. of stories
Primary residential communities:										
Hawaii Kai (Oahu) -										
The Colony at the Peninsula	Stanford Carr Development	Reservations Jun-02	Developer sales, under construction	96	INA	INA	986 to 1,578	Mountain/ marina/ interior	4-story, 3 phases, 2 buildings each phase; 1/1, 2/1, 3/2	4
Ocean Pointe (Oahu) -										
Mariners Place	HASEKO (Ewa), Inc.	Oct-01	Resales	126	7.4	17.1	823 to 1,050	Interior	2-3 bedrooms, 1-2 Bath	2
Ke Noho Kai Townhomes, increments 1 to 4	HASEKO (Ewa), Inc.	Aug-02	Developer sales	131	4.4 [3]	15.3 [3]	1,467 to 1,700	Interior and proposed golf course	5- and 6-plex; 2/2.5, 3/2; 3/2.5	2
Average or range, primary residential communities				**118**	**5.9**	**16.2**	**823 to 1,700**			
Average or range, overall[2]				**165**	**15.1**	**11.2**	**823 to 1,864**			

INA = Information not available.

[2] Gross acres and units per acre exclude Estates at Ko Olina Kai.

[3] Increment 1 and 2 only; site area not available for other increments. Units per acre based on 44 units in increment 1 and 23 units in increment 2 and their corresponding gross acreage.

Sources: Interviews with respective developers, planners, & marketing agents; site visits; project planning and marketing materials; internet research; Hawaii Real Estate Commission; Hawaii Information Service.

Exhibit 4-5: Median Sales Prices for Selected Multifamily Projects
2000 to 2004

Project	2000	2001	2002	2003	2004[1]	Annual % change[2]	Average unit size[3]
Golf resort communities:							
Ko Olina -							
The Coconut Plantation	NAP	$477,516	$435,908	$524,868	$645,000	14%	INA [5]
Villas at Ko Olina Kai[4]	NAP	NAP	NAP	NAP	$450,000+[4]	NAP	1,449
Kai Lani[6]	NAP	NAP	NAP	$508,592	$512,000	2%	INA
Ko Olina Fairways	$245,000	$250,000	$250,000	$295,000	$335,000	6%	INA
Weighted average	**$245,000**	**$297,620**	**$372,661**	**$477,499**	**$513,957**	**25%**	
Waikoloa Beach Resort -							
Waikoloa Colony Villas	NAP	NAP	$408,000	$470,250	$469,000	11%	1,440
Wailea Beach Resort -							
Wailea Fairway Villas	$341,900	$352,000	$430,000	$447,475	$598,000	18%	INA
Keauhou Resort -							
Na Hale O Keauhou	NAP	NAP	NAP	NAP	$641,000 [7]	NAP	INA
Primary residential communities:							
Hawaii Kai -							
The Colony at the Peninsula[8]	NAP	NAP	NAP	NAP	$295,000 - $610,000[8]	NAP	1,282 [9]
Ocean Pointe -							
Mariners Place	NAP	NAP	$193,990	$208,813	$262,000	8%	INA
Ke Noho Kai Townhomes	NAP	NAP	NAP	$246,680	$265,653	25%	INA
Weighted average	**NAP**	**NAP**	**$193,990**	**$343,629**	**$265,653**	**27%**	

NAP = Not applicable; INA = Information not available.

[1] Recorded sales as of March 31, 2004, except where noted.

[2] Annually compounded average percent change, from earliest to latest year for which data is available.

[3] Based on information available for all recorded sales in sample: January 1, 2000 to February 29, 2003, or on total offerings if no current record

[4] No recorded sales as of February 2004. Asking prices are estimated at mid-$400,000s, as of March 2004.

[5] Based on range of models offered in March-April 2004 (1,202 to 1,695 s.f.).

[6] Seven sales to Hawaii Land Development Corp. have not been included, due to it being a multiple deed transaction. The subsequent sales of these seven units have also been excluded.

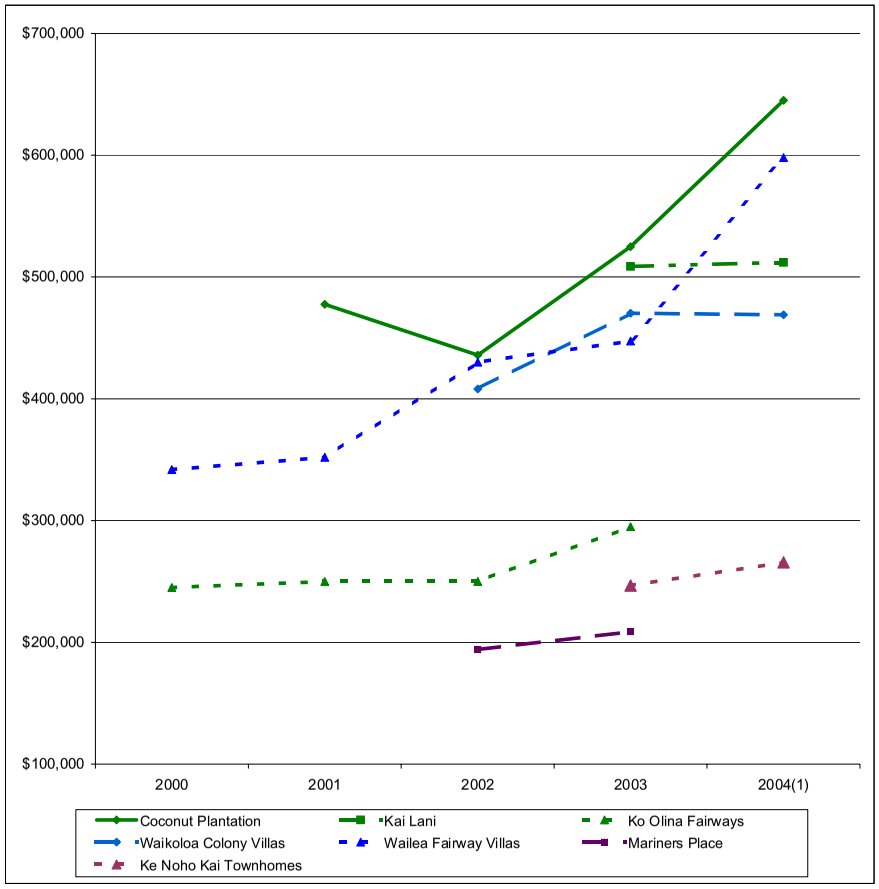
[7] Median of list prices for 20 units offered for sale as of May 4, 2004.

[8] No recorded sales as of February 2004. Asking prices range from $295,000 to $610,000 as of March 2004.

[9] Based on range of unit sizes (986 to 1,578 s.f.).

Source: Hawaii Information Service, interviews with developers and brokers.

Exhibit 4-5: **Median Sales Prices for Selected Multifamily Projects, Con't.**
2000 to 2004

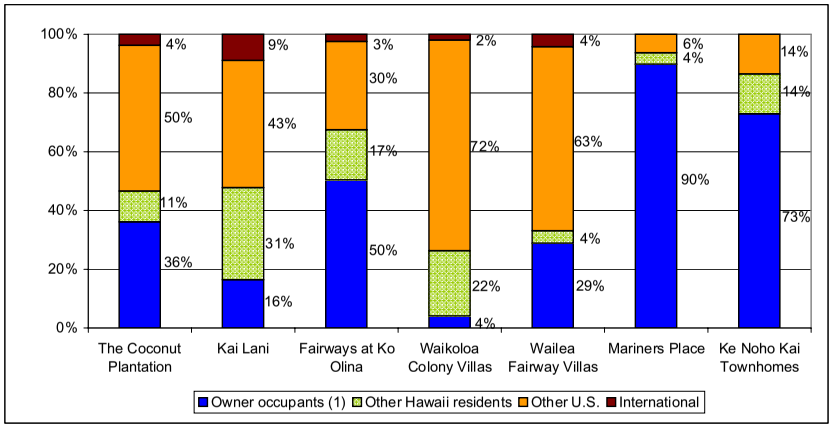


[1] Recorded sales as of March 31, 2004.

Source: Hawaii Information Service, interviews with developers and brokers.

Exhibit 4-6: **Current Owner Place of Residence for Selected Multifamily Projects**
Based on Tax Bill Address

Project	Owner occupants[1]	Other Hawaii residents	Other U.S.	International	Total
Golf resort communities:					
Ko Olina -					
The Coconut Plantation	48	14	66	5	133
Kai Lani[2]	22	42	58	12	134
Ko Olina Fairways	141	48	84	7	280
Average	**70**	**35**	**69**	**8**	**182**
Waikoloa Beach Resort -					
Waikoloa Colony Villas	4	22	71	2	99
Average	**4**	**22**	**71**	**2**	**99**
Wailea Beach Resort -					
Wailea Fairway Villas	34	5	74	5	118
Average	**34**	**5**	**74**	**5**	**118**
Primary residential communities:					
Ocean Pointe -					
Mariners Place	114	5	8	0	127
Ke Noho Kai Townhomes	70	13	13	0	96
Average	**92**	**9**	**11**	**0**	**112**



[1] Those whose tax bill address is at the surveyed unit, based on ownership records of March 31, 2004.

[2] Does not include 3 units whose tax bill address is unknown. Also excluded are 5 units that appear to be transactions between related parties

Source: Hawaii Information Service.

Exhibit 5-1: Projected Market Mix for Kapolei West by Site and Area

Site	Key market considerations	Acres	Gross density	Proposed units	Market mix: Primary resident homes	Market mix: Non-resident homes	Number of units: Primary resident homes	Number of units: Non-resident homes	Number of units: Total projected homes
Eastern lands:									
A	Golf-front, east end	23.8	8	190	85%	15%	162	29	190
B	Golf-front, east end	30.6	8	245	85%	15%	208	37	245
C	Golf-front, connects to Golf clubhouse	18.8	8	150	75%	25%	113	38	150
D	Northern, views, adj. Kamokila Park	38.7	8	310	85%	15%	263	46	310
E	Golf- and park-front	27.1	10	271	85%	15%	230	41	271
L[1]	Transit/mixed use site, no golf frontage	10.0	15	150	87%	13%	130	20	150
	Subtotal/average, eastern sites (rounded)	**149.0**	**8.9**	**1,320**	**85%**	**15%**	**1,110**	**210**	**1,320**
Western lands:									
F	On Ko Olina GC	28.3	18	509	30%	70%	153	357	509
G	Park-front, on historic railroad ROW	10.0	18	180	30%	70%	54	126	180
H	On Ko Olina GC, marina-view	8.1	18	146	25%	75%	36	109	146
I	Views, overlooks future Ko Olina residences	20.0	7	140	45%	55%	63	77	140
J	Views, overlooks Ko Olina park & school sites	9.7	7	68	45%	55%	31	37	68
K	On Ko Olina GC, private park and marina	9.3	1	11	40%	60%	4	7	11
	Subtotal/average, western sites (rounded)	**85.4**	**12.3**	**1,050**	**31%**	**69%**	**340**	**710**	**1,050**
	Total/average - overall (rounded)	**234.4**	**10.1**	**2,370**	**61%**	**39%**	**1,450**	**920**	**2,370**

[1] Acreage shown is net of 5.8 acres allocated to transit or commercial purposes. Remaining 10 acres to be a mixed use development including residential units
Reference: Helber Hastert & Fee Planners, 2004; Mikiko Corporation, 2004

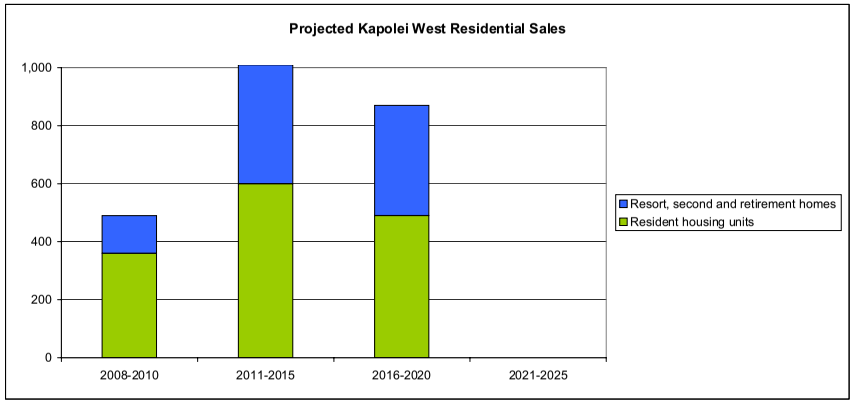
Exhibit 5-2: Resort Residential Developer Product Sold in Ko Olina Resort
2002 and 2003

Project	Number of units in project	2002	2003	Total	Average annual
The Coconut Plantation	270	64	51	115	58
Villas at Ko Olina Kai[1]	60	NAP	NAP	0	0
Estates at Ko Olina Kai	264	NAP	NAP	0	0
Kai Lani	116	NAP	116	116	58
Total	710	64	167	950	116

NAP = Not applicable; units not available for sale.
[1] No recorded sales as of March 31, 2004, but lotteries sold all units offered in first phase.
Source: Hawaii Information Service.

Exhibit 5-3: Projected Residential Unit Sales Absorption at Kapolei West
2006 to 2025

	Reference	2006-2010	2011-2015	2016-2020	2021-2025	Total/ average, 2006-2025
Resident housing unit sales:						
Island-wide deficit (cumulative)	*Ex. 3-8, end of*	17,300	24,000	37,400	56,600	
Ewa DP area share of island	*Ex. 3-3*	55%	55%	55%	55%	
Ewa DP area deficit, rounded		9,520	13,200	20,570	31,130	
Projected Kapolei West sales	*Begins 2008*					
Total in period	*120 per year*	360	600	490		1,450
Cumuative		360	960	1,450	1,450	
Share of Ewa DP area deficit		4%	5%	2%	0%	
Non-resident housing unit sales:						
Potential Ko Olina area market	*125 per year*	625	625	625	625	2,500
Projected Kapolei West sales	*Begins 2008*					
Potential share of Ko Olina area market		20%	65%	65%	NAP	
Total in period (rounded)		130	410	380	0	920
Cumuative		130	540	920	920	
Summary of Kapolei West sales:						
Total in period -						
Resident housing units		360	600	490	0	1,450
Non-resident/second home housing units		130	410	380	0	920
Total		490	1,010	870	0	2,370
Average annual -						
Resident housing units		120	120	98	0	112
Non-resident/second home housing		43	82	76	0	71
Total		163	202	174	0	182
Cumulative sales		490	1,500	2,370	2,370	



NAP = Not applicable.



APPENDIX J
Cultural Impact Assessment
(Cultural Surveys Hawaii, Inc.)

A Cultural Impact Assessment
of Approximately 595 Acres
at Kapolei, Honouliuli Ahupua‘a, ‘Ewa District of O‘ahu

TMK 9-1-14: 33 and 9-1-15: 4, 18, and por. 20

by
Auli‘i Mitchell, B. A.
and
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Prepared for
Helber Hastert & Fee Planners, Inc.
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Honolulu, HI. 96813

by
Cultural Surveys Hawai‘i, Inc.
December 2004

MANAGEMENT SUMMARY

Title	A Cultural Impact Assessment of Approximately 595 Acres at Kapolei, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu
Date	December 2004
Project Number	Cultural Surveys Hawai‘i Inc. (CSH) Job Code: KAPO 7
Agency	Office of Environmental Quality Control, Hawai‘i State Department of Health
Permit Number	Fieldwork associated with this assessment was performed under CSH’s annual archaeological research permit, No. 0404, issued by DLNR / SHPD.
Location	The project area lies within TMK 9-1-14: 33 and 9-1-15: 4, 18, and por. 20 lying west of Kalaeloa Blvd., and north and east of the Barber’s Point Harbor in the Kapolei area of Honouliuli Ahupua‘a, ‘Ewa District, southwestern O‘ahu. The O‘ahu Railway and Land Company (O.R. & L.) alignment runs through the project area. This area is depicted on the 2002 ‘Ewa 7.5-minute US Geological Survey (USGS) topographic quadrangle.
Land Jurisdiction	Private, owned by the Estate of James Campbell and Aina Nui Corporation
Project Acreage	The development proposed project area is 547 acres. However, this study also includes an adjacent area to the southeast, for a total of 595 acres.
Project Description	The proposed development of the current property includes an 18-hole golf course, park spaces, a school, single and multi-family residences, and commercial uses. Most of the project area will have subsurface ground disturbance.
Area of Potential Effect (APE)	For this cultural impact assessment, the project’s area of potential effect (APE) is defined as the entire approximately 595-acre property.
Document Purpose	At the request of Helber Hastert & Fee, CSH undertook this cultural impact assessment. The assessment was designed to fulfill the requirements related to Cultural Impact Assessments (CIAs) under Act 50, Chapter 343, Hawai‘i Revised Statutes, 2000.
Scope of Work	Includes: examination of historical documentation, review of archaeological studies, community consultations and interviews
Summary of Findings	The project area lies back from the coast, on the extensive ‘Ewa limestone plain. Historical documentation and archaeological studies indicate that this area was probably never permanently inhabited during traditional Hawaiian times. It could have, however, provided temporary habitation for bird catchers, gatherers, and fisherman traveling to the coast. Planters could have also used the natural limestone sinks for seasonal, small-scale agriculture.

Summary of Findings (cont.)

Archaeological investigations have documented two historic properties within the project area that may date to traditional Hawaiian times: a large sinkhole that may have had a habitation function and a burial cave. Both sites have been designated as archaeological preservers and are delineated with chain-link fencing and are marked as restricted. Impact to these preserves should be avoided during any future project area development.

Twentieth-century agricultural, military and commercial activities have eliminated much of the surface sites related to traditional Hawaiian culture that may have been present formerly within the project area. These activities would also have restricted access to these lands for any ongoing cultural practices throughout the twentieth century.

None of the interviewees or community contacts identified any cultural sites in the project area, or recalled anyone entering the project area – either in the past or present – for any traditional cultural practice. It appears that at present no contemporary or continuing cultural practices occur within the project area.

Recommendations

Based on the findings of this assessment, the proposed project will not adversely affect rights customarily and traditionally exercised for subsistence, cultural and religious purposes. It will have minimal or no impact on Hawaiian culture, its practices and traditions.

TABLE OF CONTENTS

MANAGEMENT SUMMARY i

LIST OF FIGURES vi

LIST OF TABLES vi

I. INTRODUCTION 1

A. Project Background 1

B. Project Area Description 1

C. Scope of Work 1

D. Methods 5

II. MYTHOLOGICAL AND TRADITIONAL ACCOUNTS 6

A. The Pele Family at Honouliuli 7

B. Kahalaopuna at Pōhākea Pass (Many accounts) 7

C. Keahumoa, Residence of Maui's Grandfather (Legend of Maui's Flying Expedition) 7

D. Kāne and Kanaloa and The Boundaries of ʻEwa (Simeon Nawaa account) 8

E. Kāne and Kanaloa and the Kauwā of Puʻu Kuʻua (*Ka Loea Kālaiʻāina*) 8

F. Kamapuaʻa at Honouliuli (Nakuina's Legend of Kaliuwaʻa) 9

G. *Moʻo* at Maunauna (*Kuokoa*) 9

H. Home of the Shark-Goddess Kaʻahupāhau (Legend of KaʻehuikimanōoPuʻuloa) 9

I. The Frightened Populace of Honouliuli *(He Kaʻao no Palila)* 9

J. Two Old Women who Turned to Stone *(Ka Loea Kālaiʻāina)* 10

K. The Strife of Nāmakaokapāoʻo and Pualiʻi *(Kaʻao no Nāmakaokapāoʻo)* 10

L. The Naming of Honouliuli (Legend of Lepeamoa) 11

M. The Story of Kaihuopalaʻai Pond, Honouliuli (*Kaʻao no Maikohā*) 11

N. The Traveling Mullet of Honouliuli (Fish Stories and Superstitions) 11

O. Honouliuli and the Head of Hilo-a-Lakapu (Legend of the Sacred Spear-point) 12

P. The Strife at Honouliuli from which Kūaliʻi unites Hawaiʻi nei *(Moʻolelo o Kūaliʻi)* 12

Q. The Vacationing Place of Kākuhihewa (*Ke Au Hou*) 12

R. The Last Days of Kahahana and Honouliuli (The Land is the Sea's) 12

S. Puʻuokapolei and the Reckoning of the Seasons (Kamakau) 13

T. Honouliuli in the Poetry of Halemano *(Kaʻao no Halemano)* 13

U. Winds of Honouliuli (M. Nakuina) 13

III. HISTORICAL BACKGROUND 14
A. Precontact and Early History 14
B. Mid to late 19th Century 17
C. Twentieth Century 18
D. Modern Land Use 18
IV. ARCHAEOLOGICAL RESEARCH IN HONOULIULI AHUPUA‘A 23
A. Overview of Archaeological Studies in Western Honouliuli 23
B. Archaeological Studies Relevant to the Present Project Area 27
1. Studies of *Mauka* Portion of Project Area (north of the O. R. & L. alignment) 27
2. Studies of *Makai* Portion of Project Area (south of the O. R. & L. alignment) 28
V. COMMUNITY CONSULTATIONS 30
VI. KAMA‘ĀINA INTERVIEWS 33
A. Shad Kane 33
B. George Ka‘eliwai 34
VII. TRADITIONAL LAND USE IN HONOULIULI AHUPUA‘A 36
A. The Physical Layout 36
B. The Coastal Zone 37
1. Kalaeloa (Barber’s Point) 37
2. Ko ‘Olina (West Beach) 37
C. Honouliuli Taro Lands 38
D. Pu‘u Ku‘ua: Inland Settlement 38
E. Summary of Traditional Land Use in Honouliuli 39
VIII. TRADITIONAL CULTURE IN THE PROJECT AREA 41
A. Gathering for Plant Resources 41
B. Marine Resources 41
C. Historic Properties 41
D. Burials 42
E. Trails 42
F. *Wahi pana* (Storied Places) 43
IX. SUMMARY AND RECOMMENDATIONS 44
A. Summary of Findings 44
B. Recommendations 44

X. REFERENCES CITED 46

LIST OF FIGURES

Figure 1. Portion of U.S. Geological Survey Map, ʻEwa Quad (2002), Showing Project Area 2
Figure 2. Tax Map Showing *Mauka* Portion of Project Area 3
Figure 3. Tax Map Showing *Makai* Portion of Project Area 4
Figure 4. Map Showing Location of Honouliuli Ahupuaʻa in West Oʻahu (adapted from Sterling and Summers 1978) 15
Figure 5. Trails of Leeward Oʻahu as Described by (ʻĪ ī) 16
Figure 6. Portion of 1922 War Department Fire Control Map, Barber's Point Quad, Showing Project Area 19
Figure 7. Portion of 1928 U.S. Geological Survey Map, Barber's Point Quad, Showing Project Area 20
Figure 8. 1939 Map of Ewa Plantation 21
Figure 9. Portion of 1943 USGS Barber's Point Quad Map Showing Project Area 22
Figure 10. Map Showing General Areas of Archaeological Study Near the Project Area 26

LIST OF TABLES

Table 1. Archaeological and related studies in western Honouliuli Ahupuaʻa 23
Table 2. Community Contacts and Comments 31

I. INTRODUCTION

A. Project Background

Cultural Surveys Hawaiʻi, Inc. was contracted by Helber Hastert & Fee Planners, Inc. to conduct a Cultural Impact Assessment (CIA) for approximately 595 acres owned by The Estate of James Campbell and Aina Nui Corporation. The project area, which includes tax map key parcels 9-1-14: 33 and 9-1-15: 4, 18, and por. 20, is located west of Kalaeloa Blvd., and north and east of the Barber's Point Harbor in the Kapolei area of Honouliuli Ahupuaʻa, ʻEwa District, southwestern Oʻahu (Figures 1-3). The Oʻahu Railway and Land Company (O. R. & L.) alignment runs through the project area. The proposed development of the current property includes an 18-hole golf course, park spaces, a school, single and multi-family residences, and commercial uses. Most of the project area will have subsurface ground disturbance.

B. Project Area Description

The project area is located on the ʻEwa plain, south of the Waiʻanae Mountain Range in the southwest corner of Oʻahu. The terrain is limestone and alluvial deposits, overlying flows of the Waiʻanae volcanic series (Macdonald et al. 1983:423). The project area is generally quite level varying between sea level at the western end of the project area and 70 feet elevation above sea level at the project area's eastern (*mauka*) end.

The project area is largely covered with thin clay soils including a moderately shallow ʻEwa silty clay loam, and Mamala stony silty clay loam overlying coral (limestone) outcrop (Foote et al. 1972). Some of these clay and silty clay loam deposits are most likely of historic deposition owing to increased erosion from introduced grazing animals and deliberately induced erosion to improve agricultural fields. In traditional Hawaiian times, the areas of coral outcrop were probably more extensive.

Lying in the lee of the Waiʻanae mountain range, the project area is one of the driest areas of Oʻahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik 1998:56). In pre-contact Hawaiʻi the project area would have been mostly lowland dry shrub and grassland, but this area has been extensively disturbed and transformed by human activity with a variety of exotic grasses, weeds, and shrubs now dominating. These grasses and shrubs, along with pockets of *kiawe* forest, and a few scattered banyan trees are characteristic of the vegetation of the project area.

C. Scope of Work

This study is meant to satisfy requirements related to Cultural Impact Assessments under Act 50, Chapter 343, Hawaiʻi Revised Statutes, 2000.

The scope of work includes:

1) Examination of 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) A review of the existing archaeological information pertaining to the properties and vicinity as they may allow us to reconstruct traditional land use activities and identify and describe the cultural resources, practices and beliefs associated with the parcels and identify present uses, if appropriate.

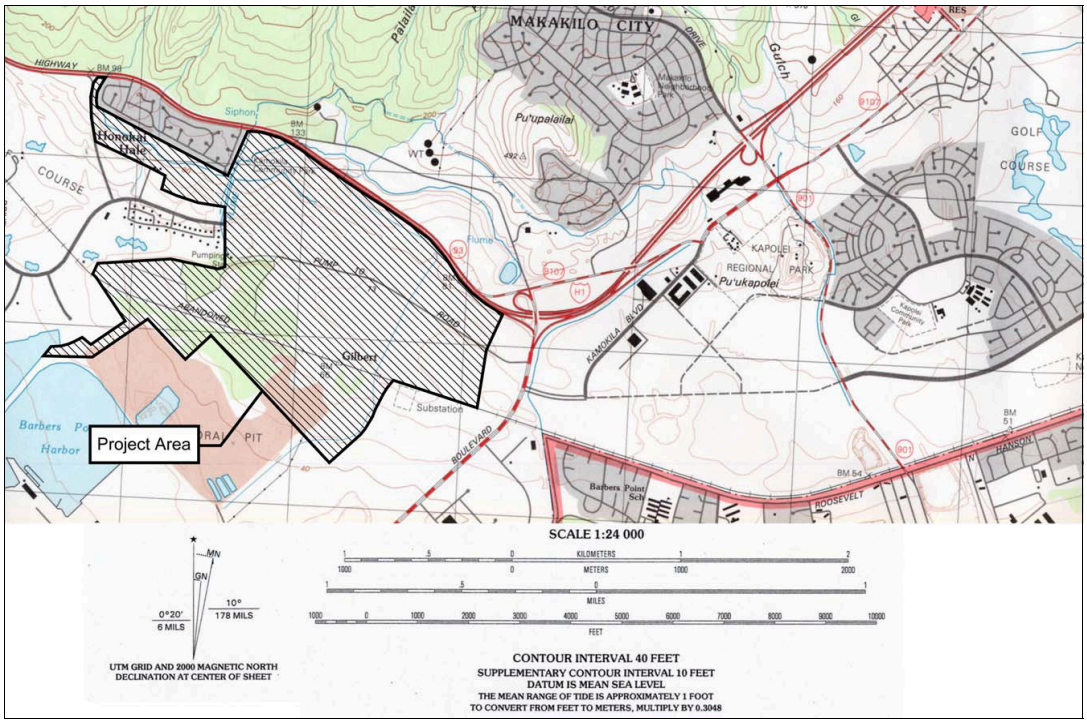


Figure 1. Portion of U.S. Geological Survey Map, 'Ewa Quad (2002), Showing Project Area

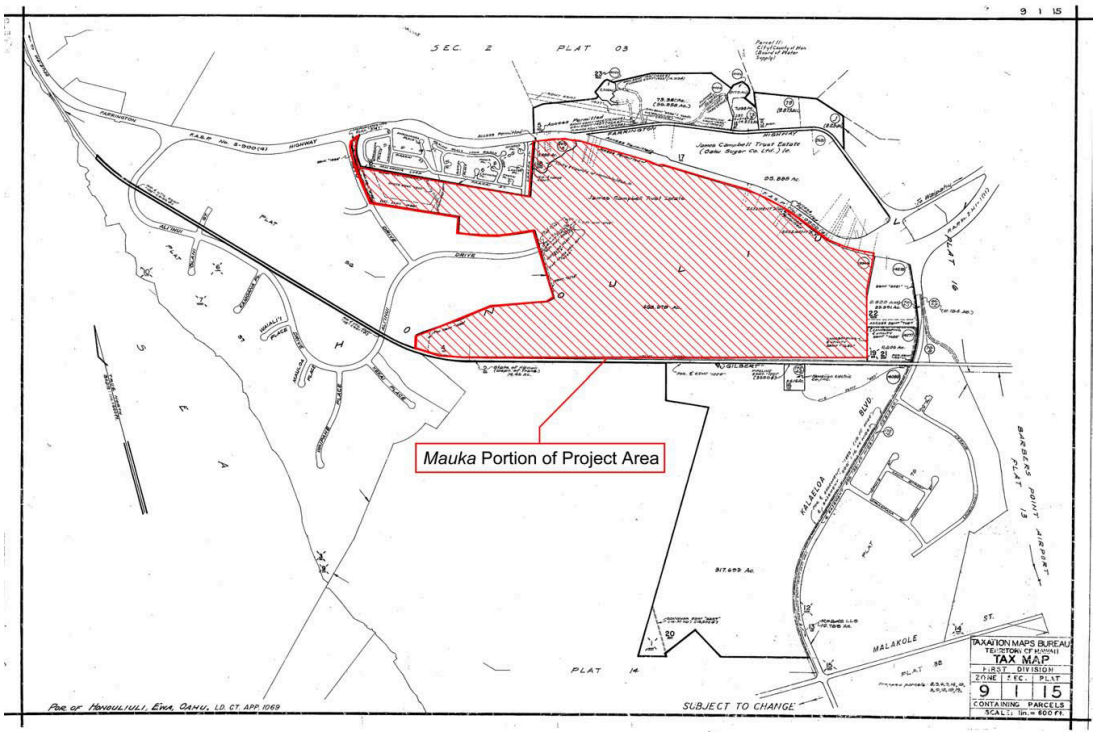


Figure 2. Tax Map Showing *Mauka* Portion of Project Area

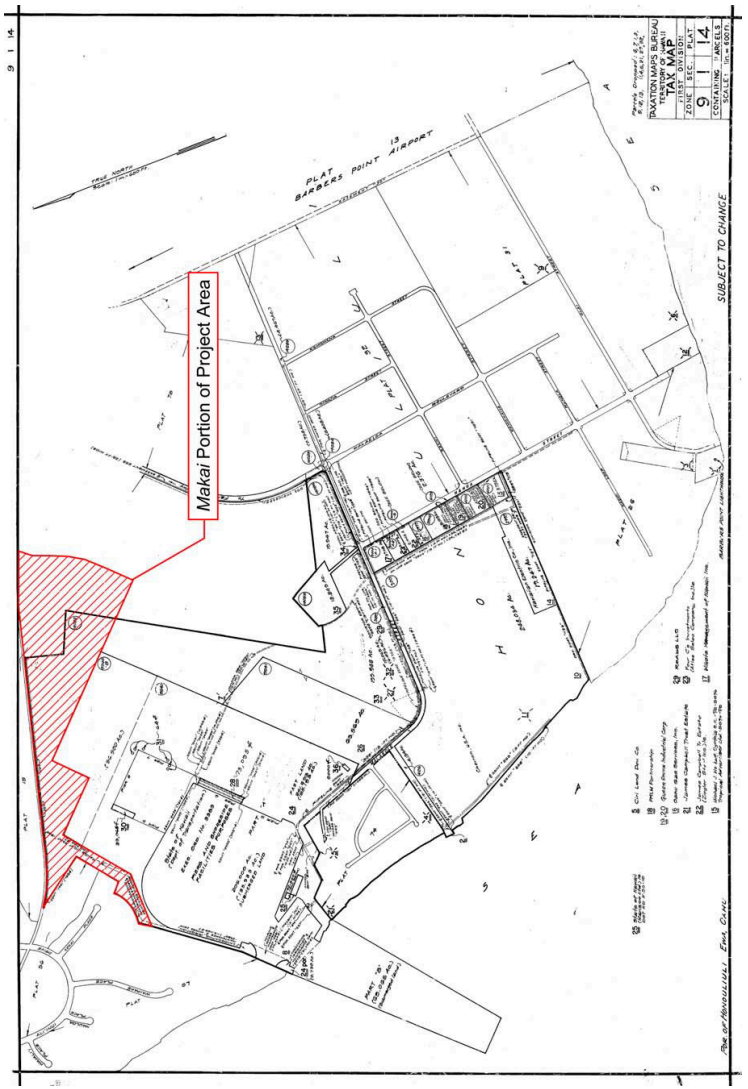


Figure 3. Tax Map Showing *Makai* Portion of Project Area

3) Conduct consultations and oral interviews with persons knowledgeable about the historic and traditional practices in the project area and region. We anticipate utilizing our previous contact list to facilitate the interview process.

4) Preparation of one report on items 1-3 summarizing the information gathered related to traditional practices and land use for the project area. The report will assess the impact of the proposed actions on the cultural practices and features identified within the project area.

D. Method*s*

Historical documents, maps and existing archaeological information were researched at the State Historic Preservation Division library, Cultural Surveys Hawai'i library, and the University of Hawai'i's Hamilton library. The Office of Hawaiian Affairs, O'ahu Island Burial Council, Hui Mālama O Nā Kūpuna, and members of other community organizations were contacted in order to identify potentially knowledgeable individuals with cultural expertise and or knowledge of the study area and the surrounding vicinity.

II. MYTHOLOGICAL AND TRADITIONAL ACCOUNTS

Honouliuli, Oʻahu is associated with a number of legendary accounts. Many of these concern the actions of gods or demi-gods such as Kāne, Kanaloa, Maui, Kamapuaʻa, the reptile deity Maunauna, the shark deity Kaʻahupūhau, and the demi-god hero Palila. While there are several references to chiefly lineages and references to the ruling chiefs Hilo a Lakapu and Kūaliʻi, there is no clear reference to powerful chiefs living permanently in Honouliuli.

The traditions of the ʻEwa plains have been complied and summarized numerous times in studies by Sterling and Summers(1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), Maly (1992), and Tuggle & Tuggle (1997). Some of the themes of these traditions include connections with Kahiki (the traditional homeland of Hawaiians, probably in reference to central Polynesia) and the special character and relationship of the places known as Puʻuokapolei and Kualakaʻi.

Connections with Kahiki are found in numerous place names, traditional events, and with the beings associated with Honouliuli. There are several versions of Kahaʻi leaving from Kalaeloa for a trip to Kahiki to bring breadfruit back to ʻEwa (e.g. Kamakau 1991:110). There are several stories that associate places in the region with Kamapuaʻa and the Hina family, as well as with Pele's sisters, all of whom have strong connections with Kahiki (cf. Kamakau 1991:111; Pukui et al. 1974:200).

Puʻuokapolei, located northeast of the current project area was perhaps one of the most sacred places in Honouliuli (cf Sterling and Summers 1978:33). Puʻuokapolei's connections with Kahiki are emphasized when it is noted that the hill was the home of Kamapuaʻa's grandmother, Kamaunuaniho, the Kahiki ancestor to the people of Oʻahu (Fornander 1916-20, V: 318; Kahiolo 1978:81, 107; Charlot 1987:62). By name, Kapolei is associated with the goddess Kapo, another connection with the Pele and Kamapuaʻa stories (Kamakau 1976:14).

McAllister (1933:108) records that a *heiau* or temple was located on Puʻuokapolei, but was destroyed before his survey of the early 1930s. No remains were found in a recent field study of the area (Kennedy 1991). The *heiau* may have been associated with the sun (Fornander 1916-20, III: 292). The hill was used as a point of solar reference or as a place where such observations were made. Puʻuokapolei might have been understood as the gate of the setting sun. It is notable that the rising sun at the eastern gate of Kumukahi in Puna is associated with the Hawaiian goddess Kapo (Emerson 1978:41). There is little specific information for Puʻuokapolei, but the place name itself ("hill of beloved Kapo") is hard to ignore. It is mentioned in some cosmologies, Kū was the god of the rising sun, and Hina should be associated with the setting sun (Hina is the mother of Kamapuaʻa). Fornander (1916-20, III; 292) states, Puʻuokapolei may have been a jumping off place (also connected with the setting sun) and associated with the dead who roamed the adjacent Plain of Kaupeʻa.

Puʻuokapolei was also the primary landmark for travelers between Pearl Harbor and the west Oʻahu coast, with a main trail running just inland of it (ʻĪʻī 1959:27, 29) (Figure 5). Puʻuokapolei was probably the most common name used as a reference for the area of the ʻEwa Plain including the present project area in traditional Hawaiʻi (cf. Nakuina 1990:54; Fornander 1916-20, II: 318; E.M. Nakuina 1904, in Sterling and Summers 1978:34).

Traditional and legendary accounts are presented below starting with those pertaining to Pōhākea Pass and then in a loose arrangement from more mythological accounts of gods and demi-gods to accounts of a more historical nature. There is no sharp distinction in this regard.

A. The Pele Family at Honouliuli

Kapolei (beloved Kapo), specifically the 166-foot high cone of that name, is understood to have been named in reference to the volcano goddess Pele's sister Kapo (Pukui et al. 1974:89). Pōhākea Pass is understood as one of the resting places of Pele's sister Hiʻiaka as she was returning from Kauaʻi with Pele's lover Lohiau (Fornander 1919 Vol. V:188 note 6). A considerable number of *mele* (songs) and *pule* (prayers) are ascribed to Hiʻiaka 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 Hiʻiaka could see through her powers of vision that her beloved *lehua* groves and friend Hopoe at Puna, Hawaiʻi Island had been blasted by Pele. She could also see that in her canoe, off the coast of Waiʻanae, Lohiau was seducing her traveling companion Wahineʻōmaʻo! A spring located at Kualakaʻi near Barber's Point was named Hoaka-lei (lei reflection) because Hiʻiaka picked *lehua* flowers here to make a lei and saw her reflection in the water.

B. Kahalaopuna at Pōhākea Pass (Many accounts)

One of the most popular legends of Oʻahu is that of Kahalaopuna (or Kaha) a young woman of Mānoa who is slandered by others and then killed by her betrothed, Kauhi, a chief from Koʻolau. While the numerous accounts (Day 1906:1-11, Fornander 1919 Vol. V:188-193, Kalākaua 1888:511-522, Nakuina 1904:41-45, Patton 1932:41-49, Skinner 1971:220-223, Thrum 1907:118-132, Westervelt 1907a 127-137, Westervelt 1907b 84-93) vary in details they typically have Kahalaopuna slain and revived repeatedly with the aid of a protective owl. Kauhi forces her to hike west from Mānoa through the uplands until they get to Pōhākea Pass through the southern Waiʻanae Range in north Honouliuli. At Pōhākea Pass, Kauhi beats her with a stick until she is very dead ("*Ia hahau ana a Kauhi i ka lāʻau, make loa o Kahalaopuna*"). Her spirit *(ʻuhane*) flies up into a *lehua* tree and chants for someone to go notify her parents:

E haʻi aku ʻoukou ua make o Kahalaopuna;	Go tell them Kahalaopuna is dead
Aia la i ka uka o Pōhākea,	There in the uplands of Pōhākea
i ke kumu lehua la o lalo iho	Beneath a *lehua* tree

Upon hearing the news her parents fetch Kahalaopuna back to Mānoa and she is restored.

C. Keahumoa, Residence of Maui's Grandfather (Legend of Maui's Flying Expedition)

In the Legend of Maui's Flying Expedition (Thrum 1923:252-259) Maui-*kupua* looks toward Pōhākea Pass and sees his wife, Kumulama, being carried away by chief Peapeamakawalu. After failing to recover her, Maui returns and tells his problems to his mother, Hina. Hina instructs her son to go to Keahumoa and visit his grandfather Kuolokele who lives there in a large hut. The hump-backed Kuolokele returns home with a load of potato leaves and Maui cures him by striking him in the back with a stone (which Kuolokele throws to Waipahu where it remains). Kuolokele has Maui gather *kī* leaves, ʻieʻie vines and bird feathers from which the old man fabricates a "bird-ship" (*moku-manu*) which Maui uses to defeat Peapeamakawalu and recover

his wife. They return to Kuolokele's house where they feast and Maui eats Peapeamakawalu's eyeballs.

D. Kāne and Kanaloa and The Boundaries of 'Ewa (Simeon Nawaa 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:

> When Kāne and Kanaloa were surveying the islands they came to O'ahu and when they reached Red Hill saw below them the broad plains of what is now 'Ewa. To mark boundaries of land they would throw a stone and where the stone fell would be the boundary line...They hurled the stone as far as the Wai'anae Range and it landed somewhere in the Waimānalo section...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... (Simeon Nawaa In Sterling and Summers 1978:1)

E. Kāne and Kanaloa and the Kauwā of Pu'u Ku'ua (*Ka Loea Kālai'Āina*)

Divine sanction was also given to social stratification and the designation of a land for *kauwā* (outcastes, pariahs) in the vicinity of Pu'u Ku'ua: 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, [a place in the Wai'anae Range famous as a *kauwā* residence and place of mixed caste] 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.

> *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 kō a'ela nā 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 kā 'ana, a laila kau nā lima o ka Mō'ī i luna o kahi keiki a me kahi keiki, ma nā 'ō'ō 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 pōlh 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)*

F. Kamapua'a at Honouliuli (Nakuina's Legend of Kaliuwa'a)

Kamapua'a the pig god is associated with Honouliuli:

> 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) speaks of Kekeleaiku, the older brother of Kamapua'a, who also lived on Pu'uokapolei.

G. *Mo'o* at Maunauna (*Kuokoa*)

Moses Manu in recounting the Legend of Keaomelemele makes a reference to a *mo'o* (fabulous lizard, dragon, serpent) named Maunauna who lived above Līhu'e (presumably at the landform of that name in extreme northern Honouliuli) who was a bad lizard (*Kuokoa* April 25, 1885).

H. Home of the Shark-Goddess Ka'ahupāhau (Legend of Ka'ehuikimanōo Pu'uloa)

In the Legend of Ka'ehuikimanōoPu'uloa (Thrum 1923:293-306) the Big Island shark god, Ka'ehuiki travels to visit the famous shark deity Ka'ahupāhau "reaching Honouliuli, the royal residence." Ka'ahupāhau is said to have lived in a royal cave at Honouliuli (Thrum 1923:302).

I. The Frightened Populace of Honouliuli *(He Ka'ao no Palila)*

In the Legend of Palila (Fornander 1917 Vol. V 136-153), the *kupua* or demigod hero of Kaua'i lands at Ka'ena point with his fabulous war club (*lā'au pālau*), which required eighty

men to carry it, and crosses into Honouliuli through the Pōhākea Pass. He descends 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*

J. Two Old Women who Turned to Stone *(Ka Loea Kālai'Āina)*

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. The legend is as follows:

> There were two supernatural old women or rather peculiar women with strange powers and Pu'ukaua belonged to them. While they were down fishing at Kualaka'i [near Barber's 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.

K. The Strife of Nāmakaokapāo'o and Puali'i *(Ka'ao no Nāmakaokapāo'o)*

In the Legend of Nāmakaokapāo'o (Fornander 1917 Vol. V 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 and the 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*

L. The Naming of Honouliuli (Legend of Lepeamoa)

In the Legend of Lepeamoa, the chicken-girl of Pālama, 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 (1917:209) gives an almost identical account.

M. The Story of Kaihuopala'ai Pond, Honouliuli (*Ka'ao no Maikohā*)

In the Legend of Maikohā (Fornander 1917 Vol. V 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 [1919].
>
> *'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.*

N. The Traveling Mullet of Honouliuli (Fish Stories and Superstitions)

The story of (Ka)Ihuopala'ai is also associated with the tradition of the "'*anae-holo*" or traveling mullet (Thrum 1907:270-272):

> 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 1907:271)

In Thrum's account, Ihupala'ai is a male who possesses a Kū'ula or fish god which 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 the only proverb or poetical saying identified with Honouliuli:

Ka i'a hali a ka makani

The fish fetched by the wind

(Pukui 1983: # 1330)

Pukui explains "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." Whether this saying was used in contexts other than in reference to mullet is unclear.

O. Honouliuli and the Head of Hilo-a-Lakapu (Legend of the Sacred Spear-point)

In the Legend of the Sacred Spear-point (Kalākaua 1888:209-225) 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 1888:224).

P. The Strife at Honouliuli from which Kūali‘i unites Hawai‘i nei *(Mo‘olelo o Kūali‘i)*

The celebrated chief, Kūali‘i, is said to have lead 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 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*) which makes passing reference in word play to the blue *poi* which appeases the hunger of Honouliuli (*Uliuli ka poi e piha nei-o Honouliuli*).

Q. The Vacationing Place of Kākuhihewa (*Ke Au Hou*)

One historical account of particular interest refers to an *ali‘i* residing in Ko ‘Ōlina, an area located south of the project area:

> 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)

R. The Last Days of Kahahana and Honouliuli (The Land is the Sea’s)

In the tradition of the prophecy of the *kahuna* (preist) Kaopulupulu, Moke Manu (Thrum 1907:203-214) relates that the deposed O‘ahu chief Kahahana fled for his life:

> Upon the arrival here at O‘ahu of Kahekili, Kahahana fled, with his wife Kekuapoi, and friend Alapa‘i, and hid in the shrubbery of the hills. They went to Āliamanu, Moanalua, to a place called Kinimakalehua; then moved along to Keanapua‘a, and Kepo‘okala, at the lochs of Pu‘uloa, and from there to upper Waipi‘o; thence to Wahiawā, Helemano, and on to Līhu‘e; thence they came to Po‘ohilo, 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 1907:213-214).

S. Pu‘uokapolei and the Reckoning of the Seasons (Kamakau)

Samuel Kamakau (*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‘ōilo* [winter, rainy, season].

T. Honouliuli in the Poetry of Halemano *(Ka‘ao no Halemano)*

In the Legend of Halemano (Fornander 1917 Vol. V 252), the romantic O‘ahu anti-hero chants a love song with a reference to Honouliuli:

> Search is made to the top of Ka‘ala, The lower end of Pōka‘ī is plainly seen. Love looks in from Honouliuli, The dew comes creeping, it is like the wind of Līhu‘e...
>
> *Huli a‘e la Ka‘ala kau i luna, Waiho wale kai o Pōka‘ī, Nānā wale ke aloha i Honouliuli, Kokolo kēhau he makani no Līhu‘e..*

U. Winds of Honouliuli (M. Nakuina)

The winds of the region are 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
>
> (Mo‘okini and Nākoa, trans. 1992:51)

III. HISTORICAL BACKGROUND

A. Precontact and Early History

Various legends and early historical accounts indicate that the *ahupua'a* of Honouliuli (shown in Figure 4) was once heavily populated by pre-contact Hawaiians. This substantial settlement is attributable for the most part to the plentiful marine and estuarine resources available at the coast, and lowlands suitable for wetland taro cultivation. In addition, forest resources along the slopes of the Wai'anae Range, as suggested by E.S. and E.G. Handy, probably acted as a viable subsistence alternative during times of famine and/or low rainfall.

> The length or depth of the valleys and the gradual slope of the ridges made the inhabited lowlands much more distant from the '*wao*, or upland jungle, than was the case on the windward coast. Yet the '*wao* here was more extensive, giving greater opportunity to forage for wild foods during famine time [Handy and Handy 1972:469-470].

The upper valley slopes may have also been a resource for sporadic quarrying of basalt for 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. 1991).

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). Following 'I'ī's description, a portion of this trail network would have passed close to the presently existing Farrington Highway (*Figure 5).

The Hawaiian *ali'i* were attracted to this region. One historical account of particular interest refers to an *ali'i* residing in Ko 'Olina, just west of the project area:

> Ko'olina 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'olina 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 in Sterling and Summers 1978:41].

Other 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 pre-contact and early post-contact populations also adapted to less inviting areas, despite the environmental hardships.

Barber's Point is named after Captain Henry Barber whose ship ran aground on October 31, 1796. Subsequent to western contact in the area, the landscape of the 'Ewa plains and Wai'anae slopes was adversely affected by the over harvesting of the sandalwood forest, and the introduction of domesticated animals and exotic plant species. Domesticated animals including goats, sheep and cattle were brought to the Hawaiian Islands by Capt. George Vancouver in the

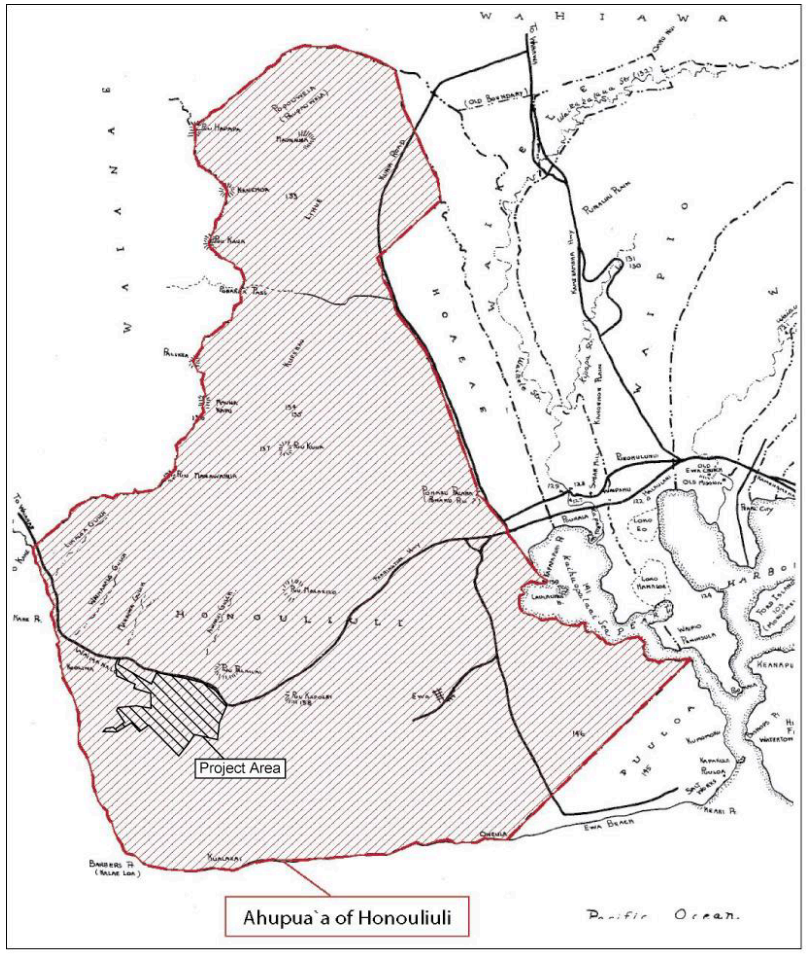
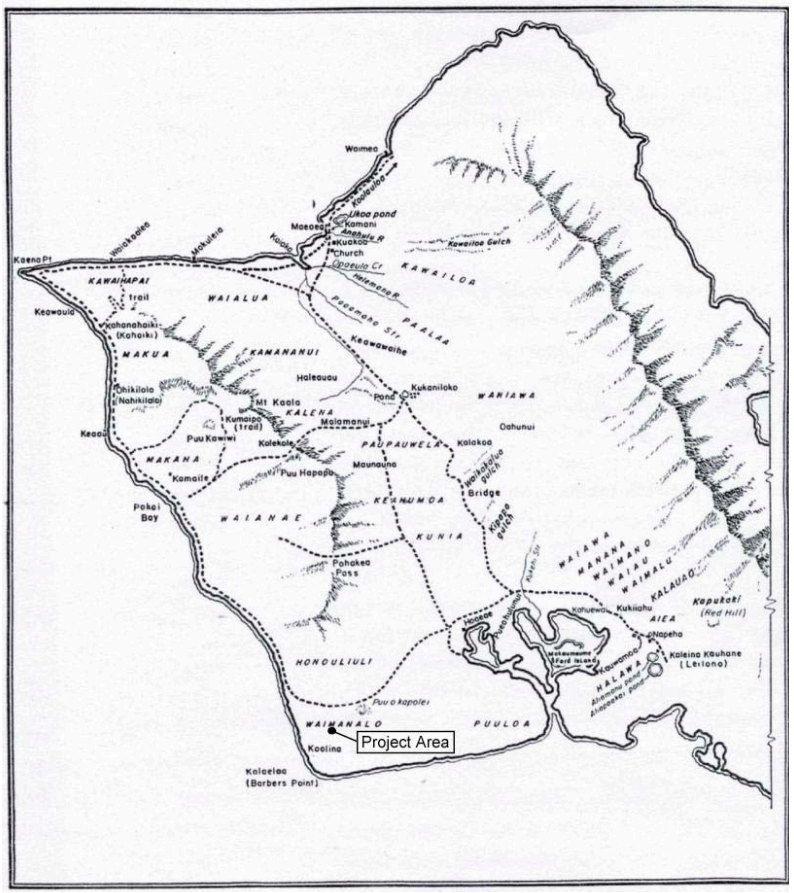


Figure 4. Map Showing Location of Honouliuli Ahupua'a in West O`ahu (adapted from Sterling and Summers 1978)


Waimea
Waimea R
Loko pond
Kamani
Anahulu R
KUOKOO
Church
Kawailoa Gulch
Opaeula Cr
KAWAILOA
Kaena Pt
Mokuleia
KAWAIHAPAI
trail
WAIALUA
Keawaula
Pahanahaiki (Kahaiki)
Poamoho Str
PAALAA
Keawawaiiki
MAKUA
KAMANANUI
Haleauau
Kukaniloko
Pond
WAHIAWA
Ohikilolo
Nahikilolo
Mt Kaala
KALENA
Kumaipo (trail)
Malamanui
Oahunui
Keaau
Puu Kawiwi
Kolekole
PALIPAUWELA
Kalakoa
MAKAHA
Maunauna
Komaile
Puu Hapapa
Waikakaua gulch
Bridge
Pokai Bay
KEAHUMOA
WAIANAE
KUNIA
Waiawa
Hanawana
Waimano
Waiau
Waimalu
KALAUAO
Kapukaki (Red Hill)
Pohakea Pass
Kukuhau
Waiawa
Waiau
Waimalu
Waiawa Res
Waiawa Res
Waiawa Res

C. Twentieth Century

In the early 20th century, the ‘Ewa Plantation Company instituted an effort to bring arable soils to the coral plain (Frierson 1973:17). Drainage ditches were dug from the lower slopes of the Wai‘anae range onto the lowlands and the adjacent slopes were plowed in vertical furrows just before the rainy season to induce erosion.

In 1902, a Magnetic Observatory was established by the U.S. Coast and Geodetic Survey (USCGS) near what is now the center of Naval Air Station Barber’s Point (Kelly 1991:170). Also known as the Honolulu Observatory, the observatory measured earth movement and magnetic fields. After the 1946 tsunami, construction of the Hawai‘i Tsunami Warning Center in ‘Ewa Beach was initiated, and was completed in 1948. By the 1970s, its function had expanded to include weather monitoring and in 1973, responsibility for the Tsunami Warning System was turned over to the National Weather Service.

A 1922 War Department Fire Control Map (Figure 6) shows a compound of four structures within the project area (likely associated with a plantation railway) but this appears to have been no longer extant in the 1928 USGS map (Figure 7). Both the 1919 and 1928 maps show walls and fences within the project area but these configurations are rather dissimilar on these two early twentieth century maps.

By 1920, the lands of Honouliuli were used primarily for sugar cultivation and ranching (Frierson 1973:18). A 1939 map of Ewa Plantation indicates that much of the *mauka* portion (north of the O. R. & L. railway line) of the present project area comprised sugar cane fields (Figure 8).

Major land use changes came to the ‘Ewa Plain from the 1930s, when the U.S. Military began development in the area. The 1930s and early 1940s saw Army, Navy, and Marine facilities constructed, the most massive and lasting of which was Naval Air Station (NAS) Barber’s Point, initial development of Barber’s Point Deep Draft Harbor, and development of Campbell Industrial Park (Figure 9).

During the 1970s and early 1980s, there was a relative abundance of industrial land available for development near to the bulk of population as well as at Campbell Industrial Park (Wanket 1991). A national economic slowdown occurred during the early 1980s and high interest rates curtailed demand for industrial and commercial development in areas like the Campbell Industrial Park.

D. Modern Land Use

Today the project area borders the Ko ‘Olina resort complex on the northwest and is traversed by the O.R.&L. right-of-way. Much of the project area *makai* of the right-of-way appears to have had no formal use for quite some time, though portions of the area are currently part of a quarry for coral limestone, and adjacent to areas of active development including the Barber’s Point Deep Draft Harbor and Ko ‘Olina resort areas.

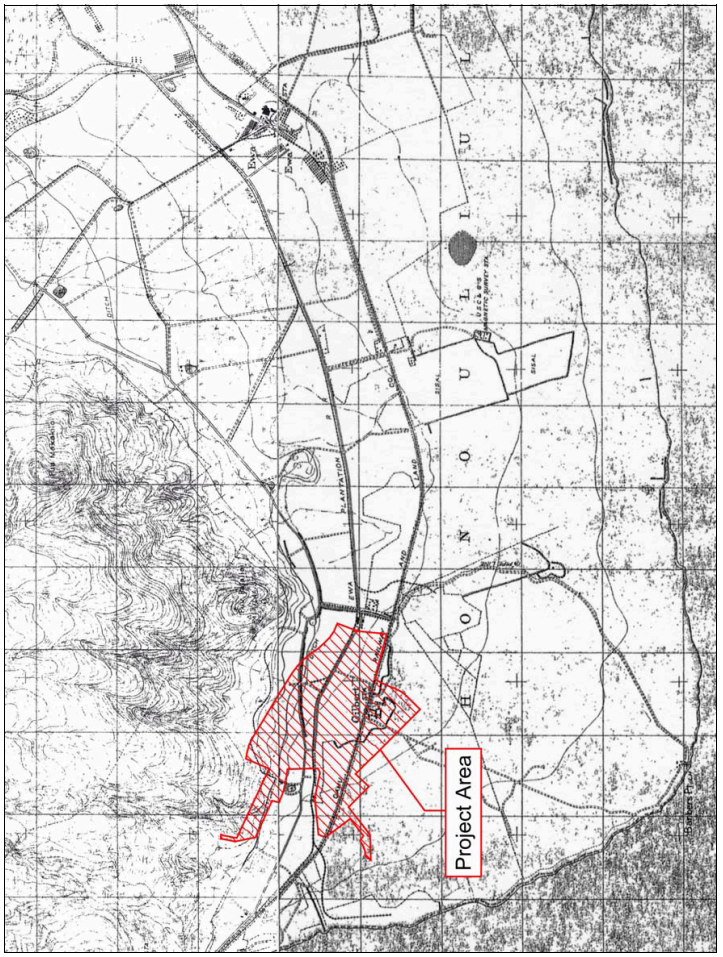


Figure 6. Portion of 1922 War Department Fire Control Map, Barber’s Point Quad, Showing Project Area

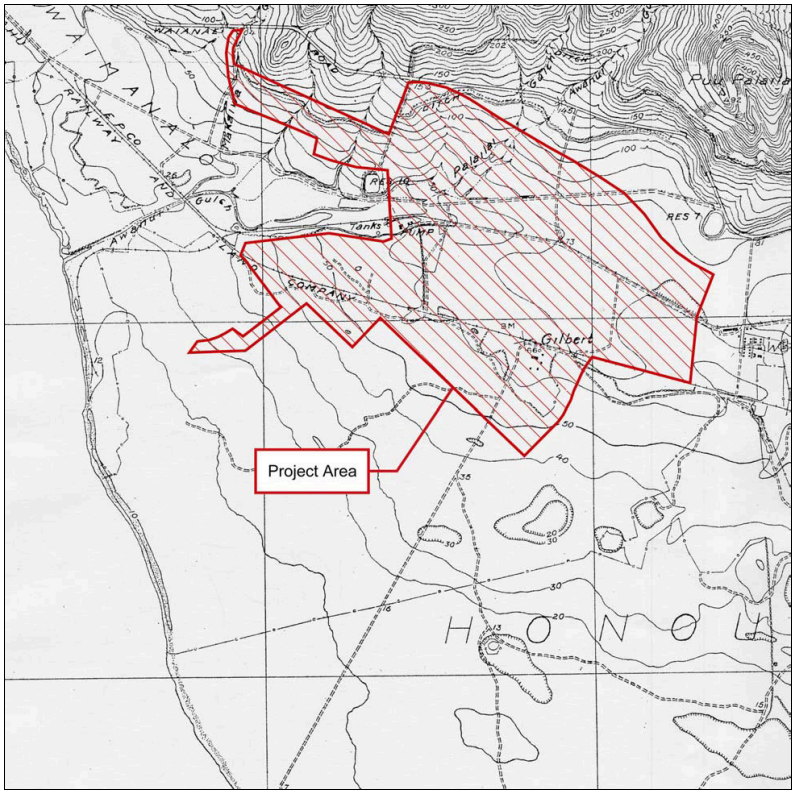


Figure 7. Portion of 1928 U.S. Geological Survey Map, Barber's Point Quad, Showing Project Area

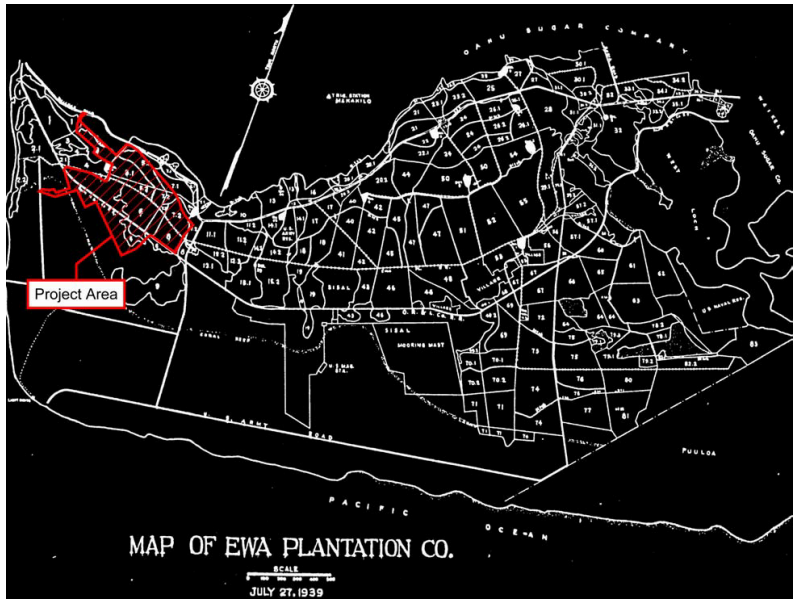


Figure 8. 1939 Map of Ewa Plantation

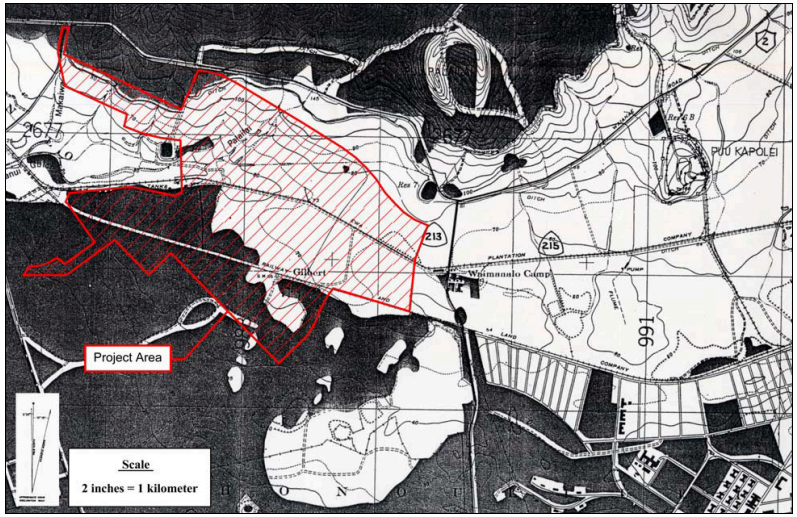


Figure 9. Portion of 1943 USGS Barber's Point Quad Map Showing Project Area

IV. ARCHAEOLOGICAL RESEARCH IN HONOULIULI AHUPUA'A

A. Overview of Archaeological Studies in Western Honouliuli

The Barber's Point area (western Honouliuli Ahupua'a) has a reputation as the most archaeologically studied place in Polynesia. An overview of archaeological studies in the western half of Honouliuli Ahupua'a is presented in Table 1 and Figure 10. A discussion of archaeological findings germane to the present project area follows.

Table 1. Archaeological and related studies in western Honouliuli Ahupua'a

Reference	Nature of Study	General Location of Study
Thrum 1907	*Heiau* study	Hawaiian Islands
McAllister 1933	All island survey	O'ahu Island
Kikuchi 1959	Site letter report	Barber's Point
Lewis 1970	Reconnaissance survey	Barber's Point (harbor area)
Frierson 1972	Study of land use & vegetation change	Honouliuli
Barrera 1975	Reconnaissance survey	Barber's Point (harbor area)
Clark and Connolly 1975	Reconnaissance survey	Barber's Point (harbor area)
Oshima 1975	Reconnaissance survey	Barber's Point
Sinoto 1976	Cultural resources survey	Barber's Point (harbor area)
Bordner 1977	Reconnaissance survey	Kalo'i Gulch
Davis 1978	Scholarly paper	Barber's Point (harbor area)
Davis and Griffin 1978	Archaeological Survey	Barber's Point (harbor area)
Hawai'i Marine Research Inc. 1978	Geoarchaeological reconnaissance	Barber's Point (harbor area)
Kirch 1978	Land snail study	Barber's Point (harbor area)
Sinoto 1978	Archaeological & Paleontological salvage	Barber's Point (harbor area)
Barrera 1979	Archaeological Survey	West Beach
Clark 1979	Reconnaissance survey	Barber's Point (harbor area)
Cleghorn 1979	Reconnaissance survey	Barber's Point
Davis 1979a	Emergency excavations	Barber's Point (harbor area)
Davis 1979b	Emergency excavations	Barber's Point (harbor area)
Davis 1979c	Emergency excavations	Barber's Point (harbor area)
Komori and Dye 1979	Archaeological testing	West Beach
Sinoto 1979	Cultural resources survey	Barber's Point (harbor area)
Davis 1980	Research design	Barber's Point
Kirch and Christensen 1980	Land snail study	Barber's Point (harbor area)
Christensen and Kirch 1981	Land snail study	Barber's Point (harbor area)
Hammatt and Folk 1981	Archaeological and Paleontological Investigation	Barber's Point (harbor area)
Davis 1982	Academic paper	Barber's Point
McCoy et al. 1982	Proposal for investigations	Barber's Point (harbor area)
Neller 1982	Scholarly study	Barber's Point

Reference	Nature of Study	General Location of Study
Ahlo and Homon 1983	Reconnaissance survey	Barber's Point (harbor area)
Bordner and Silva 1983	Reconnaissance survey	Waimānalo Gulch
Ahlo and Homon 1984	Test excavations	Barber's Point (harbor area)
Hammatt 1984	Reconnaissance survey	Kahe Point
Haun and Kelly 1984	Research resign	Naval Air Station
Tuggle 1984	Survey report	Naval Air Station
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. 1986 a and b	Research design	West Beach
Haun 1986a	Reconnaissance survey	Kapolei Town
Haun 1986b	Reconnaissance survey	Kapolei Town
Davis and Haun 1987	Intensive survey & test excavations	West Beach
Rosendahl 1987a	Reconnaissance survey	Kapolei Town
Rosendahl 1987b	Survey report	Kapolei Town
Welch 1987	Reconnaissance survey	Naval Air Station
Bath 1989a	Petroglyph study	Waimānalo Gulch
Bath 1989b	Burial documentation	Kahe
Burgett and Rosendahl 1989	Subsurface archaeological testing	North of O. R. & L.
Hammatt and Shideler 1989a	Archaeological assessment	Barber's Point (harbor area)
Hammatt and Shideler 1989b	Reconnaissance survey	Kahe
Carlson and Rosendahl 1990	Inventory survey	Kaomi Loop Subdivision
Cleghorn and Davis 1990	Archaeological and paleontological investigation	Barber's Point (harbor area)
Davis 1990b	Archaeological and paleontological investigation	Barber's Point (HECO area)
Davis 1990a	Archaeological and paleontological study (Ph.D. dissertation)	Barber's Point (harbor area)
Rosendahl 1990	Letter report	Kapolei Town
Kennedy 1991	Subsurface testing	Pu'uokapolei
Hammatt et al. 1991	Inventory survey	Makaiwa Hills
Hammatt and Shideler 1991	Archaeological assessment	Barber's Point (harbor area)
Haun et al. 1991	Survey report	Naval Air Station
Burgett and Rosendahl 1992	Inventory survey	Barber's Point (harbor area)
Hammatt and Folk 1992	Subsurface testing	Barber's Point (harbor area)
Glidden et al. 1993	Data recovery excavations	Paradise Cove
Jones 1993	Fossil coral reefs study (Ph.D. dissertation)	Hawaiian Islands
Landrum 1993	Reconnaissance and subsurface testing	Naval Air Station

Reference	Nature of Study	General Location of Study
Miller 1993	Data recovery	Barber's Point (harbor area)
Hammatt and Shideler 1994	Archaeological assessment	Barber's Point (harbor area)
Hammatt et al. 1994	Inventory survey	Barber's Point (harbor area)
Davis 1993	Archaeological and paleontological investigation	Barber's Point (harbor area)
Erkelens 1992	Archaeological survey	Naval Air Station
Hammatt and Shideler 1995	Data recovery plan	Barber's Point (harbor area)
Jourdane 1995	Burial documentation	Paradise Cove
O'Hare et al. 1996	Intensive survey and testing	Naval Air Station
Wulzen and Rosendahl 1996	Subsurface testing & data recovery	Naval Air Station
Athens et al. 1997	Cultural resource inventory, paleoenvironmental investigation	'Ewa Plain:Naval Air Station
Tuggle 1997a	Cultural resource inventory	Naval Air Station
Tuggle 1997b	Synthesis	'Ewa Plain
Tuggle and Tomonari 1997a	Cultural resource inventory survey	Naval Air Station
Wickler and Tuggle 1997	Cultural resource inventory, Inventory Survey	Naval Air Station
McDermott et al. 2000	Data recovery	Barber's Point (harbor area)
Cordy and Hammatt 2003	Archaeological assessment	Barber's Point, North of O. R & L.

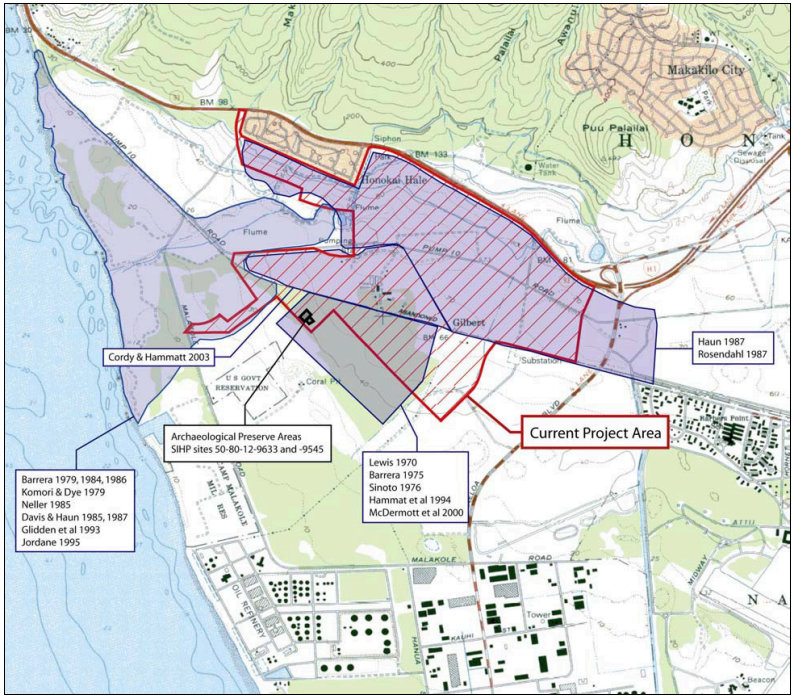


Figure 10. Map Showing General Areas of Archaeological Study Near the Project Area

The first effort to record sites at Honouliuli was by Thrum (1907:46) and references "a *heiau* on Kapolei hill, Ewa-size and class unknown. Its walls thrown down for fencing." This *heiau*, Pu‘u Kapolei, is north of the present study area.

In his surface survey of 1930, archaeologist J. Gilbert McAllister recorded the specific locations of important sites, and the general locations of some sites of lesser importance. McAllister (1933:107-108) recorded seven specific sites at Honouliuli (numbered 133-139) and these became the first seven sites in the Bishop Museum's Site Numbering System (OA-B6-1 through OA-B6-7). The nearest of these to the present project area is McAllister Site 138, including the Pu‘u Kapolei Heiau and an adjacent rock shelter. McAllister (1933:109) includes his impressions as follows:

> ‘Ewa coral plains, throughout which are remains of many sites. The great extent of old stone walls, particularly near the Pu‘uloa Salt Works belongs to the ranching period of about 75 years ago. It is probable that the Hawaiians formerly used the holes and pits in the coral. Frequently the soil on the floor of larger pits was used for cultivation, and even today one comes upon bananas and Hawaiian sugar cane still growing in them. They afford shelter and protection, but I doubt if previous to the time of Cook there was ever a large population here.

These Hawaiian sites of the ‘Ewa coral plains would be the subjects of some 37 archaeological reports in the 1970s and 1980s.

From the period between McAllister's 1930 study and the flurry of work that began in 1969, there are only a few sporadic pieces of poorly documented research. "In 1933, Dr. Kenneth P. Emory examined a well-preserved house site and a possible *heiau* in the western part of the coral plain; these sites were later destroyed by sugar-cane planting” (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, south of the present project area (Kikuchi 1959; Davis 1990:146, 147). In 1960, Yoshi Sinoto and Elspeth Sterling made note of a house site (Bishop Museum Site OA-B6-8). “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 (per Sinoto 1960), Lloyd Soehren "carried out salvage excavations at BPBM. Site # 50-OA-B6-13 (a possible fishing shrine.)” The site was reported as destroyed by construction (Barrera 1975:1) but Davis (1990a:148) relocated the shrine and performed additional excavations in 1982. In 1969, artifacts were recovered by Roger Green from a beach midden site (B6-14), south of the barge harbor.

To the west of the project area, Paradise Cove, Lanikūhonua, and West Beach have been the subject of numerous archaeological studies (Barrera 1979, 1984, 1986; Komori & Dye 1979; Neller 1985; Davis & Haun 1986, 1987; Glidden et al. 1993; and Jourdane 1995).

B. Archaeological Studies Relevant to the Present Project Area

1. Studies of *Mauka* Portion of Project Area (north of the O. R. & L. alignment)

Archaeological study germane to the portion of the present project area lying *mauka* (north) of the O.R. & L. alignment is a letter report entitled *Preliminary Archaeological Reconnaissance*

Survey for Environmental Assessment (EA) 'Ewa Town Center/ Secondary Urban Center, Land of Honouliuli, 'Ewa, Island of Oahu (TMK: 9-1-15: Por. 4, 5, 17; 9-1-16:1, Por. 4, 6, 9, 16, 18, 24, 30: 9-2-19: Por. 1)(Haun 1986b, PHRI report # 275-111886). This study covered a petition area of approximately 1,400 acres. The Haun study notes the extensive modification for sugarcane cultivation and concludes that only two sites had been previously reported in the vicinity: the O. R. & L. alignment on the southern border of the study area and a *heiau* and large rock shelter on Pu'uokapolei. (outside of the Haun study area and outside the present area of concern). The Haun study identified two new sites: an irrigation ditch north of the H-1 and a WWII military structure on Pu'u Palailai but both lie outside the present area of concern and both were regarded as of minimal significance. The Haun study (1986:4) concluded that "no further archaeological work is recommended.

A study by Burgett and Rosendahl (1989) involved the excavation of seventy-two backhoe test trenches in a 360-acre portion of the Haun study area. There were no significant finds.

The Haun (1986b) study area encompassed the vast majority of the areas of present concern with the notable exception of an approximately 100-acre area (shaped somewhat like Diamond Head) in the southwestern corner of the project area adjacent on the north side of the O. R. & L. alignment. This approximately 100-acre area is the subject of an archaeological assessment study conducted by Cultural Surveys Hawai'i (Cordy and Hammatt 2003). Several sinkholes were noted as of potential archaeological interest. The study also documented the presence of a historic chicken farm as well as other twentieth century architectural remains, including a Quonset hut of unknown use. The majority of the area comprised certain scrublands never under cane cultivation.

2. Studies of *Makai* Portion of Project Area (south of the O. R. & L. alignment)

Several studies have also been carried out within the *makai* portion of the current project area (south of the O. R.&L. alignment) in the last several decades. In the fall of 1969, Mr. Ellis Cross, a supervisory employee at the nearby oil refinery on the coast, informed Dr. Sinoto that he had found house sites and walls at various locations on Campbell Estate land, near Campbell Industrial Park and the coral quarry (Lewis 1970:2). This resulted in a number of visits by Dr. Sinoto and student volunteers in late 1969 and early 1970. A University of Hawaii graduate student, Mr. Ernest Lewis, did a preliminary survey and test excavations for a graduate seminar in Polynesian Archaeology and donated his report to the Bishop Museum. Lewis was the first to document sites within the *makai* portion of the present project area.

The sites Lewis documented just south of the O. R. & L. line were subject to a number of further studies including Barrera 1975, Sinoto 1976, Hammatt et al. 1994 and McDermott et al. 2000 (Figures 10, 11 & 12). Two sites were identified for protection within fenced off preserve areas. SIHP site 50-80-12-9633 is a cave that was found to contain human created rock piles and wall, a human burial, and part of what appears to be a wooden canoe (Hammatt et al. 1994:93-94). Because of its function as a burial site, the cave was not excavated and remains protected in the state in which it was discovered. Just east of that fenced preserve is another smaller preserve area surrounding SIHP site 50-80-12-9545. This site is a very large sinkhole measuring about nine meters in diameter and six meters deep (Sinoto 1976:16). The interior of the sinkhole has been modified for human habitation in traditional times, including "cleared areas, low terraces, firepits, and a large *ahu* which was probably constructed to facilitate entry and egress" (Hammatt et al. 1994:87).

At the time of the preparation of this cultural impact assessment, Cultural Surveys Hawai'i has conducted an archaeological inventory survey of the *makai* portion of the project area. A report on this inventory survey is to be submitted to the State Historic Preservation Division for review. During the course of this inventory survey, nineteen historic properties were identified (Hoffman et. al. 2004). These properties, among which are sites identified previously in the above studies, include ten sites associated with agriculture and/or ranching, six habitation sites, one burial site (the above-mentioned burial preserve), one transportation site (the O. R.&L. alignment) and one marker (Gilbert Trig Station). Five of the ten sites associated with agriculture and/or ranching appear to be clearing mounds related to traditional Hawaiian subsistence agriculture.

The six habitation sites include temporary habitation sites and a very large sinkhole that may have had a permanent habitation function during traditional Hawaiian times. This sinkhole is the above-mentioned archaeological preserve, delineated with chain-link fencing and marked as restricted, which has been designated State Inventory of Historic Properties (SIHP) site 50-80-12-9545.

The transportation site is the O'ahu Railway & Land Company Right-of-way which was placed on the National Register of Historic Places on December 1, 1975 (site number 80-12-9714).

The burial comprises the cave within an archaeological preserve delineated with chain-link fencing and marked as restricted. As noted above the site was previously described in Hammatt et al. (1994) and was designated SIHP site 50-80-12-9633.

V. COMMUNITY CONSULTATIONS

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 specifically related to the project area. This effort was made by letter, e-mail, telephone and in person contact. In the majority of cases, letters along with a map of the project area were mailed with the following text:

> In collaboration with, Helber Hastert & Fee Planners, Inc., Cultural Surveys Hawai'i is conducting a Cultural Impact Assessment for the proposed project of the City of Kapolei (TMKs 9-1-16:1, 30, 34, 121, 122, 123, & 124), Honouliuli Ahupua'a, 'Ewa District, O'ahu. The purpose of the cultural study is to assess potential impacts to traditional cultural practices. This study is meant to satisfy requirements related to Chapter 343 HRS Articles IX and XII and Act 50 and their applicability to the project area.
>
> We are seeking your input regarding the following issues:
>
> General history and present and past land use of the study area.
>
> Knowledge of cultural sites which may be impacted by the project, e.g., historic sites, archaeological sites, burials, etc…
>
> Knowledge of traditional gathering practices in the study area-both past and present.
>
> Cultural associations with the study area through legends, traditional use or otherwise.
>
> Referrals of *kūpuna* who might be willing to share their cultural knowledge of the study area in general.
>
> Any other cultural concerns the community might have related to Hawaiian or other cultural practices in this area of the district of Wai'anae, Island of O'ahu.

The individuals, organizations, and agencies we attempted to contact are presented in Table 2. The initial contact letter was followed-up with at least three attempts to contact each of the individuals, organizations and agencies by telephone. The results of any consultations are also presented in Table 2 below.

As a result of the contact process, two interviews were subsequently conducted with Mr. Shad Kane and Mr. George Ka'eliwai, both of whom have knowledge and concerns about the project area. These interviews are presented in Section VI below.

Table 2. Community Contacts and Comments

Name	Affiliation	Comments
Batalon, Pedro	'Ewa Plantation Worker	No Comment.
Cayan, Coochie	O'ahu Island Burial Council	Referred to Shad Kane
Collins, Sarah	State Historic Preservation Division	No response.
Debutiaco, Gregorio	'Ewa Plantation Worker	No response.
Eaton, Arlene	Hale O Na'auao Society	No response.
Espero, Willie	Hawai'i State Legislature	No response.
Gabbard, Mike	Honolulu City Council	No response.
Guth, Heidi	Office of Hawaiian Affairs	Referred to Shad Kane
Hermosura, Jowe	'Ewa Plantation Worker	No comment.
Ka'eliwai, George Jr.	Hawaiian Civic Club of Pu'uloa and 'Ewa	Telephone interviewed on February 2, 2004.
Kane, Shad	'Ahahui Siwila Hawaiian Civic Club	Interviewed on February 6, 2004.
Kanno, Brian	Hawai'i State Legislature	No response.
Kapeliela, Kana'i	State Historic Preservation Division	No response.
Kimoto, Ernest	Office of Hawaiian Affairs	No response.
Komori, Eric	State Historic Preservation Division	Referred to reports at SHPD
Lonowaila, Peter	Kapolei High School	No response.
Malama, Tesha	'Ewa Neighborhood Board No. 23	No response.
McKinzie, Edith	Kupuna	Her childhood was spent in 'Ewa.
Moses, Mark S.	Hawai'i State Legislature	Referred to Shad Kanē
Napōka, Nathan	State Historic Preservation Division	Referred to Shad Kane and John Kaimikaua.

Name	Affiliation	Comments
Tamayo, Tulsi, Gabbard	Hawai‘i State Legislature	No response.
Tawata, Shigeru	‘Ewa Plantation Employee	No response.
Tiffany, Nettie Pualani	O‘ahu Island Burial Council	No response.

VI. KAMA‘ĀINA INTERVIEWS

Two informants with knowledge of the project area were interviewed for this assessment. Mr. Shad Kane participated in an informal face-to-face interview “talk-story” session and Mr. George Ka‘eliwai participated in a telephone interview with Cultural Surveys Hawai‘i.

A. Shad Kane

Mr. Shad Kane was interviewed by Cultural Surveys Hawai‘i on February 6, 2004. The interview took place at his residence in Makakilo on the island of O‘ahu.

Shad Kane was born in Honolulu on February 23, 1945 to Hattie and Tazoni Kane. He was raised on the Pearl City Peninsula and currently resides in Makakilo. Now retired from the Honolulu Police Department, he is active as a community leader and volunteer. He is a member of a number of community groups including: The Nature Conservancy, the ‘Ahahui Sivila Hawai‘i O Kapolei Hawaiian Civic Club, and the Makakilo/Kapolei/Honokai Hale Neighborhood Board. Mr. Kane is an avid hiker and an accomplished horseman who often visits the mountain ranges above the project area. He is presently working with the noted Kumu Hula John Kaimikaua on the establishment of a cultural center below Pu‘uokapolei.

Mr. Kane commented:

> I am aware of several trails. Anybody familiar with the cultural history is familiar with the trails. Not just this area but the whole island of O‘ahu. There are several of our roadways today that at one time served carriages, horses and buggies. If you go back far enough in the history of O‘ahu there were also foot trails. One of those trails is where the Farrington Highway is today. There is archival data. I think it is referenced by Archibald Campbell. I think he is referenced in *Sites of O‘ahu.* This would be around the early 1800s. I think it is one of the earliest references to trails. He makes reference to passing the *lo‘i kalo* and fish ponds of Pu‘uloa.
>
> The most significant name in the immediate area and it falls just north of the project area is Pu‘uokapolei or Fort Barrette as it was known during the 40s and 50s. In fact in ancient times Pu‘uokapolei was used as a landmark for passers by. For people who were traveling from Honolulu, from Kona to Wai‘anae. So the people traveling from Kona in this direction made reference to many trails. They made reference to Kolekole by way of Kolekole Pass. They made reference to another trail by the way of Pōhākea, midway between Makakilo and Schofield Barracks. It is very identifiable when you’re traveling from town in this direction. You can see the V shape in the Wai‘anae Range. That particular area has a lot of cultural resources besides, biological native plants. The third trail is by way of Pu‘uokapolei. And this particular trail followed Farrington Highway along the coast of Wai‘anae out to Ka‘ena.
>
> According to Gilbert McAllister, who referenced the work of Samuel Kamakau, in ancient times there was a *heiau* on top of Pu‘uokapolei. He also pointed out the fact that it served as a residence of Kamaunuaniho, the grandmother of Kamapua‘a. History tells of the battle between Kamapua‘a and Olopana. Olopana was the brother of Mō‘īkeha. Both were sons of Māweke who we refer to genealogically as

one of our Tahitian ancestors during this period in history and getting established on the island of O‘ahu. After the death of Olopana, Kamapua‘a set his grandmother Kamaunaniho up in residence on the *makai* side of Pu‘uokapolei.

Around 1930 some 300 acres *makai* of Pu‘uokapolei was converted to a sisal plantation. Much of Pu‘uokapolei’s past sites may have been lost as a result of the encroachment of sugar and sisal.

When Campbell Estate was building the Kapolei Regional Park during which Pu‘ukapolei was turned over from the U.S. Navy to the city. I submitted a proposal to build a “Hula Mau” in 1999 as part of a city vision team project. Samuel Kamakau wrote that Pu‘uokapolei served as a place for solar observation determining the seasons of *ho‘ōilo* and *makali‘ī.*

My personal *mana‘o* is that we need to understand that this is an island and the reason why our *kūpuna* came this far north is because they understood that an island can only support so many people. For whatever reason there is only so much food, so much water, and limited lands. That is why the Hawaiians were so unique because they went farther than anybody else to find that place and they found it here. We need to understand that our resources are limited. We need to understand that this island environment cannot be compared with a continental one. The mainland has plenty land. Here in Hawai‘i we don’t have. Our *kūpuna* told us that we can only support so many people. Soon we will not have enough water and we will run out of space. Our traffic will get bad and soon we will look like another Hong Kong. All depends on what we want. The time is now to make up your mind. All the stuff and goods shipped to the islands later becomes potential trash. What is going to happen with all that trash? The more we develop these lands the more people will come and the island will get smaller and smaller until we have a crisis situation. It is my *mana‘o* that we are going to have to come to a point one day and understand we cannot handle any more people. It’s a difficult decision, but I think the sooner we address those issues the better off we are going to be.

B. George Ka‘eliwai

Mr. George Ka‘eliwai who was raised in ‘Ewa participated in a telephone interview with Cultural Surveys Hawai‘i on February 2, 2004. Mr. Ka‘eliwai is in his eighties and is currently a resident of Kalihi on the island of O‘ahu. He is a long-time member of the Hawaiian Civic Club of Pu‘uloa and ‘Ewa.

Mr. Ka‘eliwai commented:

As a young child I only lived in ‘Ewa. At that time the Hawaiians were moving all over where they could find work. It was the plantation people who had ties with the land. In those days we lived near the beach. My mama was a single parent and she was schoolteacher in Kaimuki. Mama was of the Nahinu Family from Kona on the island of Hawai‘i and they had relatives in ‘Ewa. There were fifteen children in my family. Mama could not care for all of us so there was a lot of *hānai* [adoption] in our family. I caught the train to school from ‘Ewa to Kaimukī. My uncle was the conductor at that time. Sometimes I would stay at relative’s house a couple days of

the week. The old ways were like that. At a very early age I learned to *mahi‘ai* [farm] and some of the culture. We all knew how to survive through our culture by the age of thirteen. The older boys would go up mountain and I had to know how to make the *palu* [bait] for fishing. You are never to talk about fishing. You just get up early and go. I knew *Tūtū* [grandmother] Campbell on the ranch. She liked me and favored me. She gave me fishing rights as long as I gave her some fish. It was nice living close to the beach and hear the waves at night.

The Hawaiian language was spoken in our home. The children were sent away [when Hawaiian was spoken] so we never learned [the language]. I witnessed *kūpuna* [elders] chanting Barber’s Point area when I lived there.

VII. TRADITIONAL LAND USE IN HONOULIULI AHUPUA‘A

A. The Physical Layout

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* 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 does Honouliuli boast a long coastline along the normally calm waters of leeward O‘ahu, but there are four miles of waterfront running along the west side of West Loch. The land immediately inland of the sea coast consists of a flat karstic raised limestone reef forming a level, nearly featureless "desert" plain covered in pre-contact times by a sparse soil mantle. The microtopography is notable in containing countless sinkholes in some areas, created by chemical weathering (dissolution) of the limestone shelf. Proceeding inland, this plain is overlain by alluvium deposited through a series of gulches draining the Wai‘anae Mountains, the largest of which, Honouliuli gulch, is on the east side of the plain draining into West Loch. To the west are fairly steep gradient gulches forming a more linear than dendritic drainage pattern. The major gulches are (from east to west) Awanui, Palailai, Makaīwa, Waimānalo and Lumaloa. These gulches are 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 inland portions of the plain. These gulches are generally dry, but during seasonal Kona storms they 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 in their upper reaches. These gulches do not have valleys suitable for extensive irrigated agriculture. However, this lack is more than compensated for by the rich, watered lowlands at the base of Honouliuli Gulch (the ‘*ili* of Honouliuli).

Honouliuli Ahupua‘a, as a traditional land unit, had tremendous and varied resources available for exploitation by early Hawaiians. The "karstic desert" and marginal characterization of the limestone plain (which is the most readably visible terrain) does not do justice to the *ahupua‘a* as a whole. The following available resources mark the richness of this land unit:

1. Twelve 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-Laulaunui for example.
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 of 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 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.
6. Within this natural setting archaeological and traditional sources show a general pattern of three main areas of settlement within the *ahupua‘a*: 1) the coastal zone including Kalaeloa (Barber’s Point), Ko ‘Olina (West Beach), and One‘ula (‘Ewa Marina), 2) the Honouliuli Taro Lands and 3) the inland area of Pu‘u Ku‘ua.

B. The Coastal Zone

1. Kalaeloa (Barber’s Point)

Archaeological research at Barber’s Point has focused on the areas in and around the recently constructed Deep Draft Harbor (see Table 1). A series of small clustered shelters, enclosures and platforms show limited but recurrent use at the shoreline zone for marine 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.

An attraction of the area to early Hawaiians was the plentiful and easily exploited bird population. Particular evidence for taking of petrel occurs at State Inventory of Historic Properties (SIHP) site 50-80-12-2763 located just south of the current project area (Hammatt and Folk 1981:213). Initial heavy exploitation of nesting seabirds and other species, in conjunction with habitat destruction, probably led to early extinction of these bird communities.

The archaeological content of the sites here indicates a major focus on marine resources. There is, however, some indication of agriculture in mulched sinkholes and soil areas. Considering rainfall, this activity would have been constrained by accessibility to water, probably involving tree crops and roots (sweet potatoes).

Bertel Davis (1990a:135), in his Ph.D. dissertation, summarizes our knowledge of traditional Hawaiian use of the coastal zone of Honouliuli:

> I suggest the west coast of O‘ahu, including the area off Barber’s Point, (a) probably became a well established fishery at least by AD 1000, perhaps much earlier; (b) the initial settlement at Barber’s Point also began around this time or possibly earlier; and (c) the settlement initially involved task-specific groups exploiting the adjacent fishery on a seasonal round, probably during the winter months.

2. Ko ‘Olina (West Beach)

Studies associated with the Ko ‘Olina area, which includes the western portion of the present project, document around 200 component features at approximately 50 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 (1987:37) describe as "one of the longest local sequences in Hawaiian prehistory.” Information for the

earliest part of the sequence comes from an inland marsh site but early dates were also obtained for a beachfront site and an inland rock shelter.

C. 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. This area bordering West Loch was clearly a major focus of population within the Hawaiian Islands. 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. As early as 1825 all the roads of southwest O'ahu converge as they descend the *pali* funneling into the locality that gave the district of Honouliuli its name. Dicks et al. (1987:78-79) concludes, on the basis of 19 radiocarbon 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. Prehistoric population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census (1831-1832) the land of Honouliuli contained 1026 men, women, and children (Schmitt 1973:19). It is not clear whether this population relates to Honouliuli Village or district 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 pre-contact population of Honouliuli Village may well have been significantly greater than it was in the 1830s.

D. Pu'u Ku'ua: Inland Settlement

Documentation of inland settlement in Honouliuli Ahupua'a is more problematic due to a general absence of archaeological studies. 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 traditional importance.

In 1899 Hawaiian Newspaper "*Ka Loea Kalaiaina*" relates a story of Pu'u Ku'ua as "a place where chiefs lived in ancient times" and a "battle field," "thickly populated." The article summarizes:

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 [in Sterling and Summers 1978:33].

McAllister (1933:134, 137) recorded three sites in this area: two *heiau,* Pu'u Kuina and Pu'uKu'ua (both destroyed), and most interesting, a series of enclosures in Kukuilua which he calls "kuleana sites." There is no direct archaeological evidence available that Hawaiian settlement occurred here but extensive settlement appears likely from traditional accounts. Geographically, the area is well-watered and would have had abundant locally available forest resources.

E. Summary of Traditional Land Use in Honouliuli

Based on the above summary of areas of Honouliuli land use, the following general considerations are made. There are three areas of Hawaiian settlement in the *ahupua'a*; two are well documented while the third is more problematic:

1) The extensive limestone plain with recurrent use habitations for fishermen and gatherers and sometime gardeners;

2) The rich cultivated lands of Honouliuli *'ili* for extensive wetland taro- the *ahupua'a* population center;

3) The uplands around Pu'uku'ua probably for agriculture and forest resource utilization.

Honouliuli, as a unit, contains 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 highly advantageous characteristic for human subsistence is included in a vast coastline and fringing reef, as well as an extensive limestone plain that 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 forestland for foraging for wood, birds, feathers, etc. would have been the east slope of the Wai'anae Range. The *mauka/makai* route would have been up Honouliuli Gulch or up the Makakilo ridge, paralleling the coast from Honouliuli Gulch to Kahe. The most convenient route to *mauka* lands, even from the western end of the coast (Ko'Olina), would have been *mauka* only to the base of the hills and then either up the Makakilo Ridge or northeast to a trail to Pu'u Ku'ua. The *makai* slope is the dry side of the ridgeline. Here streams would respond to rainfall quickly but drain quickly leaving little available water for even short-term use.

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 continuation of the Ko'Olina 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. Supported by seasonal dry land planting and forest foraging, this *mauka* habitation could have been the lower portion of a thinly scattered, but widespread zone of settlement stretching eastward and northeast along the east Wai'anae Range slopes, possible increasing in intensity along the more watered lands forming the *mauka* western boundary of Honouliuli.

There is to date no archaeological evidence of high status residences in Honouliuli. Large residential structures are not present along the 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) but to date there is no direct archaeological evidence of this. Concerning status associations with Honouliuli it is interesting to note the connection of the Pu'uku'ua settlement with pariah (*kauwā*), the lowest class of Hawaiians (Sterling and Summers 1978:33).

The central place of the *ahupua'a* of Honouliuli in terms of population, as well as cultivated foods, was the *'ili* of Honouliuli. There is good reason to assume, given the lack of intensive

agricultural resources in other locations during prehistoric times, that all other habitation zones were economically and socially co-dependent.

VIII. TRADITIONAL CULTURE IN THE PROJECT AREA

The project area lies back from the coast, on the extensive ʻEwa limestone plain, which was, according to Honouliuli settlement predictions, probably never permanently inhabited. It could have, however, provided temporary habitation for gatherers and fisherman traveling to the coast. A relatively barren and waterless area, it nonetheless might have been occasionally transversed, as the project area lay between the greater populated and watered uplands and *makai* resources. The extended limestone plain would have been used for bird catching, and would include the temporary habitations that would result from such forays. Planters could have also used the natural limestone sinks for agriculture, though it would have been seasonal and on a small scale. In general the project area lies in a region that would have been less than bountiful, and therefore sparsely utilized, even in ancient times.

Discussions of specific aspects of traditional Hawaiian culture as they may relate to the project area are presented below. Information from *kūpuna* and *kamaʻāina* interviews are incorporated where appropriate.

A. Gathering for Plant Resources

Upland resources were utilized by Hawaiians for a multitude of purposes. Forest resources were gathered, not only for the basic needs of food and clothing, but for tools, weapons, canoe-building, house construction, dyes, adornments, hula, medicinal and religious purposes. These resources were found and gathered at higher elevations than the present project area.

Within the project area itself, there is no specific documentation of plant gathering during traditional Hawaiian times. In the course of this assessment there were no ongoing practices related to traditional gathering identified in the present project area. None of the individuals contacted or interviewed for this assessment identified any native gathering practices within the project area.

B. Marine Resources

The sea is a rich resource and the Hawaiian people were traditionally expert fishermen. Fish of all types supplied the Hawaiian diet with a rich source of protein. The gathering of seaweed and salt was practiced by Hawaiian women. In the interview with Mr. George Kaʻeliwai, he mentioned, "We all knew how to survive through our culture by the age of thirteen. The older boys would go up mountain and I had to know how to make the *palu* (bait) for fishing. You are never to talk about fishing. You just get up early and go. I knew *Tūtū* (grandmother) Campbell on the ranch. She liked me and favored me. She gave me fishing rights as long as I gave her some fish." Today many people continue to fish along the shoreline south of the project area.

The present project lie more than a mile from the coast (1.8 km). In traditional Hawaiian times Hawaiians going to and from marine resources at the coast may have crossed it.

C. Historic Properties

As noted in Section IV above, archaeological studies of lands within the *mauka* portion (north of the O. R. & L. alignment) of the present project area have identified only sites related to western development of the Honouliuli plain. These sites include the O. R. & L. alignment, an historic chicken farm, as well as other twentieth century architectural remains, including a Quonset hut of unknown use.

Archaeological studies of lands within the *makai* portion (south of the O. R. & L. alignment) of the present project area (including an archaeological inventory survey conducted by Cultural Surveys Hawai‘i which is to be submitted to the State Historic Preservation Division for review) have identified nineteen historic properties. These properties include ten sites associated with agriculture and/or ranching, six habitation sites, one burial site, one transportation site (the O. R. & L. alignment) and one marker (Gilbert Trig Station). Five of the ten sites associated with agriculture and/or ranching appear to be clearing mounds related to traditional Hawaiian subsistence agriculture.

The six habitation sites include temporary habitation sites and a very large sinkhole which may have had a permanent habitation function during traditional Hawaiian times. This sinkhole is presently an archaeological preserve delineated with chain-link fencing and marked as restricted. It has been designated State Inventory of Historic Properties (SIHP) site 50-80-12-9545.

The burial site is discussed immediately below.

The findings of the inventory survey appear to confirm that the *makai* portion of the project area, in traditional Hawaiian times was marginally utilized for temporary habitation and non-intensive agriculture.

None of the individuals contacted or interviewed for this assessment identified any historic properties associated with traditional Hawaiian culture within the entire project area.

D. Burials

As noted above one burial was identified within the project area during the archaeological inventory survey conducted by Cultural Surveys Hawai‘i Inc. This burial cave is within an archaeological preserve delineated with chain-link fencing and marked as restricted. The site was previously described in Hammatt et al. (1994) and was designated SIHP site 50-80-12-9633.

None of the community contacts or interviewees were aware of any burials within the present project area.

E. 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* correlated closely to the existing major roadways. 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). Following ‘I‘ī’s description, a portion of this trail network would have passed close to the presently existing Farrington Highway (see Figure 5).

In the interview with Mr. Shad Kane he noted:

> I am aware of several trails. If you go back far enough in the history of O‘ahu there were also foot trails. One of those trails is where the Farrington Highway is today. In fact in ancient times Pu‘uokapolei was used as a landmark for passer bys. For people who were traveling from Honolulu, from Kona to Wai‘anae. So the people traveling from Kona in this direction made reference to many trails.

It seems clear that a major east/west artery from ‘Ewa and Kona O‘ahu to Wai‘anae ran just upslope of Pu‘uokapolei roughly along the Farrington Highwaty alignment. To our knowledge, no clear remnant of this trail or associated site has been identified in the vicinity. It seems likely that there would have been a spur trail off of this artery descending down to the sea near Kalaeloa approximating modern Kalaeloa Blvd. but again there are no clear remnants of this trail or clearly associated sites.

No traditional Hawaiian trails have been documented within the present project area. None of the community contacts or interviewees mentioned any former trails in the project area.

F. *Wahi pana* (Storied Places)

While clearly Pu‘uokapolei (Kapolei Regional Park) was a storied place (*wahi pana*) associated with a number of Hawaiian traditions, there are no other storied places identified within the project area itself or the immediate vicinity.

IX. SUMMARY AND RECOMMENDATIONS

A. Summary of Findings

The project area lies back from the coast, on the extensive ‘Ewa limestone plain, which was, based on Honouliuli settlement patterns and archaeological investigations of the *ahupua‘a*, probably never permanently inhabited. It could have, however, provided temporary habitation for gatherers and fisherman traveling to the coast. A relatively barren and waterless area, it nonetheless might have been occasionally traversed, as the project area lay between the relatively well-watered uplands and *makai* resources. The extended limestone plain would have been used for bird catching, and would include the temporary habitations that would support such forays. Planters could have also used the natural limestone sinks for agriculture, though it would have been seasonal and on a small scale. In general the project area lies in a region that would have been less than bountiful, and therefore sparsely utilized, even in pre-contact times.

Interviews were conducted with two members of the ‘Ewa community. One interviewee noted that the most significant name in the immediate area “Pu‘uokapolei” lies just north of the project area. The *pu‘u* was used as a landmark for passer bys in traditional times and was said to be the residence of Kamaunuaniho, the grandmother of Kamapua‘a. Pu‘uokapolei was also said to have been used as a solar observatory. The other interviewee mentioned as a young child living in ‘Ewa he learned how to survive by the age of thirteen learning the culture practices of his *kūpuna* with traditional practices focused at the coast and in the uplands.

As a result of archaeological investigation within the project area, a large sinkhole that may have had a habitation function during traditional Hawaiian times is presently an archaeological preserve (State Inventory of Historic Properties site 50-80-12-9545) delineated with chain-link fencing and marked as restricted.

One burial cave within the project area has also been documented during archaeological investigation. The cave is within an archaeological preserve (SIHP site 50-80-12-9633) delineated with chain-link fencing and marked as restricted.

For many decades, starting in the early 1900s, much of the *mauka* portion (north of the O. R. & L. alignment) of the project area has been subject to the intensive commercial cultivation of sugar cane. The remainder of the project area appears to be scrubland that has been subject to intermittent development for commercial and military usages throughout the twentieth century. These activities would have eliminated much of the surface sites related to traditional Hawaiian culture that may have been present formerly. The activities would also have restricted access to these lands for any ongoing cultural practices throughout the twentieth century.

None of the interviewees or community contacts queried for this evaluation identified any cultural sites in the project area, or recalled anyone entering the project area – either in the past or present – for any traditional cultural practice. It appears that at present no contemporary or continuing cultural practices occur within the project area.

B. Recommendations

Based on the above findings, the proposed project will not adversely affect rights customarily and traditionally exercised for subsistence, cultural and religious purposes. It will have minimal or no impact on Hawaiian culture, its practices and traditions.

It should be noted that, as mentioned above, two archaeological preserves are located within the project area. Personnel involved in future development activities within the project area should be informed of the necessity to avoid impact to these preserves.

It should also be noted that subsurface properties associated with former traditional Hawaiian activities in the project area, such as artifacts and cultural layers, may be present despite modern activities within the area throughout the twentieth century. As a precautionary measure, personnel involved in future development of the area 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 K
Traffic Impact Study
(Wilbur Smith Associates)

KAPOLEI WEST
TRAFFIC IMPACT ASSESSMENT REPORT

CITY OF KAPOLEI

Prepared For:

AINA NUI CORPORATION
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June 1, 2005

(WSA Project No. 397230)

TABLE OF CONTENTS

CHAPTER	Page
EXECUTIVE SUMMARY	S-1
1. **INTRODUCTION**	1-1
Project Description	1-2
Methodology and Assumptions	1-2
Analysis Scenarios	1-3
Forecast Methodology and Assumptions	1-5
Future Roadways	1-6
Intersection Analysis Methodology	1-7
Report Organization	1-7
2. **EXISTING CONDITIONS**	2-1
Existing Roadway System	2-1
Existing Traffic Volumes	2-2
Existing Traffic Conditions	2-4
Existing Intersection Conditions	2-4
H-1 Freeway Conditions	2-5
Public Transportation	2-6
3. **FUTURE TRAFFIC CONDITIONS WITHOUT PROJECT**	3-1
Future Development Assumptions	3-1
Development Within City of Kapolei	3-1
2004-2014 Development	3-2
Developments Near the City of Kapolei	3-3
Growth of H-1 Freeway Through Traffic	3-7
Planned Roadways	3-8
2014 Roadway Improvements	3-8
2020 Roadway Improvements	3-9
Roadway Improvements Not Included by 2020	3-10
Public Transportation	3-11
2014 Peak Hour Traffic Conditions	3-11
Trip Generation	3-11
2014 Peak Hour Traffic Volumes	3-12
2014 Peak Hour Traffic Conditions	3-13
2020 Traffic Conditions	3-16
Trip Generation	3-17
2020 Peak Hour Traffic Volumes	3-17
2020 Peak Hour Traffic Conditions	3-18

CHAPTER **Page**

4. **2014 WITH THE URBANIZED AREA LAND USES** 4-1
Description of the Project 4-1
Project Trip Generation 4-3
Peak Hour Traffic Volumes 4-5
Peak Hour Intersection Conditions 4-6
Peak Hour Freeway Conditions 4-8
Public Transit and Bicycle Travel 4-9
Public Transit 4-9
Bicycles 4-10
Proposed Mitigative Actions 4-10

5. **2014 WITH THE PROJECT PETITION AREA** 5-1
Description of the Project 5-1
Project Trip Generation 5-2
Peak Hour Traffic Volumes 5-3
Peak Hour Traffic Conditions 5-4
Peak Hour Freeway Conditions 5-6
Proposed Mitigative Actions 5-7

6. **2020 WITH THE PROJECT AREA BUILD-OUT** 6-1
Description of the Project 6-1
Project Trip Generation 6-2
Peak Hour Traffic Volumes 6-3
Peak Hour Traffic Conditions 6-4
Peak Hour Freeway Conditions 6-8
Proposed Mitigative Actions 6-9

APPENDICES

A Distribution of Vehicle Trips
B Vehicle Trip Generation for 2014
C Vehicle Trip Generation for 2020
D Methodology for Analyzing Levels of Service
E Traffic Conditions at Key Freeway Access Ramps
F Public Transit Trip Generation

Under Separate Cover
Intersection analysis Worksheets for Existing Conditions and Future Scenarios

ILLUSTRATIONS

Figure **Follows**

S-1 Proposed Roadways, 2014 with Kapolei West Project S-6
S-2 Proposed Roadways, 2020 with Kapolei West Project S-9
1-1 Development Concept Plan 1-1
2-1 Existing Roadways 2-1
2-2 Existing Morning Peak Hour Traffic 2-3
2-3 Existing Afternoon Peak Hour Traffic 2-3
3-1 2014 Roadways without Kapolei West Project 3-8
3-2 2020 Roadways without Kapolei West Project 3-9
3-3 2010 Traffic without Project, Morning Peak Hour 3-12
3-4 2010 Traffic without Project, Afternoon Peak Hour 3-12
3-5 2020 Traffic without Project, Morning Peak Hour 3-17
3-6 2020 Traffic without Project, Afternoon Peak Hour 3-17
4-1 2014 Traffic with Urbanized Area, Morning Peak Hour 4-5
4-2 2014 Traffic with Urbanized Area, Afternoon Peak Hour 4-5
4-3 2014 Proposed Intersection Lanes 4-12
5-1 2014 Traffic with Petition Area, Morning Peak Hour 5-4
5-2 2014 Traffic with Petition Area, Afternoon Peak Hour 5-4
6-1 2020 Traffic with Project Buildout, Morning Peak Hour 6-3
6-2 2020 Traffic with Project Buildout, Afternoon Peak Hour 6-3
6-3 2020 Proposed Intersection Lanes 6-11

TABULATIONS

Table **Page**

1-1 Areas Needing Luc and Zoning Approvals 1-3
2-1 Existing Traffic Conditions at Key Intersections 2-4
2-2 H-1 Freeway Condition 2-6
3-1 2010 Traffic Conditions at Key Intersections Without Kapolei West 3-13
3-2 2014 H-1 Freeway Conditions Without Kapolei West 3-16
3-3 2020 Traffic Conditions at Key Intersections Without Kapolei West 3-19
4-1 Planned Residential Units For 2014 Urbanized Area Scenario 4-2
4-2 Vehicle Trip Generation For 2014 Urbanized Area Scenario 4-5
4-3 2014 Traffic Conditions at Key Intersections with Kapolei West Urbanized Area 4-7
4-4 2014 H-1 Freeway Conditions with Kapolei West Urbanized Area 4-9
5-1 Planned Residential Units For 2014 Petition Area Scenario 5-2
5-2 Vehicle Trip Generation For 2014 Petition Area Scenario 5-3
5-3 2014 Traffic Conditions at Key Intersections with Kapolei West Petition Area 5-5
6-1 Planned Residential Units For 2020 Combined Areas Scenario 6-2
6-2 Vehicle Trip Generation For 2020 Project Build-Out Scenario 6-3
6-3 2020 Traffic Conditions at Key Intersections with Kapolei West Build-Out 6-6
6-4 2020 H-1 Freeway Conditions with Kapolei West Build-Out 6-8

EXECUTIVE SUMMARY

The Aina Nui Corporation is planning the development of approximately 536 acres of vacant lands on the Waianae side of the City of Kapolei. This development, referred to as the Kapolei West project, would include lands along both sides of the future Kapolei Parkway from a short distance west of Kalaeloa Boulevard to the eastern boundary of the Ko Olina development area. The mauka borders of the Kapolei West lands are formed by the H-1 Freeway and the Nanakai Gardens/Honokai Hale communities, with the lands extending makai to or slightly makai of the former Oahu Railway and Land Company (OR&L) track alignment.

The Kapolei West development, hereinafter referred to as the Project, is planned to include a mix of residential, commercial, recreational, and public land uses. The planned uses include:

Residential communities on 138 acres with an estimated 2,370 units
A regional commercial area of 23.2 acres
A transit/mixed use development on 15.8 acres
A 2-acre neighborhood commercial area
A golf course, driving range, and clubhouse occupying about 200 acres
About 25 acres of public park lands.

Development and occupancy of the Project is planned to begin in 2008, with the initial development progressing from the east and west towards the center. Development of the Project is expected to extend over 13 years, with full occupancy by the end of 2020.

The mauka and eastern portions of the Kapolei West area have already received State Land Use Commission (LUC) approval for urban development; City zoning approval is being sought for this area, which is referred to as the "Urbanized" area scenario. This area includes the non-residential uses and 1,253 of the residential units. This portion of the area could be fully developed in 2014 based on the anticipated housing absorption rate.

Both State LUC approval and City zoning approval are being sought for the 174.2 acres in the southwest portion of the Project area, referred to herein as the "Petition" area. This area would accommodate about 1,117 residential units, with a large portion of the units expected to be occupied by part-time residents. If this area is approved for development, much of the housing developed by 2014 would likely be in these parcels due to the marketability to part-time residents, with a commensurate reduction in the residential development in the Urbanized area.

This study has assessed traffic conditions for three scenarios for year 2014:

1. No Project, to serve as a baseline for assessment the Project impacts

2. An "Urbanized Area" Scenario, which would include the build-out of the lands that have already received State LUC approval

3. A "Petition Area" Scenario which would shift some of the development to the southwest parcels and defer development beyond 2014 of some mauka and eastern areas that were earlier approved for urban development.

The assessment of year 2020 traffic conditions included the baseline No Project Scenario and a scenario with full build out of the combined "Urbanized" and "Petition" areas.

The traffic impact assessment for the Kapolei West development focuses primarily on the key intersections located near the Project as well as the intersections of the Project roadways with the Kapolei Parkway. The study proposes roadway improvements only where necessary to mitigate Project traffic impacts. The overall street conditions and future roadway needs in the City of Kapolei area are being reassessed in a separate traffic update study for the roadway master plan study conducted in the early 1990's.

An assessment of the Kapolei West Project impact on the H-1 Freeway mainline (through lane) conditions are provided for the 2014 and 2020 forecast years. The conditions on the freeway ramps and weaving areas are being assessed in the separate update study of the City of Kapolei roadway system, which provides a more detailed assessment of conditions with the planned Kapolei Interchange and other interchange modifications planned for the area.

The assessment of Project impacts did not include the extension of Project Road D mauka to connect to the planned location of the future Makaiwa Hills Interchange since the timing of the Makaiwa Hills facility is uncertain. The connection of Road D to the Makaiwa Hills Interchange would be expected to attract use by some of the Kapolei West and Ko Olina vehicles that would otherwise use Koio Drive, Aliinui Drive, Hanua Street Extension, or Kalaeloa Boulevard to access Farrington Highway/H-1 Freeway. This diversion of Kapolei West and Ko Olina trips to the Road D connection would reduce the numbers of vehicles using the parallel sections of Kalaeloa Boulevard, Hanua Street, Koio Drive, and Aliinui Drive from those presented herein.

As an interim measure, Road D could be connected to Farrington Highway without construction of the Makaiwa Hills Interchange. This right-turn in/out connection would primarily divert traffic from the Koio Drive connection to Farrington Highway and, to a lesser extent, from the Hanua Street Extension connection. This connection was not included in order to provide a conservative assessment of the Project impacts.

PROJECT TRIP GENERATION

The planned development for the Urbanized Area of the Project (2014) would generate an estimated 1,424 vehicle trips to or from the planned land uses in the morning peak hour and 2,309 vehicle trip ends in the afternoon peak hour, as summarized in Table S-1. In the afternoon peak hour, approximately one-half of the trips would be to or from the residential uses and one-half to or from the commercial uses. In the morning peak hour, the planned middle school would

generate about 20% of the Project trips. Note that some trips between land uses within the Project area are counted twice, once at the origin and a second time at the destination.

With the inclusion of the Petition Area, some of the development by 2014 would likely occur in the Petition parcels since these would likely be more marketable to part-time residents. A similar total number of residential units is assumed to be developed by 2014. Since units occupied by part-time residents generate fewer trips than full-time residents, as well as the delay to development of Parcel L Mixed Use area, the scenario with development in both the Urbanized and Petition areas by 2014 is estimated to generate fewer total trips to/from the Project development by 2014. About 10% fewer trips are estimated for the morning peak hour and 16% fewer in the afternoon peak hour.

Full build-out is estimated to generate 1,881 and 2,835 vehicle trips to or from the Project land uses in the morning and afternoon peak hours, respectively. With full development, the commercial uses are estimated to generate about 43% of the total afternoon peak hour trips and residential uses most of the remainder. Many of the vehicles entering/exiting the commercial properties would be "pass-by trips" which would be additional stops by vehicles passing by the sites on the way to their primary destination, and thus do not represent additional vehicles on the adjacent roadways. The total new trips on the area roadways, without pass-bys, would amount to 1,801 and 2,404 trip ends in the morning and afternoon peak hours, respectively.

At full build-out, the Petition Area would contribute 457 total vehicle trip ends in the morning peak hour, which would amount to 24% of the total number of vehicle trips entering or exiting the Project areas. In the afternoon peak hour, the Petition Area would contribute 526 trips or 18.5% of the total Project vehicle trip ends. The Petition Area trips would represent 25% and 22% of the new vehicle trips added to area roadways (without pass-bys) at Project build-out.

Table S-1
VEHICLE TRIP GENERATION
FOR PROJECT SCENARIOS

Item	Morning Peak Hour			Afternoon Peak Hour		
	Total	Enter	Exit	Total	Enter	Exit
Year 2014						
Urbanized Area Scenario	1,424	592	832	2,309	1,233	1,076
Petition Area Scenario	1,290	550	740	1,939	1,028	910
Year 2020						
With Project Build-Out	1,881	745	1,136	2,835	1,522	1,313

Wilbur Smith Associates; November 29, 2004

2014 TRAFFIC CONDITONS WITH URBANIZED AREA ONLY

The development of the urbanized area is estimated to increase the traffic passing through the Kapolei Parkway intersection with Kalaeloa Boulevard by about 26.7% over 2014 volumes without the Project in the morning peak hour, and by 36.1% in the afternoon peak hour. Traffic volumes along the Kapolei Parkway just west of Kalaeloa Boulevard are estimated at about 1,625 vehicles in the morning peak hour and about 2,260 vehicles in the afternoon peak hour. Traffic volumes along the Kapolei Parkway at the Waianae end of the Project near Koio Drive are estimated at approximately 960 and 1,070 vehicles in the morning and afternoon peak hours, respectively.

The peak hour traffic conditions at key intersections in the vicinity of the Project, as well as the Kapolei Parkway intersections with the Project access roadways and driveways, are summarized in Table S-2. The Without (No) Project conditions in the table reflect the planned roadway projects by 2014 as well as any additional intersection improvements needed to provide acceptable service conditions for the 2014 Without Project traffic. The conditions reflect the use of STOP sign control on all of the Project access road connections to the Kapolei Parkway.

The addition of the Project traffic, with the Urbanized Area development scenario, indicates the impacts on area intersections as described in the following paragraphs:

- The Project traffic would worsen peak hour conditions at the Kapolei Parkway intersection with Kalaeloa Boulevard, with the traffic exceeding intersection capacity by 8% to 10% and traffic delays at LOS E or F.

- With STOP sign control, the traffic exiting the Regional Commercial Center Driveway onto the Kapolei Parkway would experience long delays in the afternoon peak period. The long delays would satisfy MUTCD Warrant #3 criteria to allow consideration of a traffic signal for the intersection to address the cross street delays.

- The other Project access road connections to the Kapolei Parkway would operate at acceptable conditions with STOP sign controls.

- Within the Ko Olina area, the extension of the Kapolei Parkway would allow some Ko Olina traffic to use the Kapolei Parkway to access areas east of Ko Olina such as the employment areas and services in the Kapolei Business Park, Campbell Industrial Park, and City of Kapolei. This would likely reduce delays at the Olani Street intersection and other intersections near the western end of the Project. The increased traffic would worsen conditions in the eastern end of the Ko Olina, such as Koio Drive, which is expected to operate at acceptable traffic conditions.

Table S-2
2014 CONDITONS AT KEY INTERSECTION

Intersection	Scenario	Morning Peak Hour			Afternoon Peak Hour		
		V/C	ADPV	LOS	V/C	ADPV	LOS
Kalaeloa Blvd.- Farrington Hwy.	Existing	0.44	25.7	D	1.97	476.8	F
	No Project	0.49	37.6	D	0.70	35.8	D
	Urbanized Area	0.62	35.9	D	0.97	57.0	E
Kapolei Pkwy.- Kamokila Blvd.	Existing	0.68	21.7	C	0.59	16.9	B
	No Project	0.53	25.1	C	0.75	30.0	C
	Urbanized Area	0.59	26.4	C	0.86	33.0	C
Kapolei Pkwy.- Kalaeloa Blvd.	Existing	0.63	34,6	C	0.73	28.8	C
	No Project	0.91	53.4	D	0.86	44.6	D
	Urbanized Area	1.08	100.2	F	1.10	73.4	E
	With Mitigation	0.87	49.6	D	0.92	47.5	D
Kapolei Pkwy.- Commercial Dwy.	Urbanized Area	0.41	30.5	D	4.53	1690	F
	With Mitigation	0.36	26.4	C	0.84	43.5	D
Kapolei Pkwy.- Parcels A/B Rd.	Urbanized Area	0.43	34.2	D	0.42	47.2	E
Kapolei Pkwy.- Rd. H	Urbanized Area	0.15	13.7	B	0.21	20.0	C
Kapolei Pkwy.- Rd D/F	Urbanized Area	0.13	13.8	B	0.15	18.8	C
Aliinui Dr.- Koio Dr.	Existing	NA	NA	NA	NA	NA	NA
	No Project	0.01	10.9	B	0.02	12.3	B
	Urbanized Area	0.04	14.4	B	0.13	18.9	C
Aliinui Dr.- Olani St.	Existing	0.10	11.5	B	0.13	14.0	B
	No Project	0.46	38.7	E	1.46	318.3	F
	Urbanized Area	0.35	26.4	D	0.95	108.7	F

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.
NA = Not Analyzed
Urbanized Area = Eastern and mauka portions of Kapolei West area that have received prior approval for development with urban uses.

Wilbur Smith Associates; June 1, 2005.

The traffic lanes needed to accommodate the forecast 2014 peak hour traffic volumes with the development of the Urbanized Area are depicted in Figure S-1. The figure identifies those that are proposed to mitigate Project impacts on the key intersections, which include:

Kapolei Parkway-Kalaeloa Boulevard

- Provide right-turn lane on makai-bound Kalaeloa Boulevard to accommodate increased volume of right turns
- Provide a second (double) left-turn lane and a right-turn lane on the Honolulu-bound approach of the Kapolei Parkway to offset the increase in Project traffic along the Parkway.

Kapolei Parkway-Regional Commercial Center Driveway

- Provide right-turn lane for high volume of traffic entering from Waianae-bound Kapolei Parkway
- Provide traffic signal control for the intersection when warranted by traffic conditions.

Kapolei Parkway-Road D

- Provide right-turn lane for high volume of traffic entering from Waianae-bound Kapolei Parkway

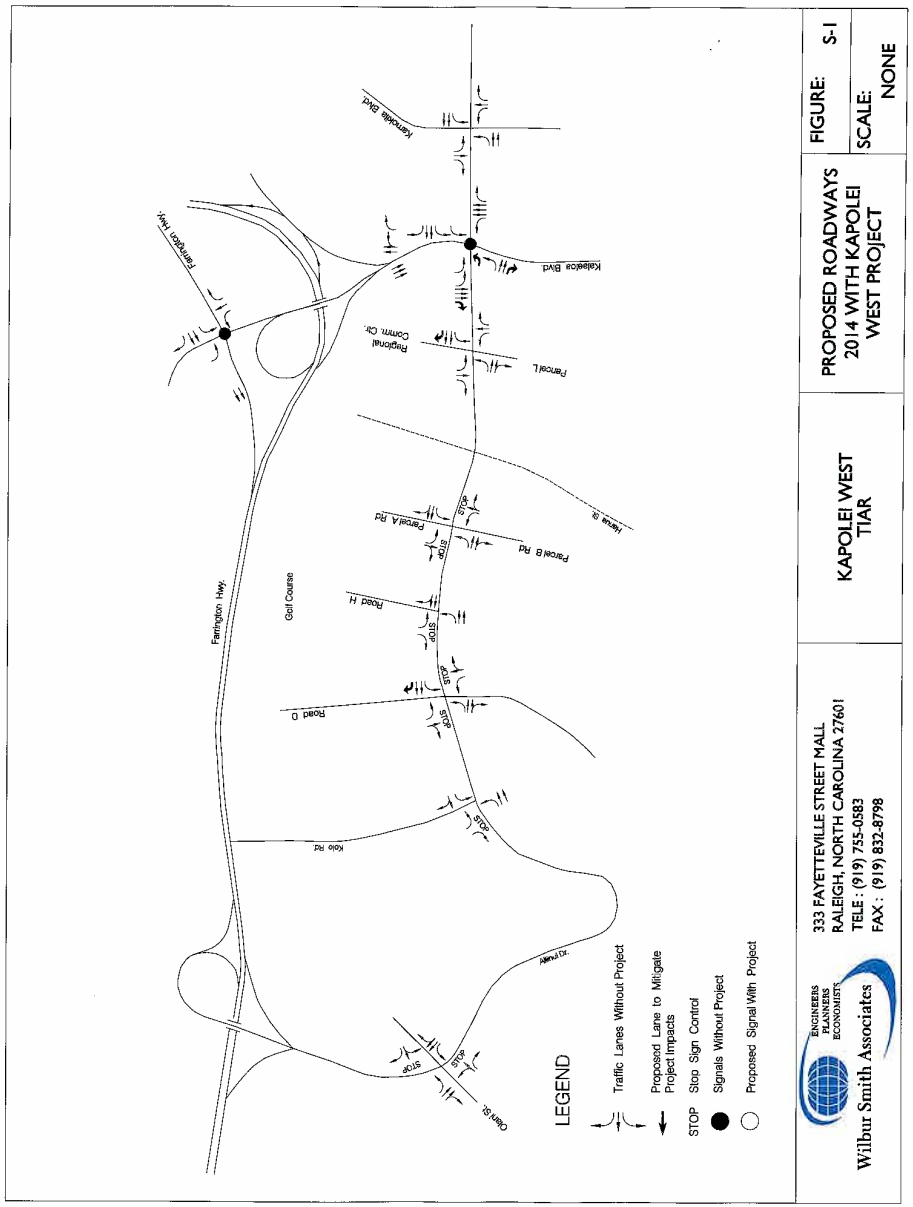
2014 TRAFFIC CONDITONS WITH PETITION AREA

The development of the urbanized area is estimated to increase the traffic passing through the Kapolei Parkway intersection with Kalaeloa Boulevard by about 23.8% over 2014 volumes without the Project in the morning peak hour, and by 31% in the afternoon peak hour. Traffic volumes along the Kapolei Parkway just west of Kalaeloa Boulevard are estimated at about 1,850 vehicles in the morning peak hour and about 2,500 vehicles in the afternoon peak hour. Traffic volumes along the Kapolei Parkway at the Waianae end of the Project near Koio Drive are estimated at approximately 950 and 1,050 vehicles in the morning and afternoon peak hours, respectively.

The 2014 development spread through both the Urbanized and Petition Areas would have a similar impact on intersection conditions and mitigative needs. The proposed roadway improvements would be the same as those identified for the Urbanized Area scenario.

2020 TRAFFIC CONDITONS WITH PROJECT BUILD-OUT

The full development of the Project (both the Urbanized and Petition areas) is estimated to increase the traffic passing through the Kapolei Parkway intersection with Kalaeloa Boulevard



by about 6.5% over 2020 volumes without the Project in the morning peak hour, and by 21.9% in the afternoon peak hour. Traffic volumes along the Kapolei Parkway just west of Kalaeloa Boulevard are estimated at about 2,600 vehicles in the morning peak hour and about 2,940 vehicles in the afternoon peak hour. Traffic volumes along the Kapolei Parkway at the Waianae end of the Project near Koio Drive are estimated at approximately 1,330 and 1,600 vehicles in the morning and afternoon peak hours, respectively.

The peak hour traffic conditions at key intersections in the vicinity of the Project, as well as the Kapolei Parkway intersections with the Project access roadways and driveways, are summarized in Table S-3. The Without (No) Project conditions in the table reflect the planned roadway projects by 2020 as well as any additional intersection improvements needed to provide acceptable service conditions for the 2020 Without Project traffic. The conditions reflect the use of STOP sign control on all of the Project residential area access road connections to the Kapolei Parkway.

The addition of the Project traffic, with the Urbanized Area development scenario, indicates the following impacts on area intersections:

- The Project traffic would substantially worsen peak hour conditions at the Kapolei Parkway intersection with Kalaeloa Boulevard, with the traffic exceeding intersection capacity by 8% in the morning peak hour with average traffic delays at LOS F. In the afternoon peak hour, the traffic would approximate the intersection capacity with average delay per vehicle at LOS D.

- The increased Project traffic would result in congested traffic conditions at the Kapolei Parkway intersection with Kamokila Boulevard in the afternoon peak hour.

- With traffic signal control, the Kapolei Parkway intersection with the Regional Commercial Center Driveway/Parcel L Driveway would operate at acceptable conditions.

- The forecast Build-out traffic would exceed the capacity of the Kapolei Parkway intersection with the Hanua Street Extension by about 10% in the afternoon peak hour, with average delay per vehicle at LOS F.

- With STOP sign control, the traffic exiting the Parcel A Access Road onto the Kapolei Parkway would experience long delays in both the morning and afternoon peak periods. The long delays would satisfy MUTCD Warrant #3 criteria to allow consideration of a traffic signal for the intersection to address the cross street delays.

- With STOP sign control, the traffic exiting Road F onto the Kapolei Parkway would experience long delays in both the morning and afternoon peak periods. The long delays would satisfy MUTCD Warrant #3 criteria to allow consideration of a traffic signal for the intersection to address the cross street delays.

Table S-3
2020 CONDITONS AT KEY INTERSECTIONS

Intersection	Scenario	Morning Peak Hour			Afternoon Peak Hour		
		V/C	ADPV	LOS	V/C	ADPV	LOS
Kalaeloa Blvd.-	Existing	0.44	25.7	D	1.97	476.8	F
Farrington Hwy.	No Project	0.59	37.6	D	0.79	40.5	D
	Build-out	0.59	37.6	D	0.79	40.5	D
Kapolei Pkwy.-	Existing	0.68	21.7	C	0.59	16.9	B
Kamokila Blvd.	No Project	0.72	29.2	C	0.93	44.8	D
	Build-out	0.78	28.5	C	1.06	100.6	F
	With Mitigation	0.62	27.7	C	0.88	37.3	D
Kapolei Pkwy.-	Existing	0.63	34.6	C	0.73	28.8	C
Kalaeloa Blvd.	No Project	0.90	53.2	D	0.91	48.6	D
	Build-out	1.08	107.2	F	0.98	54.7	D
	With Mitigation	0.92	52.0	D	0.93	52.6	D
Kapolei Pkwy.-	Build-out	0.53	20.8	C	0.87	40.7	D
Commercial Dwy.							
Kapolei Pkwy.-	Build-out	0.97	60.0	E	1.10	83.9	F
Hanua St. Ext.	With Mitigation	0.79	44.2	D	0.93	45.7	D
Kapolei Pkwy.-	Build-out	1.80	541.4	F	1.18	294.6	F
Parcels A/B Rd.	With Mitigation	0.52	22.9	C	0.66	19.4	B
Kapolei Pkwy.-	Build-out	0.27	20.9	C	0.51	53.3	F
Rd. H							
Kapolei Pkwy.-	Build-out	0.76	68.5	F	1.87	516.6	F
Rd D/F	With Mitigation	0.44	27.5	C	0.57	29.3	C
Aliinui Dr.-	Existing	NA	NA	NA	NA	NA	NA
Koio Dr.	No Project	0.03	14.5	B	0.05	23.1	C
	Build-out	0.23	20.1	C	0.60	53.8	F
Aliinui Dr.-	Existing	0.10	11.5	B	0.13	14.0	B
Olani St.	No Project	0.46	38.7	E	1.24	220.5	F
	Build-out	0.47	40.6	E	1.32	255.1	F

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.
NA = Not Analyzed.
Build-out = Full development of entire Kapolei West development area.

Wilbur Smith Associates; November 30, 2004.

- The increased Project traffic would worsen delays for vehicles turning left from Koio Drive onto the Kapolei Parkway. However, the estimated delays would not be sufficient to satisfy warrants to allow consideration of a traffic signal.

- The increased Project traffic would worsen delays for vehicles turning left from the Olani Street approaches onto the Kapolei Parkway. The estimated delays would be sufficient to satisfy warrants to allow consideration of a traffic signal both without and with the Project. With a traffic signal and the existing roadway lanes, the intersection would operate at LOS C or better with or without the Project Therefore, no mitigative action is proposed as a result of the Project traffic increases.

The traffic lanes needed to accommodate the forecast 2020 peak hour traffic volumes with the development of the Urbanized Area are depicted in Figure S-2. The figure identifies those that are proposed to mitigate Project impacts on the key intersections, which include:

Kapolei Parkway-Kamokila Boulevard

- Provide a second (double) left-turn lane on Honolulu-bound Kapolei Parkway to allow more signal green time for the Waianae-bound through traffic

Kapolei Parkway-Kalaeloa Boulevard

- Provide right-turn lane on makai-bound Kalaeloa Boulevard to accommodate increased volume of right turns

- Provide a second (double) left-turn lane and a right-turn lane on the Honolulu-bound approach of the Kapolei Parkway to offset the increase in Project traffic along the Parkway.

Kapolei Parkway-Regional Commercial Center Driveway

- Provide right-turn lane for high volume of traffic entering from Waianae-bound Kapolei Parkway

- Provide traffic signal control for the intersection when warranted by traffic conditions.

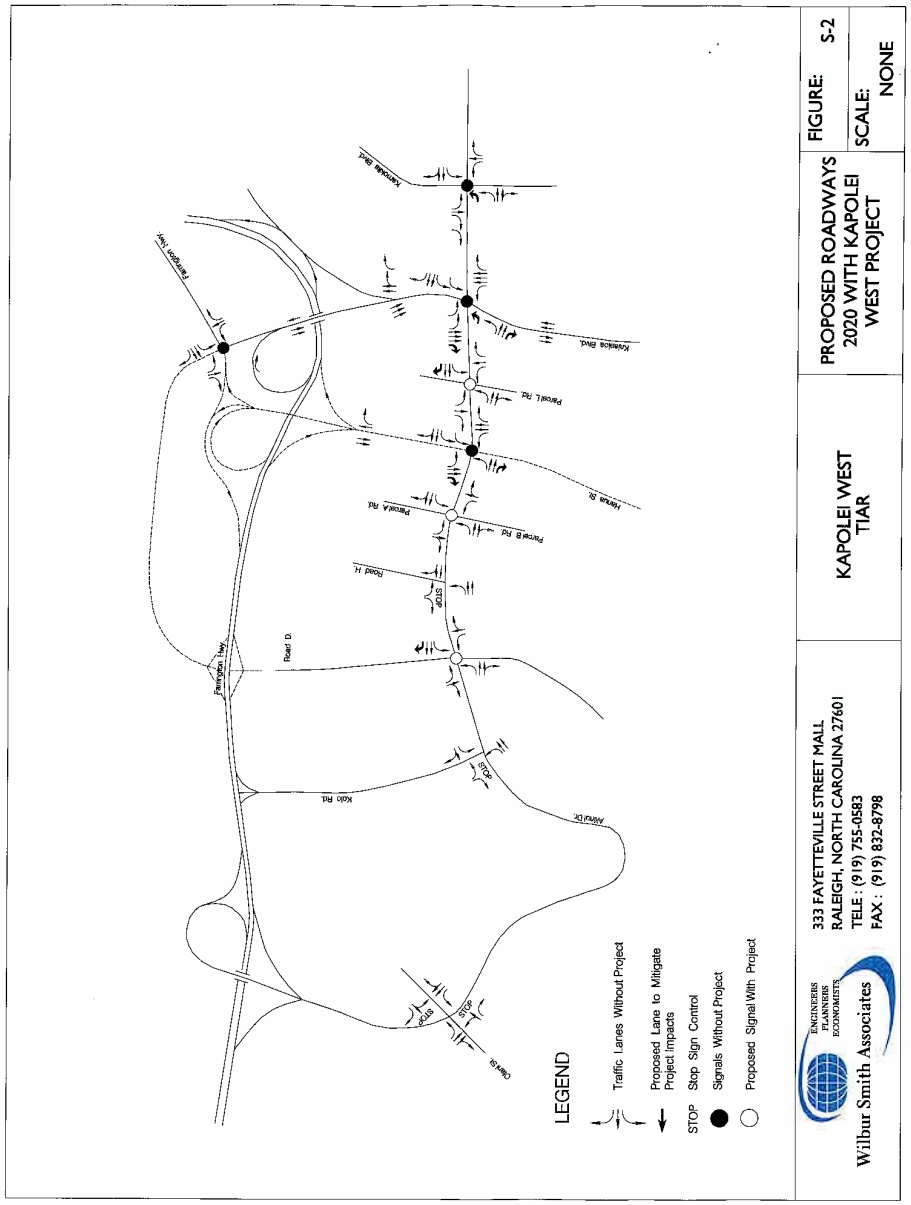
Kapolei Parkway-Hanua Street Extension

- Provide right-turn lane on makai-bound Hanua Street to accommodate increased volume of right turns

- Provide right-turn lane on the Honolulu-bound approach of the Kapolei Parkway to offset the increase in Project traffic along the Parkway.

Kapolei Parkway-Parcel A/B Access Roads

- Provide traffic signal control for the intersection when warranted by traffic conditions.



Kapolei Parkway-Road D

- Provide right-turn lane for high volume of traffic entering from Waianae-bound Kapolei Parkway
- Provide traffic signal control for the intersection when warranted by traffic conditions.

H-1 FREEWAY INCREASES

Traffic conditions were assessed for the section of the H-1 Freeway east of the Makakilo Interchange. The H-1 Freeway has three travel lanes in each direction with paved shoulders in this section. For the purpose of this assessment, the free flow speed is assumed to be 65 miles per hour (mph) in this section although field observations indicate that a substantial portion of the drivers exceed this speed. This section of freeway would have an estimated capacity of about 7,050 vehicles per hour in each direction, with this maximum capacity occurring at speeds around 52 mph.

As summarized in Table S-4, this section of the H-1 Freeway should accommodate the existing peak hour traffic volumes at very acceptable conditions. The analysis indicates that the traffic traveling this section should operate at LOS B or C in each peak hour and travel direction, with the estimated average speeds of 62 mph near the free flow speed of 65 mph.

In 2014, the Project would increase the freeway traffic by about 4% to 8% with full development of the Urbanized Area. The additional Project traffic would result in LOS D conditions versus LOS C without the Project. The Project traffic would have minimal effect on average freeway speeds, with the speeds estimated at about 61 to 62 mph with the Project versus 62 mph without the Project.

In 2020, the Project would increase freeway traffic east of Kapolei by 6% to 9% with full build-out of the entire Project area.

The addition of the Project traffic is estimated to result in the 2020 afternoon peak hour conditions for Waianae-direction traffic worsening to LOS E from LOS D without the Project. The Waianae-bound traffic would just exceed the LOS D criteria by about 30 vehicles, i.e. a 30-vehicle reduction in the forecast volumes would have resulted in LOS D conditions estimated for the afternoon peak hour. The Project is forecast to decrease the average traffic speeds by more than 2 mph, from about 60.7 mph without the Project, to 58.4 mph with the Project. The Waianae-bound traffic in the afternoon peak hour would approximate 84% of the estimated freeway capacity.

Table S-4
H-1 FREEWAY CONDITIONS
EAST OF MAKAKILO INTERCHANGE

Peak Hour	Direction	Volumes	Project Increase	Capacity Used	Speed (mph)	Level of Service
Existing (2003)						
Morning	Eastbound	3,386		48%	62.0	C
	Westbound	2,651		38%	62.0	B
Afternoon	Eastbound	2,852		40%	62.0	B
	Westbound	3,353		48%	62.0	C
2014 Without Project						
Morning	Eastbound	4,251		60%	62.0	C
	Westbound	4,119		58%	62.0	C
Afternoon	Eastbound	4,425		63%	62.0	C
	Westbound	4,561		65%	62.0	C
2014 With Project Urbanized Area Scenario						
Morning	Eastbound	4,570	+319	65%	62.0	C
	Westbound	4,329	+210	61%	62.0	C
Afternoon	Eastbound	4,599	+174	65%	62.0	D
	Westbound	4,920	+359	70%	61.8	D
2020 Without Project						
Morning	Eastbound	4,842		69%	61.9	D
	Westbound	4,854		69%	61.8	D
Afternoon	Eastbound	5,307		75%	61.0	D
	Westbound	5,453		77%	60.7	D
2020 With Project Build-out						
Morning	Eastbound	5,310	+468	75%	61.2	D
	Westbound	5,144	+290	73%	61.3	D
Afternoon	Eastbound	5,684	+377	81%	59.5	D
	Westbound	5,936	+483	84%	58.4	E

mph = miles per hour

Wilbur Smith Associates; November 29, 2004.

KEY WEAVING SECTIONS FOR H-1 FREEWAY RAMPS

Traffic conditions were analyzed for weaving sections for several ramps that would be used by traffic accessing the H-1 Freeway from the Kapolei West development (the Project) to assess the impact of the Project on these facilities. The traffic conditions for these weaving sections are summarized in Table S-5.

Weaving Section between Eastbound Off-Ramp to Farrington Highway and On-Ramp from Kalaeloa Boulevard

- The forecast 2014 traffic volumes would result in acceptable conditions for either the Urbanized Area or Petition Area scenarios, with the Project traffic reducing average speed in peak hours by about 1.5 mph.

- The forecast 2020 traffic volumes would result in acceptable conditions with the Project reducing average speeds by about 0.2 in the morning peak hour and 0.4 mph in the afternoon peak hour.

Weaving Section between Proposed Eastbound On-Ramp from Hanua Street Extension and On-Ramp to Farrington Highway

- The forecast 2020 traffic volumes would result in acceptable conditions in morning peak hour with the Project traffic reducing average speed by about 4.8 mph.

- The forecast 2020 Project traffic volumes would worsen conditions to LOS E from LOS D, with a reduction in average speeds by about 1.4 mph in the afternoon peak hour. The conditions could be improved to LOS D or better if this section of the H-1 Freeway is widened to three eastbound lanes by 2020, or by the increased length or provision of an auxiliary lane in this weaving section.

PUBLIC TRANSIT AND BICYCLE TRAVEL

The Kapolei Parkway is planned to include bicycle lanes to encourage use of bicycles for transportation purposes as well as for recreation. The Project would provide a transit center within the Parcel L mixed-use development to facilitate public transit operations and usage. Other actions that could encourage use of these modes are included in the following list.

Public Transit

- Coordinate the potential location of bus stops with the City DTS and TheBus staffs and provide bus shelters at the stop locations.

- Each residential parcel should be designed to provide convenient pedestrian linkages to the bus stop locations through the layout of the internal street system and/or greenways.

- The middle school should be sited and laid out to allow convenient and safe access to public transit stops.

Bicycles

- A network of bicycle lanes and greenways should link the residential areas to the middle school and nearby elementary school.

- The internal local streets should be designed to maintain low speeds of about 20 miles per hour to provide a safe environment for shared use by bicycles.

Table S-5
TRAFFIC CONDITIONS AT
KEY FREEWAY RAMP WEAVING SECTIONS

Year and Development Scenarios	Weekday Morning Peak Hour			Weekday Afternoon Peak Hour		
	Density	Speed	LOS	Density	Speed	LOS
Existing Eastbound Weaving Section for Off-ramp to Farrington Hwy. and On-Ramp from Kalaeloa Blvd.						
2003	10.7	31.1	B	15.8	29.3	B
2014 No Kapolei West Project	18.1	27.4	B	26.0	25.8	C
2014 with Urbanized Area	23.4	25.8	C	33.7	24.2	D
2014 with Petition Area	22.6	26.0	C	32.6	24.4	D
2020 No Kapolei West Project	19.1	27.1	B	27.0	25.5	C
2020 with Project Build-out	19.7	26.9	B	29.1	25.1	D
Proposed Eastbound Weaving Section for On-ramp from Hanua St. Extension and Off-Ramp to Farrington Hwy.						
2020 No Kapolei West Project	26.5	41.4	C	32.7	34.6	D
2020 with Project Build-out	31.9	36.6	D	39.5	33.2	E

Density = Passenger car equivalents per mile per lane in analyses section.
Speed = Average speed in miles per hour through weaving area.
LOS = Level of service in weaving area.

Wilbur Smith Associates; June 1, 2005.

Chapter 1
INTRODUCTION

The Aina Nui Corporation is planning the development of approximately 535 acres of vacant lands on the Waianae side of the City of Kapolei. This development, referred to as the Kapolei West project, would include lands along both sides of the future Kapolei Parkway from short distance west of Kalaeloa Boulevard to the eastern boundary of the Ko Olina development area. The mauka borders of the Kapolei West lands are formed by the H-1 Freeway and the Nanakai Gardens/Honokai Hale communities, with the lands extending makai to or slightly makai of the former Oahu Railway and Land Company (OR&L) track alignment. (See Figure 1-1.)

The Kapolei West development, hereinafter referred to as the Project, is planned to include a mix of residential, commercial, recreational, and public land uses. The planned uses include:

Residential communities with 138 acres
A regional commercial area of 23.2 acres
A transit/mixed use development of 15.8 acres
A 2-acre neighborhood commercial area
A golf course, driving range, and clubhouse occupying about 200 acres
About 25 acres of public park lands.

Development and occupancy of the Project is planned to begin in 2008, with the initial development progressing from the eastern portion of the development area. Development of the Project is expected to extend over 13 years, with full occupancy by the end of 2020.

The purpose of this study is to assess the traffic impacts of the planned development of Kapolei West Project. The assessment addresses the following:

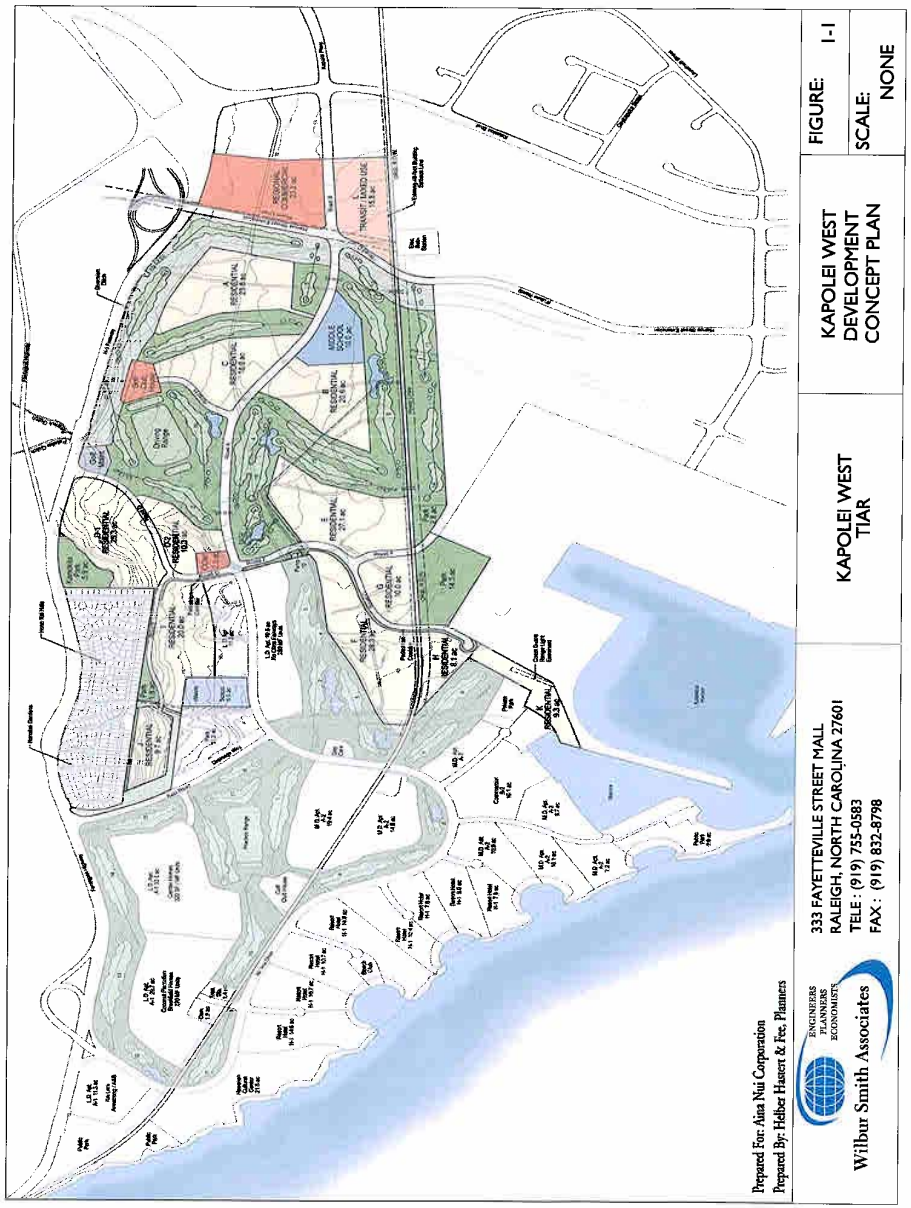
1. The numbers of vehicle trips that would be generated by the Project.

2. Future traffic levels and traffic conditions at key intersections without the Project.

3. The traffic increases on area roadways and impact on traffic conditions at key intersections as a result of the Project.

4. Identification of any actions that may be appropriate to mitigate Project traffic impacts.

The traffic impact assessment for the Kapolei West development focuses primarily on the key intersections located near the Project as well as the intersections of the Project roadways with the Kapolei Parkway. The study proposes roadway improvements only where necessary to mitigate Project traffic impacts. The overall street conditions and future roadway needs in the City of Kapolei area are being reassessed in a separate traffic update study for the roadway master plan study conducted in the early 1990's.



An assessment of the Kapolei West Project impact on the H-1 Freeway mainline (through lane) conditions are provided for the 2014 and 2020 forecast years. The conditions on the freeway ramps and weaving areas are being assessed in the separate update study of the City of Kapolei roadway system, which provides a more detailed assessment of conditions with the planned Kapolei Interchange and other interchange modifications planned for the area.

PROJECT DESCRIPTION

Ten planned residential areas are expected to include about 2,370 housing units, with a mix of both low-density and medium-density units. The residential units would be marketed to both year-round occupants and seasonal/part-time residents. The housing units in the areas closer to the City of Kapolei are expected to be marketed primarily to year-round residents, while the areas closer to Ko Olina and the Marina are likely to attract a larger number of part-time residents. The preliminary market studies for the Project estimate that about 1,450 units (61%) would be purchased by year-round residents while the remaining 920 units would be purchased by part-time or seasonal residents.

The residential areas would mostly border the planned Kapolei West 18-hole golf course, or the existing Ko Olina course. The Kapolei West golf course would include a club house facility and a driving range.

The regional commercial center is planned to include a mix of retail businesses, service establishments, and office uses. The development would include an estimated 255,000 square feet of building floor area.

The Transit/Mixed Use area would include an estimated 100,000 square feet of commercial uses and approximately 150 housing units. The commercial uses are expected to include a mix of retail businesses, service establishments, and office uses. The residential uses would include medium density apartment or condominium uses. A transit center would be located within the parcel.

Traffic access would be provided by street and driveway connections to the planned extension of the Kapolei Parkway to connect to Alii Nui Drive. The Regional Commercial Center and the Transit/Mixed Use parcel may also have access to the planned Hanua Street extension.

METHODOLOGY AND ASSUMPTIONS

The general methodology and assumptions used in the forecasting and analysis of traffic impacts with the Project are outlined in the following sections.

Analysis Scenarios

A portion of the Kapolei West Project area has been approved by the State Land Use Commission (LUC) for urban development. The present LUC urban designation encompasses the areas totaling 372.6 acres in the eastern and mauka sections of the Project. The remaining areas in the makai section of Kapolei West are subject to a petition to the LUC for urban designation.

Aina Nui Corporation is seeking approval of zoning by the City and County of Honolulu for all of the areas included within the Project. The Project areas and land uses that are subject to State LUC approval and to City Zoning approval are summarized in Table 1-1.

Table 1-1
AREAS NEEDING LUC AND ZONING APPROVALS

Area	Land Use	With Existing LUC Approval Need Zoning	Needing LUC Approval and Zoning
A	Low-density Housing	190 homes	
B	Multi-family Housing Middle School	245 homes	
C	Low-density Housing	150 homes	
D	Low-density Housing	310 homes	
E	Multi-family Housing		271 homes
F	Multi-family Housing		509 homes
G	Multi-family Housing		180 homes
H	Multi-family Housing		146 homes
I	Low-density Housing	140 homes	
J	Low-density Housing	68 homes	
K	Low-density Housing		11 homes
L	Multi-family Housing Commercial Uses Transit Center	150 units 100,000 sq.ft.	
Golf Course	Golf Course	18 holes with Club House	
Regional Center	Commercial development	23.2 acres	

Wilbur Smith Associates; November 11, 2004.

The residential developments within Parcels A, B, C, D, and L are expected to be oriented mostly towards full-time residents. Part-time residents are expected to represent a larger portion of the residential development in Parcels E, F, I, J, and K.

The more marketable units to part-time residents are located in the areas needing both LUC approval and zoning approval. Therefore, the property owner seeks to obtain approvals of the entire area to allow the early development of those areas that are more marketable to part-time residents, rather than first developing only the area that already has LUC approval for urban development.

The traffic analysis scenarios have been defined to provide separate assessment of the impacts with the development of only those areas that have already received LUC approval and those that have not received the urban area designation. The scenarios have also been defined to reflect the projected sales rate of units to full-time residents (average 112 units per year) and part-time residents (average 71 units per year). Based on this total sales rate of 183 units per year, the area with LUC approval, referred to as the "Zoning Only" area, could be built out in 2014. Therefore, 2014 has been used as an intermediate analysis year, with 2020 used for analysis of the entire 546-acre area.

- **Year 2014 No Action** – The traffic volumes on area roadways and traffic conditions at key intersections were forecast for 2014 without any development within the Kapolei West Project as a baseline to assess the Project impacts.

- **Year 2014 Urbanized Area Only Scenario** – The traffic increases and traffic conditions were forecast for 2014 with the complete development of the parcels that have already received LUC approval for urban development and for which only zoning approval is being sought by the Aina Nui Corporation. This scenario includes the full development of the parcels with LUC approval (1,253 residential units) and no development is included within the parcels needing LUC approvals. This scenario ignores the market forecast split of the housing sales rate between full-time residents and part-time residents.

- **Year 2014 Petition Area Scenario** – This scenario represents the partial development of both the areas with and without LUC approval based on the market study projections of the sales rates to full-time and part-time residents. This scenario includes the development of 1,281 units by the end of 2014, with the units distributed to parcels based on the forecast sales to full-time and part-time residents within each parcel.

- **Year 2020 No Action** – The traffic volumes on area roadways and traffic conditions at key intersections were forecast for 2020 without any development within the Project as a baseline to assess the Project impacts.

- **Year 2020 Buildout Scenario** – The traffic conditions were analyzed for 2020 with full build-out of the Kapolei West development..

Forecast Methodology and Assumptions

The traffic growth *without* the Project was forecast for years 2014 and 2020 through the use of a TRAFFIX trip generation and assignment model developed by Wilbur Smith Associates (WSA) for the City of Kapolei and the adjacent areas. The assumptions regarding the new development are outlined in the following sections. The numbers of new trips generated by new development within and near the City of Kapolei were based on standard trip generation rates compiled by the Institute of Transportation Engineers (ITE).[1] The origins and destinations of the new trips were based on the trip distribution percentages presented in Appendix A.

Non-Project Developments by 2014 – A substantial amount of new development is expected within the City of Kapolei between yearend 2003 and 2014. The additional City of Kapolei development is expected to include the following areas:

- The build-out of the commercial areas along the mauka side of Kamokila Boulevard.
- The near completion of commercial development makai of Kamokila Boulevard.
- Development of the Luana Koa Retirement Village along Manawai Street, extending from Kamaaha Avenue to the future Kapolei Parkway
- Development of the 18-acre commercial area on the northwest corner of the intersection of Kalaeloa Boulevard and the Kapolei Parkway
- Development of the 14-acre commercial site across Farrington Highway from the Hawaii Waters Adventure Park.

New development in the surrounding areas that were included in the traffic forecasts are:

- Development of 910 additional housing units in Makakilo
- Completion of Kapolei Knolls residential development
- Development of about 937 housing units in the Villages of Kapolei as well as two retail and commercial areas
- Development of about 5 acres of light industrial uses per year in the Kalaeloa Redevelopment Area, plus the operation of a vocational school and the provision of 150 acres of regional park facilities.
- Development of about 115,000 square feet of building floor space for industrial park uses each year within the Kapolei Business Park

[1] *Trip Generation, Seventh Edition*, Institute of Transportation Engineers, 2003.

- Development of the Mehana at Kapolei residential area (D R Horton, Schuler Division)
- Initial development of about 1,500 housing units in the Makaiwa Hills development.
- Development of an estimated 1,290 hotel rooms, 470 timeshare units, 660 housing units, and an aquarium facility within Ko Olina.

The estimated vehicle trips for the new City of Kapolei developments and those anticipated in the surrounding area by 2014 are presented in Appendix B.

Non-Project Developments by 2020 – The new development within the City of Kapolei between 2014 and 2020 would be centered on the build-out of the areas along Kamaaha Avenue and the Kapolei Parkway

New development in the areas surrounding the City of Kapolei that were included in the traffic forecasts are:

- Development of about 5 acres of light industrial uses per year in the Kalaeloa Redevelopment Area
- Development of about 115,000 square feet of building floor space of industrial park uses each year within the Kapolei Business Park
- Expansion of the Makaiwa Hills development to a total of about 3,000 housing units.
- Development of theme park-type uses and an amphitheater along Kalaeloa Boulevard south of the OR&L tracks.
- Development of an estimated 800 additional hotel rooms, 180 timeshare units, and 360 residential units in Ko Olina.

The estimated vehicle trips for the new City of Kapolei developments and those anticipated in the surrounding area between 2014 and 2020 are presented in Appendix C.

Future Roadways

The traffic assignments and intersection analyses reflect the construction of a number of roadway projects that would affect traffic conditions in the City of Kapolei area. The new roadways expected by 2014 that are most affect the Project area traffic conditions include:

- The widening of Kalaeloa Boulevard to a six-lane roadway.
- Construction of the new Kapolei Interchange

- Completion of the Kapolei Parkway through the City of Kapolei between Fort Barrette Road and Kamokila Boulevard.

- Extension of Kamokila Boulevard to connect to Roosevelt Avenue.

The additional roadway improvements included within the 2020 traffic forecasts and analyses are:

- The construction of Hanua Street Extension from Malakole Street mauka to connect to Farrington Highway at the Palailai Interchange.

- The construction of a new interchange along Farrington Highway east of Honokai Hale to provide access to the Makaiwa Hills development.

- The extension of the Kapolei Parkway westward to connect to Ko Olina.

Intersection Analysis Methodology

Traffic conditions at intersections controlled by traffic signals or STOP signs were analyzed using the methodology set forth in the *2000 Highway Capacity Manual*, as summarized in Appendix D. The analyses of traffic signal-controlled intersections were based on the following operational assumptions:

- Use of 4-second yellow clearances and 1-second all-red intervals.

- On major through roadways, left-turns allowed only with protected left-turn phases.

- No Right Turn on Red allowed in the analyses.

REPORT ORGANIZATION

This traffic impact analyses for the Kapolei West Project has been organized into the following chapters:

1. Introduction

2. Existing Conditions – Describes the existing roadway facilities, public transportation services, traffic volumes, and traffic conditions in the City of Kapolei area.

3. Future Conditions without the Project – Describes the traffic increases on area roadways and traffic conditions at key intersections in years 2014 and 2020 without the Project

4. 2014 With the Urbanized Area Land Uses – Describes the traffic increases on area roadways and traffic conditions at key intersections in year 2014 with the development of

only that portion of the Project site that has received State LUC approval for urban development.

5. 2014 With the Petition Area– Describes the traffic increases on area roadways and traffic conditions at key intersections in year 2014 with the development encompassing portions of both the Urbanized Area and the Petition Area..

6. 2020 With Project Buildout – Describes the traffic increases on area roadways and traffic conditions at key intersections in year 2020 with the full development of the entire Project site.

Chapter 2
EXISTING CONDITIONS

At the time of the traffic surveys in October, 2003, the Honolulu Advertiser was under construction as the first development west of Kalaeloa Boulevard in the City of Kapolei area. East of Kalaeloa Boulevard, the majority of the properties along Farrington Highway-Kamokila Boulevard in the City of Kapolei was partially or fully developed, although most of the undeveloped parcels are near the Kalaeloa Boulevard end of the area. The Kapolei Shopping Center area was almost fully developed, while about half of the area within the Kapolei Power Center was developed with Home Depot under construction. The major office developments were the Campbell Building, Bank of Hawaii Building, and the City and State Office Buildings. Public facilities included the Police Station and the Kapolei Regional Park. The Kapolei Library had been completed, but was not operational at the time of the traffic survey.

EXISTING ROADWAY SYSTEM

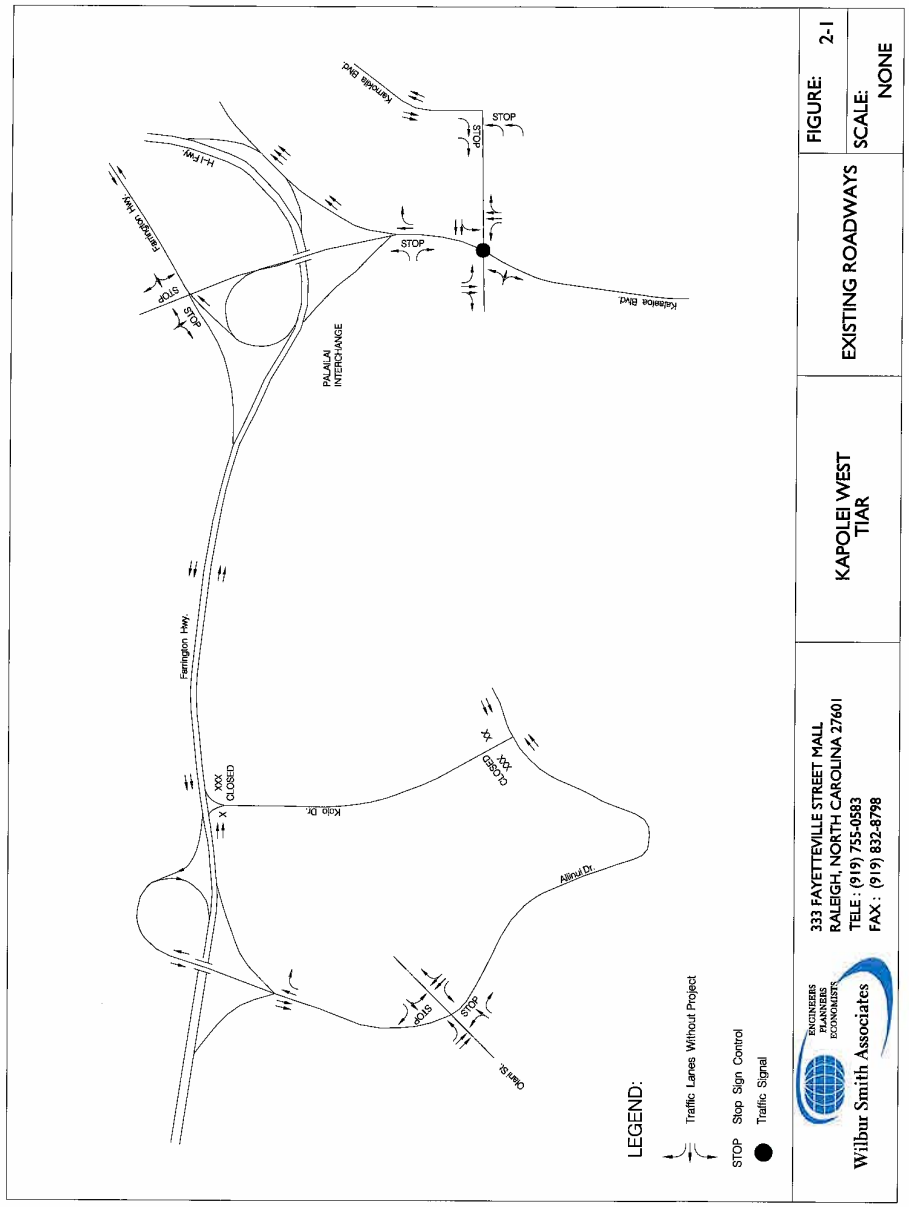
The major roadway system near the Project site is depicted in Figure 2-1. The major roadways within the area are discussed in the following paragraphs.

- **H-1 Freeway** - This six-lane freeway is the major east-west roadway in the Ewa District and connects the Ewa area to central Honolulu and other areas of Oahu. City of Kapolei traffic access to the freeway is via the Makakilo (Makakilo Drive-Fort Barrette Road) and Palailai (Kalaeloa Boulevard) interchanges.

- **Farrington Highway** - This State highway serves east-west travel through the Ewa District, and serves as the major regional route westward from the terminus of the H-1 Freeway near Kalaeloa Boulevard. It is a four-lane highway, with separate left-turn lanes, from the Kapolei Golf Course Road westward into the City of Kapolei to Kamokila Boulevard. The section between Kamokila Boulevard and Kalaeloa Boulevard is a two-lane roadway. Farrington Highway continues west of the Palailai Interchange as a four-lane divided highway to the Ko Olina and Waianae coast areas.

- **Kapolei Parkway** - This major roadway is planned to be a major traffic artery connecting the City of Kapolei to the Ko Olina area to the west and to the Villages of Kapolei and other communities to the east. Within the Kapolei area, the only completed portions of the roadway are the one-block segment between Kalaeloa and Kamokila Boulevards and a short section on the Honolulu side of Fort Barrette Road that provides access to the Kapolei Middle and High Schools, as well as the Villages of Kapolei. These segments have a median-divided roadway with two or more traffic lanes and a bicycle lane in each direction.

- **Aliinui Drive** – This four-lane highway with landscaped median provides access to the Ko Olina area from Farrington Highway. The junction with Farrington Highway is a



trumpet-type interchange. The cross street approaches to Aliinui Drive are controlled by STOP signs. At present, a guard booth is located near Farrington Highway to monitor access into Ko Olina. STOP signs are posted along Aliinui Drive at the two OR&L rail crossings as the means of crossing protection.

- **Kalaeloa Boulevard** – This major roadway provides access from the H-1 Freeway at the Palailai Interchange to the Kapolei Business Park, Campbell Industrial Park, and Barbers Point Harbor. The roadway also provides access to the City of Kapolei area via the Kapolei Parkway connection to Kamokila Boulevard. Kalaeloa Boulevard is a four-lane divided roadway from the H-1 Freeway to Malakole Road. Traffic signal controls are provided at its intersection with the Kapolei Parkway.

- **Kamokila Boulevard** - This major roadway connects Farrington Highway to the Kapolei Parkway and Kalaeloa Boulevard and provides access to the center of the City of Kapolei. Kamokila Boulevard provides two through lanes in each direction. The roadway has a landscaped median area for most of its length and has left-turn lanes at the intersections with cross streets and driveways. At present, the only traffic signal control is located at its intersection with Farrington Highway. West of the intersection with Farrington Highway, the cross street intersections are presently controlled by STOP signs on the side-street approaches. The speed limit is 25 mph.

- **Makakilo Drive-Fort Barrette Road** – Makakilo Drive provides the only access to the Makakilo community with the roadway connecting Makakilo to the Farrington Highway - H-1 Freeway corridor. The roadway continues makai as Fort Barrette Road to provide access to the Villages of Kapolei and the Kalaeloa Redevelopment Area (former Barbers Point Naval Air Station). The Makakilo Drive portion of the corridor is a four-lane roadway plus turn lanes in the section near the freeway. The Fort Barrette Road segment of the roadway has one traffic lane in each direction, plus turn lanes, from the Kalaeloa Redevelopment Area to south of Farrington Highway.

- **Koio Drive** – This four-lane roadway with a landscape median is intended to connect Aliinui Drive to Farrington Highway. The roadway has been barricaded and unused since its construction.

- **Olani Street** – This two-lane street provides access to the Ihilani Resort and Spa on the makai side of Aliinui Drive and to several existing and planned residential developments along the mauka side of Aliinui Drive. The approaches to Aliinui Drive are controlled by STOP signs.

EXISTING TRAFFIC VOLUMES

Wilbur Smith Associates (WSA) conducted special turning movement counts at the key intersections in the City of Kapolei and Ko Olina area during the weekday morning and afternoon peak commute traffic periods between October 15 and 22, 2003. Traffic counts were

made for each 15-minute period between 6:00 and 8:30 AM, and between 3:30 and 6:30 PM. The 15-minute counts were used to identify the peak one-hour volumes at the study intersections in the morning and afternoon commute periods. The peak one-hour volumes generally started at 7:00 or 7:15 AM in the morning commute period, and 4:15 to 4:30 PM in the afternoon peak period.

Peak hour traffic volumes on the H-1 Freeway and the on- and off-ramps were obtained from Hawaii State Department of Transportation 24-hour machine counts, with most of the counts made during 2002.

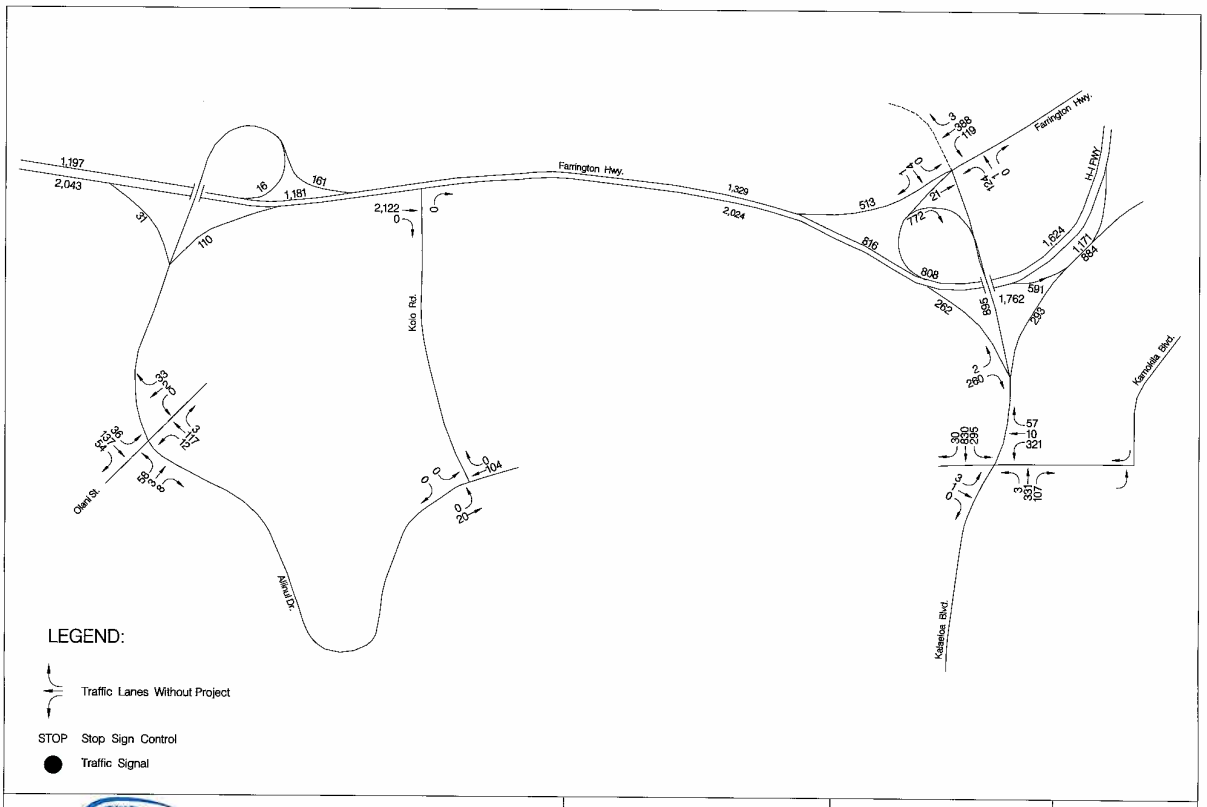
The existing weekday morning peak one hour traffic volumes are depicted in Figure 2-2 and the peak weekday afternoon volumes are depicted in Figure 2-3. At most locations, the afternoon peak hour two-way traffic volumes are higher than those in the morning peak hour.

Kalaeloa Boulevard accommodates high volumes of traffic in the makai-bound direction in the morning peak hour and the mauka-bound direction in the afternoon peak hour. This reflects the non-residential uses located along the makai section of the roadway. Approximately 300 vehicles turn left from makai-bound Kalaeloa Boulevard onto the Kapolei Parkway and from the Kapolei Parkway onto Kalaeloa Boulevard in the morning peak hour.

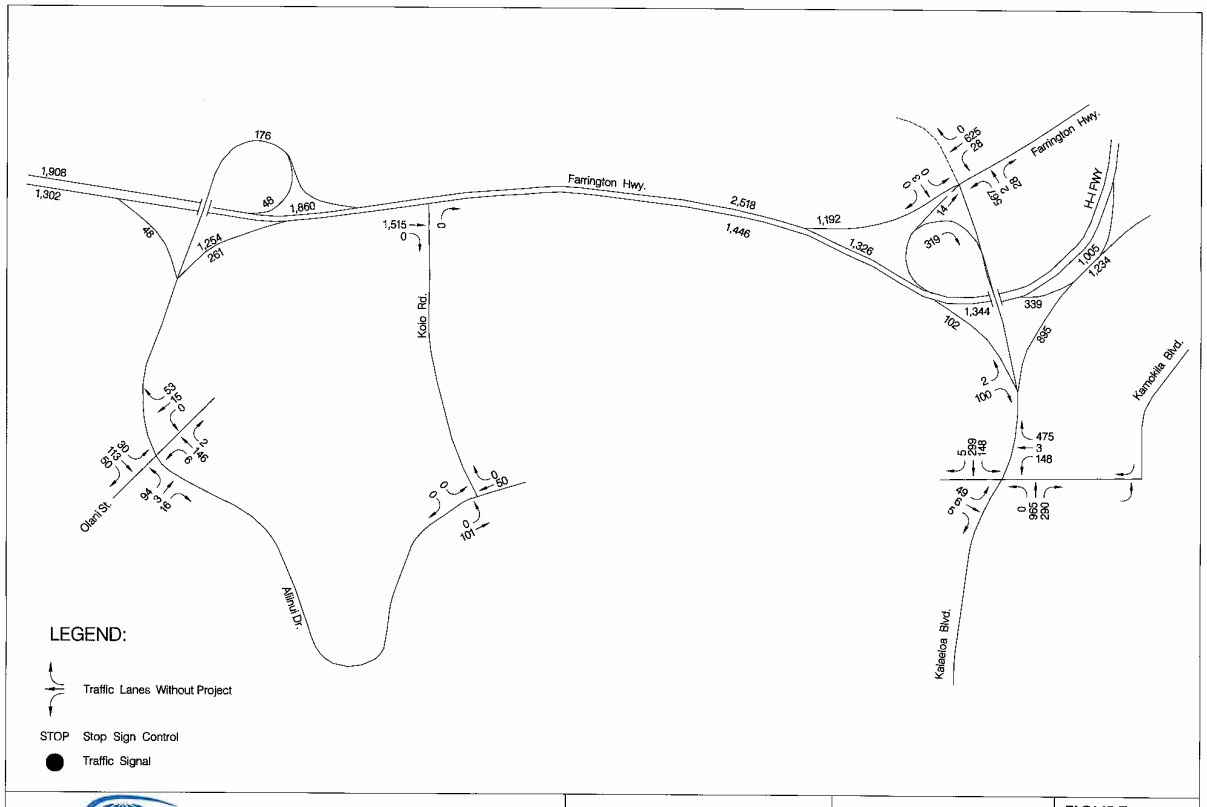
Traffic volumes along Aliinui Drive near Farrington Highway total about 320 and 530 vehicles in the morning and afternoon peak hours, respectively. Traffic volumes are much lower east of Olani Street, with about 280 vehicles in both peak hours.

The highest two-way traffic volumes on the area roadways occur along the section of Makakilo Drive between the H-1 Freeway Westbound Off-ramp and Farrington Highway, and along Farrington Highway between Makakilo Drive and Kamokila Boulevard. The intersection of Farrington Highway with Makakilo Drive/Fort Barrette Road has very high volumes of vehicles turning both left and right, which adversely affects traffic conditions at this intersection. In the afternoon peak hour, over 800 vehicles were counted turning left from eastbound Farrington Highway onto Makakilo Drive and over 700 turning left from Fort Barrette Road onto westbound Farrington Highway in the morning peak hour.

H-1 Freeway volumes are highest to the east with higher volumes eastbound in the morning peak hour (approximately 3,400 vehicles versus 2,650 westbound)) and higher westbound in the afternoon peak hour (3,350 versus 2,850 eastbound). West of the City of Kapolei, there is a more pronounced directional split in traffic volumes although the total peak hour traffic volumes are much lower than those east of the Makakilo Interchange. The highest ramp volumes occur on the Westbound Off-ramp and Eastbound On-ramp at the Makakilo Drive, with high volumes also on the Westbound Off-ramp and Eastbound On-ramp at the Palailai Interchange (Kalaeloa Boulevard.



Wilbur Smith Associates (ENGINEERS PLANNERS ECONOMISTS) 333 FAYETTEVILLE STREET MALL RALEIGH, NORTH CAROLINA 27601 TELE : (919) 755-0583 FAX : (919) 832-8798	KAPOLEI WEST TIAR	EXISTING MORNING PEAK HOUR TRAFFIC	FIGURE: 2-2 SCALE: NONE



Wilbur Smith Associates (ENGINEERS PLANNERS ECONOMISTS) 333 FAYETTEVILLE STREET MALL RALEIGH, NORTH CAROLINA 27601 TELE : (919) 755-0583 FAX : (919) 832-8798	KAPOLEI WEST TIAR	EXISTING AFTERNOON PEAK HOUR TRAFFIC	FIGURE: 2-3 SCALE: NONE

EXISTING TRAFFIC CONDITIONS

Traffic conditions were analyzed for the weekday morning and afternoon peak one-hour traffic volumes. The analyses were made for the key intersection near the Project site, and for the H-1 Freeway travel lanes east of the Makakilo Interchange.

The methodology and criteria used in analyzing the traffic conditions at the intersection and on the freeway are described in Appendix D.

Existing Intersection Conditions

The overall traffic conditions at each of the key intersections are summarized in Table 2-1 for the weekday morning and afternoon peak traffic hours.

Table 2-1
EXISTING TRAFFIC CONDITIONS AT KEY INTERSECTIONS

Intersections	Weekday Morning Peak Hour			Weekday Afternoon Peak Hour		
	V/C	ADPV	LOS	V/C	ADPV	LOS
Farrington Hwy.-Makakilo Dr.-Fort Barrette Rd.	0.80	74.3	E	0.86	68.0	E
Farrington Hwy.-Kamokila Blvd.	0.68	21.7	C	0.59	16.9	B
Kalaeloa Blvd.-Kapolei Pkwy.	0.63	34.6	C	0.73	28.8	C
Kalaeloa Blvd.-Farrington Hwy Mauka-bound Left Turn	0.44	25.7	D	1.97	476.8	F
Aliinui Dr.-Olani St.						
Mauka-bound Left Turn	0.10	11.5	B	0.13	14.0	B
Makai-bound Left Turn	0.01	11.5	B	0.01	13.5	B

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.
* = Not calculated since conditions outside normal range and represent highly unstable traffic flow.

Wilbur Smith Associates; June 16, 2004.

The signal-controlled Kalaeloa Boulevard intersection with Kapolei Parkway operated at very acceptable conditions in both peak hours with the existing traffic volumes. The morning peak hour traffic approximated 63% of intersection capacity while the afternoon peak hour traffic amounted to 73% of capacity. Average delay per vehicle was a very acceptable LOS C in both peak hours.

The traffic turning left from the STOP sign-controlled Kalaeloa Boulevard approach onto the Westbound On-Ramp at the Farrington Highway intersection experienced long delays in the afternoon peak hour. The HCS analysis indicates an average delay of about 6 minutes per vehicle. Field observations noted the formation of queues of 5 to 10 vehicles at times in the peak hour.

Peak hour traffic entering the Aliinui Drive intersection from Olani Street experiences very little delay in waiting for gaps at these STOP sign-controlled approaches. The left turns experience average delays equivalent to LOS B in both peak hours.

The most congested intersection in the area — the Farrington Highway intersection with Makakilo Drive/Fort Barrette Road — is located at some distance from the Kapolei West Project site. Traffic volumes at this intersection approximated 80% of the estimated intersection capacity in the morning peak hour and 86% in the afternoon peak hour. However, the intersection operations resulted in comparatively long average delay times with Level of Service (LOS) E conditions due to the number of signal phases and long cycle lengths.

Field observations during the traffic counts indicated that traffic conditions at the Farrington Highway-Makakilo Drive intersection were affected by signal timing and several physical features of the intersection as well as by the high volume of traffic for the critical conflicting traffic movements signal timing. In the morning peak hour, the northbound traffic on Fort Barrette Road experienced long delays for, with the queue extending beyond the Kapolei Parkway intersection. In the afternoon peak hour, the delays were concentrated on the eastbound approach of Farrington Highway, with the traffic queue extending beyond the Kamokila Boulevard intersection, as well as creating queues and delays of exiting vehicles on the Kapolei Shopping Center driveways. The morning and afternoon traffic conditions are affected by the short length of the right-turn lane on the southbound Makakilo Drive approach and the afternoon by the short length of the eastbound left-turn lane adjacent to the median, with these short lengths not allowing effective use of these turn lanes. The City and County of Honolulu DTS was testing different signal timings during the survey period for this study. On other days following the count at the Farrington Highway-Makakilo Drive-Fort Barrette Road intersection, these approaches were observed to operate without long delays, and longer queues were observed on the other approaches to the intersection.

H-1 Freeway Conditions

Existing traffic conditions were assessed for the section of the H-1 Freeway east of the Makakilo Interchange. The H-1 Freeway has three travel lanes in each direction with paved shoulders in this section. For the purpose of this assessment, the free flow speed is assumed to be the posted 65 miles per hour (mph) speed limit in this section. This section of freeway section would have an estimated capacity of about 7,050 vehicles per hour in each direction, with this maximum capacity occurring with speeds around 52 mph.

As summarized in Table 2-2, this section of the H-1 Freeway should accommodate the existing peak hour traffic volumes at very acceptable conditions. The analysis indicates that the traffic traveling this section should operate at LOS B or C in each peak hour and travel direction.

Table 2-2
H-1 FREEWAY CONDITIONS

Peak Hour	Direction	Volumes	Lanes	Density (vphpl)	Speed (mph)	Level of Service
Location: East of Makakilo Interchange						
Morning	Eastbound	3,386	3	18.8	62.0	C
	Westbound	2,651	3	15.1	62.0	B
Afternoon	Eastbound	2,852	3	16.1	62.0	B
	Westbound	3,353	3	18.8	62.0	C

vphpl = vehicles per hour per lane
mph = miles per hour

Wilbur Smith Associates; November 23, 2004.

PUBLIC TRANSPORTATION

The City and County of Honolulu provides public transportation services to the areas adjacent to the Kapolei West development area. These include a number of TheBus fixed route bus service that pass near the project site. TheHandiVan provides door-to-door service for persons who have difficulty in accessing the fixed route service.

TheBus Routes – The existing bus routes that provide service near the Kapolei West project site include the following:

Route C Country Express – Route C provides an express/limited stop service through the City of Kapolei area, with the route extending to the Honolulu Downtown area and Ala Moana Center to the east and along the Waianae Coast to Makaha to the west. The

service operates seven days a week from about 4:30 AM to 11:00 PM. Route C uses Kalaeloa Boulevard between the H-1 Freeway and the Kapolei Parkway.

Route 40 Honolulu-Makaha – This trunk route provides regular bus service along the same general route as Route C. Within the City of Kapolei, it provides service along surface streets between the Makakilo and Palailai Interchanges, with the route using Makakilo Drive, Farrington Highway, Kamokila Boulevard, Kapolei Parkway, and Kalaeloa Boulevard. Service is provided seven days a week from about 5:00 AM to 9:30 PM.

Route 413 Campbell Industrial Park – This local route provides service from the Kapolei Transit Center to the Campbell Industrial Park and Barbers Point Harbor areas, with the route using the Kapolei Parkway and Kalaeloa Boulevard. The route operates from 5:30 AM to 8:00 AM and from 3:00 PM to 6:00 PM.

Kapolei Transit Center – The City and County of Honolulu has recently completed development of a Transit Center on the alignment of the future extension of Wakea Street mauka of Kamokila Boulevard. The Transit Center provides a transfer site for all of TheBus local and regional routes that serve the City of Kapolei and the surrounding communities.

Chapter 3
FUTURE CONDITIONS WITHOUT PROJECT

Future travel on the area roadways without the Kapolei West development (the Project) was forecast by estimating traffic to/from new developments in the City of Kapolei-Ko Olina area, and then adding these new trips to the existing travel volumes. Traffic was also forecast to/from new development anticipated in the other areas near the City of Kapolei that would travel through the Project area. The overall methodology used to estimate future traffic for years 2014 and 2020 without the Project was as follows:

- Aina Nui Corporation staff provided the location, type and general timing of future development in the City of Kapolei.
- The property owners and/or developers in the areas adjacent to the City of Kapolei were contacted to identify the general description and timing of additional development in those areas.
- Wilbur Smith Associates (WSA) staff estimated the peak hour vehicle trip generation for each of the potential developments.
- The origin/destination of trips for the new developments were based on a trip distribution for the Kapolei area as developed from the OMPO regional model.
- The traffic to/from the new developments was assigned to the area roadway system using a TRAFFIX traffic model.
- An annual growth factor was used to increase through traffic along the H-1 Freeway.

Traffic conditions were then analyzed for the key intersections and roadways that would be affected by traffic generated by the Kapolei West Project.

FUTURE DEVELOPMENT ASSUMPTIONS

Most of the lands within the City of Kapolei are expected to be developed by 2014, with development of several parcels at the perimeter anticipated to extend from 2014 to 2020. Substantial additional development is also expected to occur in the areas near the City of Kapolei.

Development Within City of Kapolei

A number of new developments are planned for construction in the next few years and are assumed to be completed and occupied by the 2014 or 2020 forecast years. Where there are no specific plans as yet, the Campbell Estate staff identified the types of uses anticipated for the other vacant properties and the general timing of the development. In general, development in the central area of the City – between Fort Barrette Road and Kalaeloa Boulevard – is expected to progress from the blocks closest to Kamokila Boulevard towards the former OR&L track line. The anticipated developments are discussed by time period in the following paragraphs.

2004-2014 Development – The new developments or additions to existing development, expected between the October 2003 traffic counts and the end of 2014 include the following projects:

- **City Civic Center** - The City and County of Honolulu has completed and has occupied most of City Office Building No. 1. Discussions with the City staff indicate that about 50 employees may be added to the current staff in the next few years as the building reaches full occupancy.
- **Kapolei Public Library** – Construction has been completed, but neither the public library facilities nor the book/periodical distribution and storage area have been occupied at the end of 2003. Full operation is expected by 2006. Access is provided via Haumea Street.
- **Kapolei Park Square** – A 2-acre parcel remains to be developed within this site located along the south end of Kapowai Place across from the Kapolei Shopping Center. The site is expected to be developed with office space.
- **Luana Koa Retirement Village** – A retirement village is planned for the 40-acre area along the west side of Fort Barrette Road between the future Kamaaha Avenue and Kapolei Parkway. The main entrance will be located along an extension of Manawai Street, with a secondary access located along the future extension of Kamaaha Avenue. Complete development is expected by about 2008.
- **Island Pacific Academy** – The initial phase of a private school is under construction on block on the southeast corner of Haumea and Wakea Streets. The school is planned to reach an enrollment of 760 students in 2009.
- **Kamokila Blocks between Wakea and Uluohia Streets –** These two blocks on the makai side of Kamokila Boulevard are expected to be developed with a mix of restaurant, retail, and office uses in the next several years.
- **Kapolei Power Center** – The remaining portions of the site are expected to be developed by 2010 with a mix of retail, restaurant, and office uses, as well as the Home Depot store now under construction.
- **Advertiser Printing Plant** – The new Advertiser printing facility is currently being completed on the southwest corner of Kalaeloa Boulevard and the Kapolei Parkway intersection.
- **Kalaeloa West Commercial Area** – The 18-acre commercial area west of Kalaeloa Boulevard, located across the future Kapolei Parkway alignment from the Advertiser project site, is planned for development as a retail complex. Access to the parcel will be via driveway connections to the Kapolei Parkway.
- **Kapolei Mauka Residential Area –** A townhouse development is planned for the area just mauka of the H-1 Freeway on the west side of Makakilo Drive. The development is anticipated to have about 350 townhouses. Access would be provided to the Mauka Frontage Road or, if the Mauka Frontage Road has not been constructed, to Makakilo Drive.
- **Mehana at Kapolei Makai Residential Area** – Development of the full 130-acre project area is expected by 2014. The development would total about 1,156 residential units and a neighborhood commercial center.

- **Kapolei Makai Elementary School** – An elementary school would be located adjacent to the Mehana at Kapolei development, although not included as a part of that development project. Although the timing is unknown, it is assumed that it would be developed by 2014.
- **Kapolei Rezoning Parcel 1** – The development within this portion of the City of Kapolei is anticipated between 2011 and 2015. Approximately 80% of the floor area is assumed to be developed by 2014.
- **Kapolei Rezoning Parcel 2** – This retail development, located makai of the Hawaiian Water Adventures Park, is expected to be completed prior to 2014.
- **Kapolei Rezoning Parcel 3** – This commercial development is located on the northeast corner of the intersection of Farrington Highway and Makakilo Drive. The development of the parcel is expected between 2011 and 2015. The parcel was assumed to be 80% developed by 2014.

Traffic to/from each of these developments is included in the forecast yearend 2014 volumes.

2015-2020 Development – The new development expected within the City of Kapolei from 2015 through the end of 2020 includes the following projects:

- **Kapolei Rezoning Parcel 1** – The remaining 20% of the development within this portion of the City of Kapolei is anticipated by 2020.
- **Kapolei Rezoning Parcel 3** – The development of the remaining 20% of this parcel is expected by 2020.

The traffic to/from each of these developments was incorporated into the 2020 traffic forecasts.

Developments Near the City of Kapolei

Additional development, or occupancy of previously completed development, is expected in several areas that would directly add traffic on the roadways and through the key intersections that are the subject of this study. The amount of development was estimated for most of these areas from telephone discussions with representatives of either the developer or property owner.

Makakilo Development - Contacts with Schuler Homes and GE Capital Hawaii indicated that most of the Makakilo area should be developed by 2010. The new development is expected to add:

- 674 single-family homes
- 236 apartments.

Villages of Kapolei and Kapolei Knolls - Schuler Homes and the Housing and Community Development Corporation Hawaii (HCDCH) indicated that Kapolei Knolls and most of the Villages areas should be developed by 2010, with some development possibly extending beyond 2010. All of the area is expected to be developed by the end of 2014. An estimate of the remaining housing units in Kapolei Knolls was provided by Schuler Homes. For the Villages of

Kapolei, HCDCH provided the acreages and types of uses for the remaining undeveloped areas, while the numbers of housing units of each development were estimated by WSA. The resultant development assumptions are as follows:

- Kapolei Knolls - The remaining 212 single-family homes will be completed.
- Village Center - The 15.4-acre vacant parcel will be developed with a neighborhood shopping area and half with churches.
- Village 6 – A vacant 9.8-acre parcel will be developed with about 150 apartments.
- Village 7/8 – An estimated 314 single-family homes will be developed on the 53-acre undeveloped area
- Commercial Center in Village 1 – WSA assumed that the 22.9-acre parcel would be developed with shopping center or specialty retail uses by 2014.
- Village 2 - An 8-acre parcel would be developed with about 200 apartments.
- Village 5 – A 7.6-acre parcel would be developed with about 140 apartments.

Kalaeloa Redevelopment Area - Based on discussions with the Hawaii Community Development Authority (HCDA) and the Department of Hawaiian Home Lands (DHHL), very limited additional development was assumed to occur in the near term due to the availability and competition from other development areas, as well as the uncertainties regarding the potential return of Navy airfield uses.

WSA assumed that the light industrial areas would develop at an average rate of 5 acres per year, thus yielding about 55 acres of light industrial-warehousing uses by 2014 and 85 acres by 2020. The 85 acres would represent about one-half of the available development area for these uses.

Because of the uncertainty regarding the potential return of Navy operations, only limited other development was assumed for the other conveyance areas by 2014. By 2014, development was assumed for a vocational school and about 150 acres of regional park facilities.

Near full development was assumed by 2020, with the uses envisioned in the Kalaeloa Redevelopment Plan. The anticipated land uses include:

- 42 acres of commercial recreational uses
- 20 acres of new office development
- A motor sports center/race track occupying about 140 acres
- A festival center occupying about 100 acres.

A motor sports center and a festival center are expected to host major spectator events during several weeks and/or weekends, with these events spread out through the year. However, the typical weekday operations would likely generate only a small number of employee and visitor trips.

Barbers Point Harbor - The Harbors Division of the State DOT indicated that there is approximately 169 acres of undeveloped land at the Harbor. WSA assumed that the development of these areas would continue the same rate of traffic growth as experienced along

Malakole Street in recent years (about 2.2% per year). This uniform rate of development and traffic growth would result in the following numbers of new vehicle trips to/from the Barbers Point Harbor:

By Yearend of	Morning Peak Hour			Afternoon Peak Hour		
	To	From	Total	To	From	Total
2014	113	27	140	37	78	115
2020	190	45	235	61	129	190

Makaiwa Hills Development - A representative of the potential developer for this area indicated that preliminary plans are to develop approximately 4,000 housing units with an emphasis on single-family homes. The developer plans to begin occupancy of units in 2009, with completion of the development projected for 2025, for an average of about 250 housing units per year.

Based on a uniform rate of occupancies through the 2009-2025 period, the development would have approximately 1,500 occupied housing units at yearend 2014 and 3,000 units in 2020. WSA has assumed that 50% would be single-family homes, 25% townhouses, and 25% medium density units.

The developer plans to build only limited neighborhood commercial uses that would be intended to serve the residents of the development.

The potential developer has indicated it would like to rely on an extension of Kalaeloa Boulevard for access through at least 2014. The longer range plans indicate additional access points to Farrington Highway east and west of the existing Honokai Hale and Nanakai Gardens residential areas. The initial analyses for 2014 were made with access provided only via an extension of Kalaeloa Boulevard to test the necessity of the second access for Makaiwa Hills at these levels of development. The 2020 traffic forecasts were based on the construction of a Makaiwa Hills interchange with Farrington Highway on the east side of Honokai Hale.

Ko Olina Development - Representatives of the Ko Olina Community Association and the Marriott Corporation were contacted regarding the planned general type and timing of development for the Ko Olina area. Based on available information and these discussions, WSA estimated the following levels of new development:

2004 to 2014

- 1,290 new hotel rooms
- 470 new timeshare units
- 60 additional single-family homes (Centex)
- 390 additional townhouses (Coconut Plantation and Centex)
- 160 additional low density houses (across from Fairways Villas)
- 50 additional medium density houses
- Aquarium

2015 to 2020

- 800 additional hotel rooms (to 2,580 hotel rooms)
- 180 additional timeshare units (to Marriott project total of 750 units)
- 360 additional medium density houses (to 1,416 housing units)

Kapolei Business Park - An average of 115,000 square feet of new warehouse and distribution floor area are expected to be developed during each year based on discussions with staff of the Aina Nui Corporation. The new building floor area would total:

- 1,268,000 square by yearend 2014
- 1,952,000 square feet between 2014 and 2020

Traffic was estimated based on the trip rates for industrial parks, which includes a mix of light manufacturing, distribution, warehousing, and office uses.

After 2020, with this level of development there would be about 25 acres of vacant lands available within the Kapolei Business Park.

Kapolei Theme Park – A theme-type amusement park has been proposed for the approximately 65 acres along the west side of Kalaeloa Boulevard. The site would extend from the Oahu Railroad & Land (OR&L) railroad tracks makai to the vicinity of Opakapaka Street.

The Theme Park would include family-oriented attractions such as rides, retail shops, food concessions, and performance areas. Plans are to operate the park seven days a week throughout the year. Most of the rides and attractions in the park would usually open from about 9 or 10 AM until late evening. The Park would also provide evening dinner shows, with seating up to 600 persons. The total number of guests for the Theme Park is estimated at 1.5 million persons per year.

Guest entrance to the Theme Park would be provided by a single driveway exiting makai-bound Kalaeloa Boulevard between Lauwiliwili and Opakapaka Streets, with the entrance gates located inside the site about 1,100 feet from Kalaeloa Boulevard. Present plans provide the exit from the guest parking area via a driveway connection to Kalaeloa Boulevard as the west leg of the present T-type intersection with Opakapaka Street. A driveway for employee and service vehicle access would be provided as a west leg of the present Kalaeloa Boulevard intersection with Lauwiliwili Street. Parking areas will include about 1,800 spaces for guest automobiles, 76 bus spaces, and about 600 employee spaces.

When the Hanua Street Extension is constructed, it is assumed that the Theme Park circulation would be modified to exit most traffic onto Hanua Street.

The Theme Park is contingent upon the developer obtaining financing. Because of the uncertainty in the timing of this development, the Park has been included in the 2015-2020 forecast period.

The traffic estimates for the Theme Park have been obtained from the traffic study conducted for the proposed project.[1] In the morning commute peak hour, only a small number of administrative and maintenance employees, plus deliveries, would be traveling to/from the site, with a total of 83 vehicle trips to or from the park. In the afternoon commute peak hour, a total of about 675 vehicle trips are estimated to or from the park on a typical weekday in the peak visitor month of the year.

Amphitheater – An amphitheater has been proposed for 34 acres along the west side of Kalaeloa Boulevard. The site would extend mauka from the makai end of the planned future site of the Kapolei Theme Park (Islands of Paradise) to approximately 900 feet mauka of Malakole Street.

The Kapolei Amphitheater would accommodate concerts, performances, and similar events with up to 14,000 attendees. The events would mostly occur during the early weekday or weekend evenings, with occasional events during the daytime on weekends. Approximately 30 to 50 events are anticipated per year, with average attendance estimated at about 8,000 persons.

Access to/from the Amphitheater would be provided by driveway connections along the southward extension of Lauwiliwili Street to the west side of Kalaeloa Boulevard. A direct entrance driveway may also be provided from Kalaeloa Boulevard, with the entrance to the parking area recessed within the site to provide adequate queuing area for arriving vehicles. Present plans provide an interim two-lane driveway connection to Kalaeloa Boulevard along the future Lauwiliwili Street alignment. This interim connector would be replaced by the full Lauwiliwili Street cross-section as additional development occurs in the future. Parking would be provided about 3,750 automobiles and buses.[2]

The Amphitheater is contingent upon the developer obtaining financing. Because of the uncertainty in the timing of this development, the Amphitheater has been included in the 2014-2020 forecast period.

Since the Amphitheater would have only a limited number of large events, the estimates of the normal weekday commute hour traffic was based on the trips generated by the administrative and maintenance employees at the facility, with the number of estimated by WSA at about 30 employees.

GROWTH OF H-1 FREEWAY THROUGH TRAFFIC

A growth factor was applied to existing traffic volumes on the H-1 Freeway to reflect increased travel to/from the Waianae Coast areas west of Ko Olina. The growth factor was determined

[1] *Islands of Paradise Theme Park Traffic Impact Study*, prepared for Islands of Paradise, Inc. by Wilbur Smith Associates, 2001.
[2] *Kapolei Amphitheater Traffic Impact Study*, prepared for the Estate of James Campbell by Wilbur Smith Associates, 2001.

from the traffic counts for the State DOT count station located on the H-1 Freeway west of Makakilo Drive (count station #H10-A). The historic counts indicated an average annual growth rate of 0.8% per year between January 1999 and January 2002.

The 0.8% annual growth rate was assumed to continue through the study period. With this rate, the 2002 freeway volumes are estimated to increase 10% by 2014 and 15.4% by 2020. These volumes are further increased by the forecast trips to/from the new development within and near the City of Kapolei as identified in the preceding sections of this chapter.

PLANNED ROADWAYS

A number of transportation projects have been planned for the Ewa District that would affect travel to and within the City of Kapolei. Most of these projects have been identified and/or confirmed through the Oahu Metropolitan Planning Organization (OMPO) transportation planning process[3], as well as the Ewa Highway Impact Fee Program studies and plans[4]. The OMPO process assesses the long-range transportation needs to serve forecast travel over the next 20 or more years, but also selects a high-priority short list of projects and programs for funding within the next three years as covered by the its adopted Transportation Improvement Program (TIP). The Ewa Highway Impact Fee Program (Ewa HIFP) addresses the travel needs through 2010 and establishes a developer-funded source to pay for 20% of the regional roadways needed in the Ewa District.

A number of roadway improvements are anticipated by the year 2014 and 2020 analyses years, either as regional highway improvements are as part of area developments. The roadway improvements assumed to be in place *without* the Kapolei West development are discussed in the following sections.

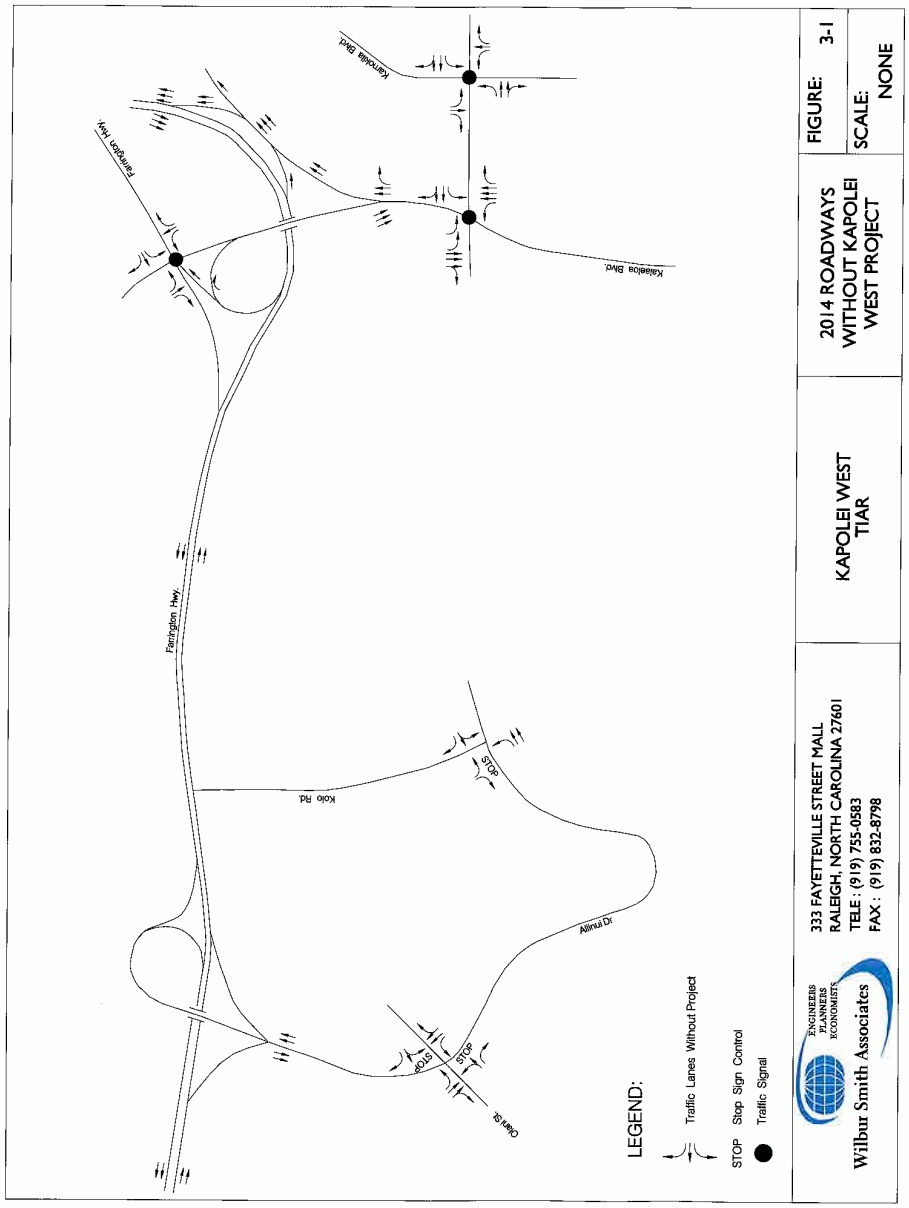
2014 Roadway Improvements

The new Kapolei Interchange, the widening of Kalaeloa Boulevard to a six-lane roadway, and the connection of the Kapolei Parkway between Fort Barrette Road and Kalaeloa Boulevard are the key area roadway improvements anticipated near the Kapolei West area during the 2004-2014 period. For the purposes of the Kapolei West traffic analyses, it is assumed that the Kapolei Parkway would not be extended from Kalaeloa Boulevard to connect to Aliinui Drive by 2014unless the Kapolei West Project is developed within this time frame.

The anticipated roadway network and numbers of traffic lanes near the Project site in 2014 are depicted in Figure 3-1. Descriptions of those roadway improvements that most directly affect the Kapolei West area are included in the following paragraphs.

Kapolei Interchange - A new interchange is planned for construction between the Makakilo and Palailai Interchanges to increase the access between the City of Kapolei and the H-1 Freeway.

[3] *Transportation for Oahu Plan, TOP 2025*, prepared for OMPO by Carter-Burgess, April 6, 2001.
[4] *Ewa Highway Impact Fee Program*, prepared for State of Hawaii Department of Transportation by Kaku Associates, Inc. July, 2002.



The interchange would initially connect to Wakea Street, but in the future it would also connect to the Mauka Frontage Road. The new interchange is included in the Ewa HIFP for 2010. Funds are allocated to the project for the planning and environmental process in the current TIP.

The Kapolei Interchange is planned to provide additional on- and off-ramps for travel to/from the Honolulu direction of the H-1 Freeway. The existing Farrington Highway connection across the Freeway west of the Kamokila Boulevard intersection would be abandoned and access provided via the Wakea Street Extension to the existing Waianae side on- and off-ramps.

Kalaeloa Boulevard Improvements - The section of Kalaeloa Boulevard between the Palailai Interchange and Malakole Street is planned for improvements in the TOP 2025. This is expected to include the widening of a portion or all of this segment to a six-lane roadway with median and turn lanes. By 2014, it is assumed that at least the mauka section between the OR&L tracks and the Palailai Interchange ramps would be widened to six lanes.

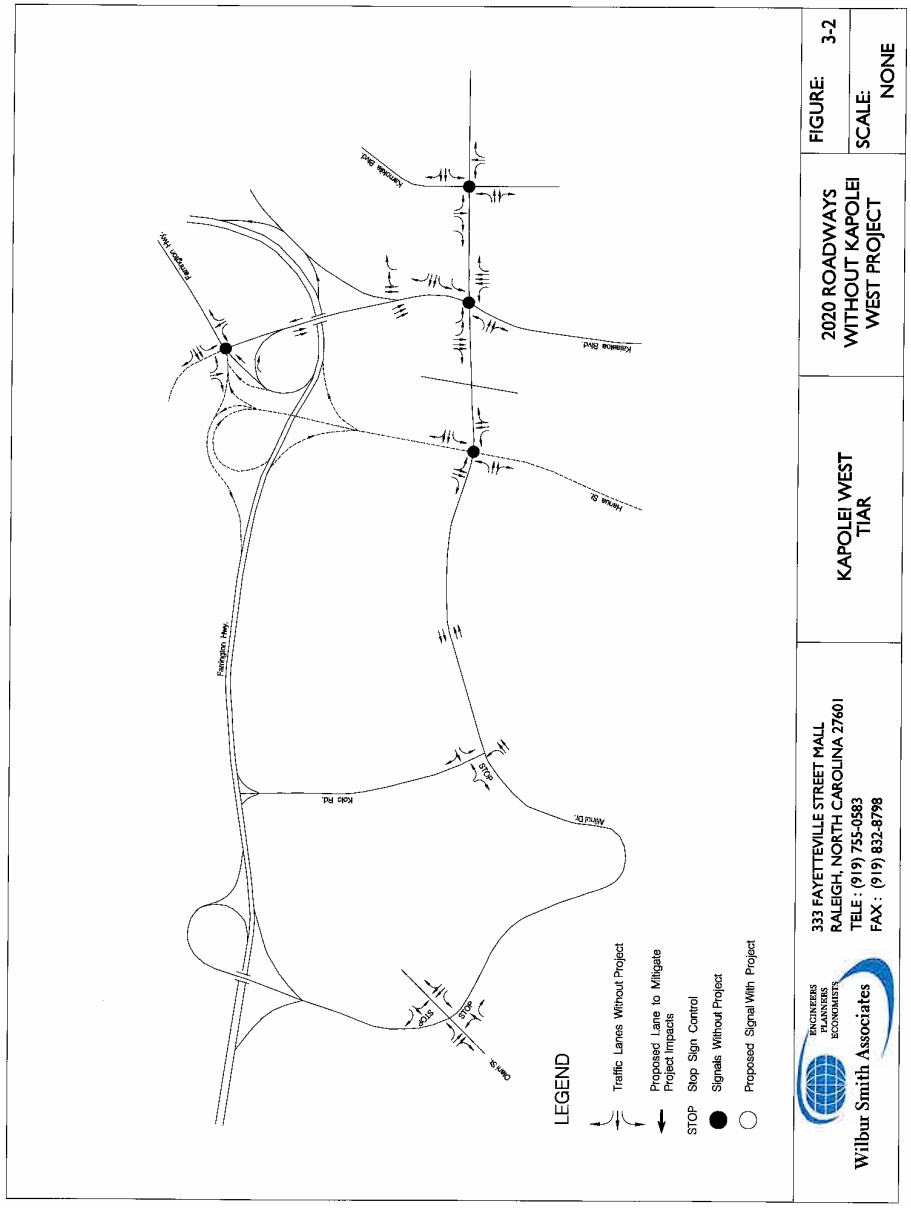
At the intersection with the Kapolei Parkway, it is expected that the widening project would also provide double left-turn lanes to accommodate the high volume of left- turns from makai-bound Kalaeloa Boulevard. Similarly, it would be appropriate for the widening to provide a right-turn lane on the mauka-bound approach to accommodate the high volume of right turns onto the Kapolei Parkway.

Kapolei Parkway – The section of the Kapolei Parkway between Fort Barrette Road and Kamokila Boulevard is expected to be completed by 2014, which would both improve east-west traffic circulation through the City of Kapolei and provide improved access to the new development within the City of Kapolei. The connection is planned as a four-lane roadway with a landscape median and turn lanes at cross streets and major driveways.

Makakilo Interchange Westbound On-Ramp - A westbound on-ramp and an eastbound off-ramp are planned for the Makakilo Interchange to reduce traffic circulation through the City of Kapolei. Traffic between the Villages of Kapolei and Makakilo areas must currently travel through the City of Kapolei on Farrington Highway to access the H-1 Freeway at the Palailai Interchange for travel to/from areas west of the City of Kapolei. The new ramps are included in the OMPO long-range plan and within the Ewa HIFP. The Aina Nui Corporation recently approved funding for the design and construction of a westbound on-ramp for this interchange, and the location and design of this ramp is now under study. For this study the westbound on-ramp is assumed to be completed and open to traffic by 2014. The ramp is assumed to be a "slip ramp" from the Mauka Frontage Road, with access provided via the intersection with Makakilo Drive.

2020 Roadway Improvements

The key new roadway improvements near the Kapolei West Project site between 2015 and 2020 are expected to include the extension of the Kapolei Parkway between Kalaeloa Boulevard and Ko Olina, a new Makaiwa Hills interchange with Farrington Highway to serve the Makaiwa Hills development, and the construction of the Hanua Street extension. The resultant roadway network and numbers of traffic lanes near the Project site in 2020 are depicted in Figure 3-2.



Descriptions of the roadway improvements that most directly affect the Kapolei West area are included in the following paragraphs.

Kapolei Parkway – The section of the Kapolei Parkway between Kalaeloa Boulevard and the eastern end of Aliinui Drive is assumed to be completed by 2020 whether or not the Kapolei West Project is developed within this time frame. This connection would provide an alternative to Farrington Highway and improve east-west traffic circulation through the area. The connection should also reduce the traffic volumes using the Palailai and Ko Olina Interchange ramps. The connection is planned as a four-lane roadway with a landscape median and turn lanes at cross streets and major driveways.

Makaiwa Hills Interchange – This planned new interchange would be located east of the Honokai Hale community. It is planned as a diamond-type interchange that would connect to and serve the Makaiwa Hills community. Past plans for the new connecting roadway between the interchange and the Makaiwa Hills community did not include any extension of the roadway makai of Farrington Highway into the Kapolei West area. Road D in the Kapolei West Project is planned to connect to the Makaiwa Hills Interchange to provide access to Farrington Highway/ H-1 Freeway. However, this connection is not reflected in this study in order to provide a more conservative assessment of Kapolei West Project impacts at planned build-out in 2020 due to the uncertainty of the timing of the interchange construction.

Hanua Street Extension – Hanua Street is a two-lane mauka-makai roadway within the Campbell Industrial Park, with the present roadway ending at Malakole Street. The TOP 2025 plans include the extension of existing Hanua Street mauka to connect to the future Kapolei Parkway and to the Palailai Interchange. The extension of Hanua Street is not expected to occur prior to the 2014 analysis year, but is assumed to be in place by 2020.

The Hanua Street Extension would likely be constructed as a four-lane roadway with median and separate turn lanes at the major cross streets. The project would include the reconstruction of the Palailai Interchange.

Roadway Improvements Not Included by 2020

Several of the roadways included in the area roadway plans were not included within the roadway network used as the initial baseline system for the traffic analyses in this traffic impact study. These include:

- **Makakilo Interchange Eastbound Off-Ramp** - The eastbound off-ramp planned for the Makakilo Interchange would also reduce traffic circulation through the City of Kapolei. However, the ramp would intersect Makakilo Drive at a very short distance from the Farrington Highway intersection, thus potentially worsening traffic operations at that intersection. For the purpose of this study, the eastbound off-ramp is not included within the baseline roadway network.

- **Makakilo Drive Extension** – The OMPO long-range plans include the construction of a new roadway to provide a second access for the Makakilo community. The new access

would be constructed as an extension of Makakilo Drive to connect to the North-South Road at the H-1 Freeway interchange. The connection would divert a substantial portion of the traffic that now uses the Makakilo Interchange to access the H-1 Freeway ramps in the Honolulu direction, and to travel to the areas of Ewa makai or east of the City of Kapolei.

PUBLIC TRANSPORTATION

The City and County of Honolulu provides public transportation services to the areas adjacent to the Kapolei West development area. These include a number of TheBus fixed route bus service that pass near the project site. TheHandiVan provides door-to-door service for persons who have difficulty in accessing the fixed route service.

TheBus Routes – The bus routes for the area are expected to be modified to increase coverage of the Kapolei area as development occurs in new areas, and service increased as the employment and number of residents increase. It is expected that TheBus service would be provided along the Kapolei Parkway between Kalaeloa Boulevard and Ko Olina once this extension has been completed.

Kapolei Transit Center – The Transit Center will be relocated when the Kapolei Interchange is constructed, as the extension of Wakea Street will be used to connect the City of Kapolei to the new interchange. The new Transit Center is planned for a site along Kapolei Parkway near Kamaaha Avenue.

2014 PEAK HOUR TRAFFIC CONDITIONS

The weekday peak hour traffic volumes were forecast for 2014 without the Kapolei West development based on the new developments and roadways described in the preceding sections. The peak hour traffic conditions were analyzed for the key locations that would be affected by traffic traveling to/from Kapolei West development.

Trip Generation

The numbers of vehicle trips generated by the new development within and near the City of Kapolei were based on standard trip rates compiled by the Institute of Transportation Engineers (ITE).[5] The vehicle trip generation rates and estimated vehicle trips for the various areas and types of developments are presented in Appendix B.

The numbers of vehicle trips entering or exiting a commercial development include both new vehicle trips and additional stops by vehicles that would be traveling through the area whether or not the Project is developed. These additional stops by traffic passing the site to use the retail and services uses are referred to as "pass-by trips," which do not represent additional trips on the adjacent roadway, but do result in additional turns into and out of the development driveways by

[5] *Trip Generation, Sixth Edition*, Institute of Transportation Engineers, 1997.

vehicles that would be passing by that site. The ITE *Trip Generation Handbook*[6] provides a methodology and pass-by rates for estimating the proportion of the Project vehicle trip ends that are pass-by trips. Pass-by trip factors are usually applied only to the afternoon peak hour since many retail and service businesses are not open or have low rates of trip generation during the morning peak hour. For the commercial uses, Appendix A lists the total number of vehicles entering and exiting the land use and also lists the number of "new" vehicle trips on the area roadways generated by the land use in the afternoon peak hour, excluding the pass-by trips.

The anticipated growth within the City of Kapolei by 2014 would increase the morning peak hour trips by about 4,000 trips, and the afternoon peak hour by about 6,000 new trips on area roadways. With the predominantly commercial uses, the majority of the trips in the morning peak hour are traveling to the City of Kapolei land uses, and in the afternoon the majority of trips are departing these uses.

By 2014, the new development near the City of Kapolei (Ko Olina, Kapolei Business Park, Villages of Kapolei, etc.) is estimated to generate an increase of about 5,000 and 6,600 new vehicle trips in the morning and afternoon peak hours, respectively.

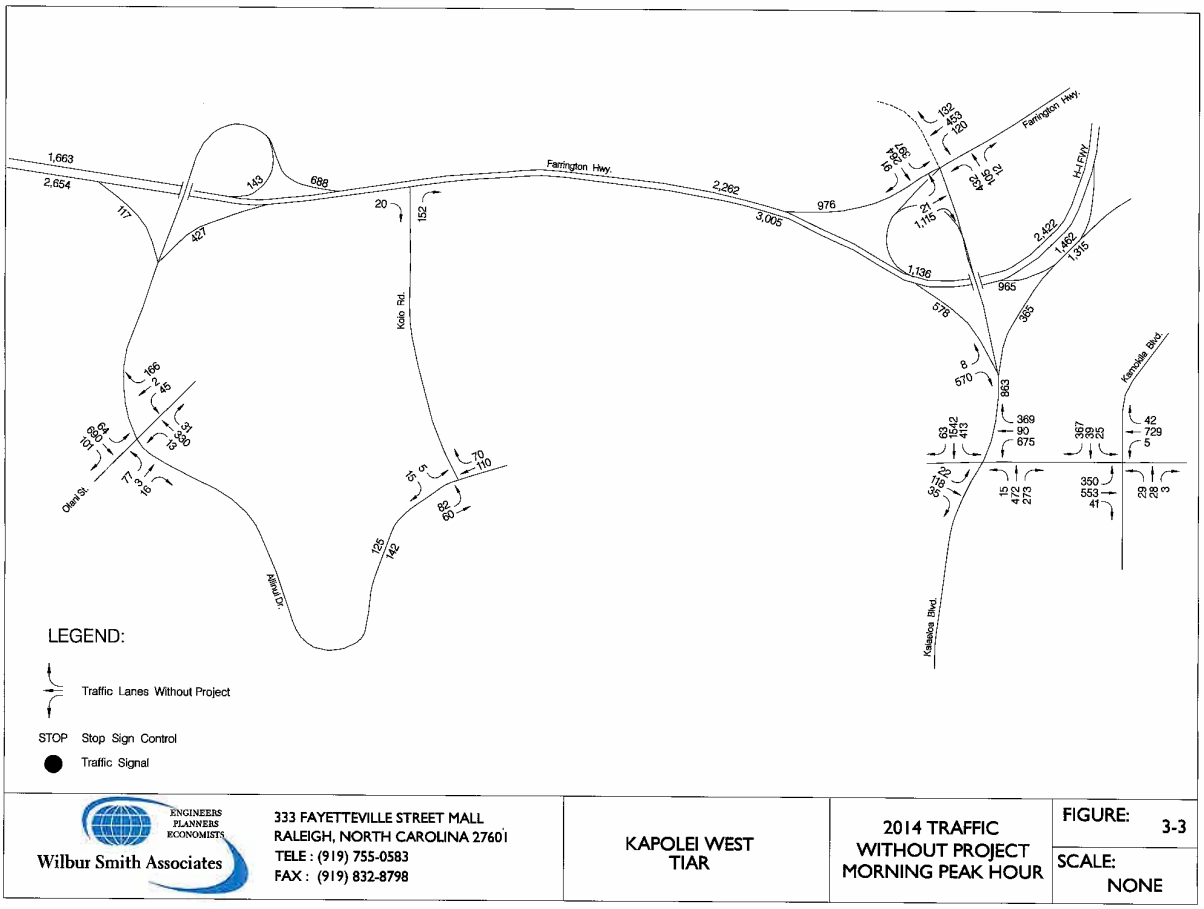
2014 Peak Hour Traffic Volumes

The origins and destinations of the additional vehicle trips were based on OMPO forecast data and assigned to the roadway system. The forecast 2014 weekday traffic volumes without the Kapolei West development are depicted in Figures 3-3 and 3-4 for the morning and afternoon peak traffic hours, respectively. The forecasts are based on the section of the Kapolei Parkway between Kalaeloa Boulevard and Ko Olina not being constructed without the development of the adjacent Kapolei West project.

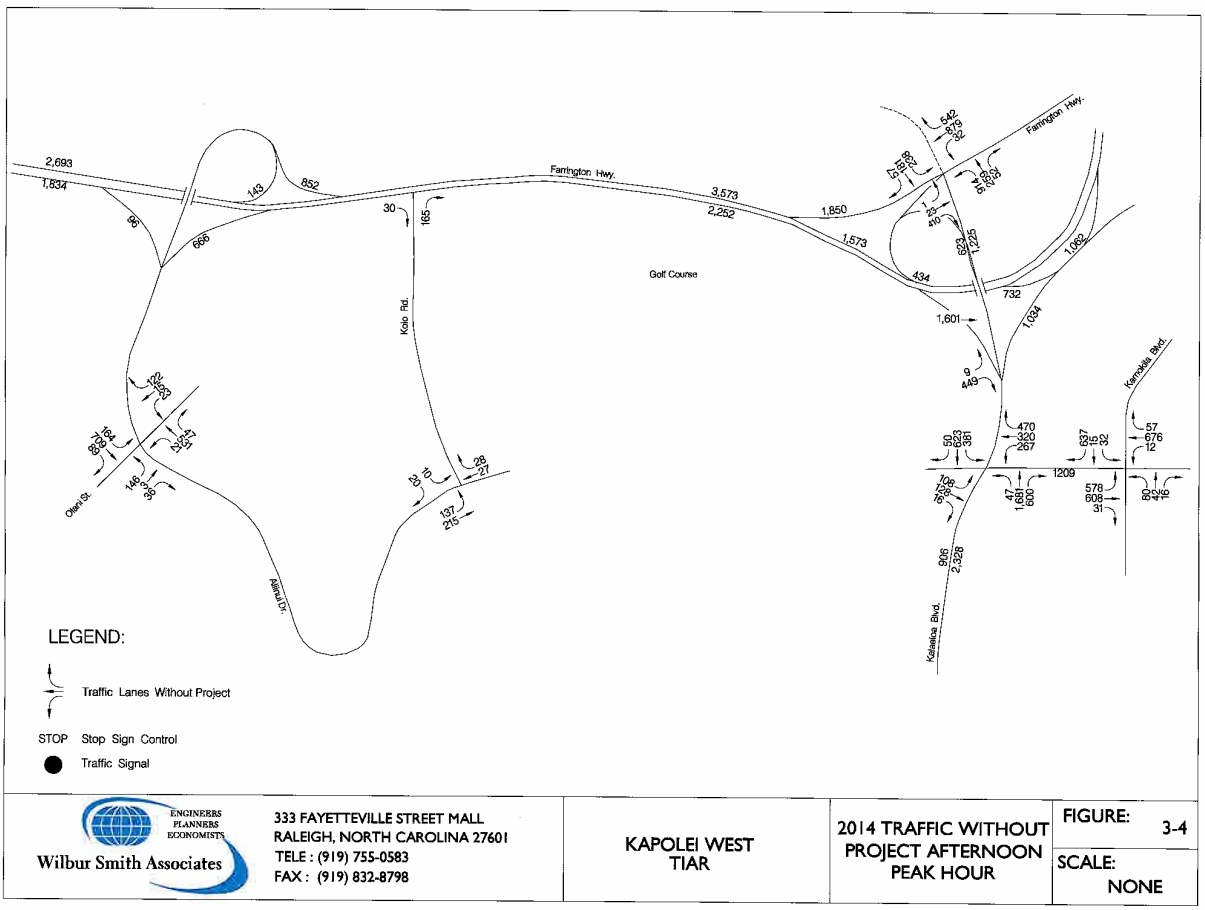
The forecast traffic volumes reflect several roadway improvements that would change the present circulation patterns. Within the City of Kapolei, the connection of Kapolei Parkway between Fort Barrette Road and Kamokila Boulevard will divert east-west traffic that would otherwise travel through this corridor using Farrington Highway/Kamokila Boulevard between Fort Barrette Road and Kalaeloa Boulevard. The planned Kapolei Interchange will divert some traffic that currently uses the Palailai Interchange and Kalaeloa Boulevard to access the City of Kapolei. However, the westward extension of the Kapolei Parkway to Kalaeloa Boulevard will also allow traffic from the Fort Barrette corridor to access Waianae-bound Farrington Highway via Kalaeloa Boulevard.

The net result of the area growth and the roadway changes is projected to increase traffic volumes along the section of Kalaeloa Boulevard between the H-1 Freeway and the Kapolei Parkway by about 85% and 71% in the morning and afternoon peak hours, respectively, as compared to the 2003 traffic volumes. The total volume of traffic passing through the Kalaeloa Boulevard intersection with the Kapolei Parkway is projected to double over the 2003 volumes in both the morning and afternoon peak hours.

[6] *Trip Generation Handbook, An ITE Proposed Recommended Practice*, Institute of Transportation Engineers, October 1998.



Wilbur Smith Associates ENGINEERS PLANNERS ECONOMISTS 333 FAYETTEVILLE STREET MALL RALEIGH, NORTH CAROLINA 27601 TELE : (919) 755-0583 FAX : (919) 832-8798	KAPOLEI WEST TIAR	2014 TRAFFIC WITHOUT PROJECT MORNING PEAK HOUR	FIGURE: 3-3 SCALE: NONE



Wilbur Smith Associates ENGINEERS PLANNERS ECONOMISTS 333 FAYETTEVILLE STREET MALL RALEIGH, NORTH CAROLINA 27601 TELE : (919) 755-0583 FAX : (919) 832-8798	KAPOLEI WEST TIAR	2014 TRAFFIC WITHOUT PROJECT AFTERNOON PEAK HOUR	FIGURE: 3-4 SCALE: NONE

The left-turn movement from Kalaeloa Boulevard to the Waianae-bound on-ramp to the H-1 Freeway/Farrington Highway is also expected to increase substantially over existing volumes as a result of the completion of the Kapolei Parkway to Kalaeloa Boulevard, coupled with area growth.

2014 Peak Hour Traffic Conditions

Traffic conditions for the year 2014 weekday traffic peak hours without the Kapolei West Project traffic are summarized for the key intersections in Table 3-1. Traffic conditions are given only for those key intersections that would be most directly affected by the Kapolei West development traffic.

Kalaeloa Boulevard-Kapolei Parkway – The forecast 2014 traffic would exceed capacity of this intersection in the morning peak hour by 11% with average vehicle delay at LOS F. In the afternoon peak hour, the forecast traffic would approximate 96% of capacity, with overall intersection delays at LOS E. The potential problem in both peak hours would result from the high volumes of Ewa-bound traffic on turning left and right from westbound Kapolei Parkway.

Table 3-1
2014 TRAFFIC CONDITIONS AT KEY INTERSECTIONS
WITHOUT KAPOLEI WEST

Intersections	Weekday Morning Peak Hour			Weekday Afternoon Peak Hour		
	V/C	ADPV	LOS	V/C	ADPV	LOS
Kalaeloa Blvd.-Farrington Hwy	0.77	43.0	D	1.23	150.3	F
Kalaeloa Blvd.-Kapolei Pkwy.	1.11	86.3	F	0.96	60.8	E
Kapolei Pkwy.-Kamokila Blvd.	0.53	25.1	C	0.75	30.0	C
Aliinui Dr.-Koio Dr.						
Makai-bound Left Turn	0.01	10.9	B	0.02	12.3	B
Aliinui Dr.-Olani St.						
Mauka-bound Left Turn	0.46	38.7	E	1.46	318.3	F
Makai-bound Left Turn	0.18	19.9	C	0.27	36.9	E

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.

Wilbur Smith Associates; November 17, 2004.

The intersection could be improved by the construction of a second (double) left-turn lane and a right-turn lane to accommodate the high volumes of vehicles turning left from westbound Kapolei Parkway. The intersection would provide acceptable conditions with these lanes

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.91	53.4	D
Afternoon	0.86	44/6	D

Farrington Highway-Kalaeloa Boulevard – The proposed Makaiwa Hills development would add a mauka leg to this intersection, which the developer plans to use as its only access through 2015. The combination of the additional intersection leg and the Makaiwa Hills traffic with the high volume of traffic turning left from the present makai leg of Kalaeloa Boulevard onto the westbound on-ramp would result in traffic volumes that exceed the intersection capacity by an estimated 23% in the afternoon peak hour.

Neither the construction of either a second (double) left-turn lane on the mauka-bound approach of Kalaeloa Boulevard, nor the provision of a second westbound through lane on Farrington Highway, would individually improve intersection conditions to acceptable levels with the forecast afternoon peak hour traffic. The combination of both the northbound second left-turn lane and the two westbound through lanes on Farrington Highway would be needed to provide acceptable conditions for 2014 traffic without the Project:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.49	37.6	D
Afternoon	0.70	35.8	D

Aliinui Drive-Olani Street – With the continuation of the present STOP sign control, the forecast 2014 afternoon peak hour traffic would result in very long delays for vehicles turning left from the mauka-bound approach of Olani Street. The very long delays for vehicles turning left onto Aliinui Drive in the afternoon peak hour could be addressed by the installation of a traffic signal. The City DTS and State DOT will not approve a traffic signal for a location unless it satisfies one or more "warrants" for installation of a traffic signal.

These "warrants" have been developed and adopted by highway officials to govern consideration of a traffic signal at a new location.[7] If a location does not satisfy one or more of the warrants, a traffic signal is not appropriate; if it satisfies one or more warrants, a traffic signal *may be considered* as a potential action to improve operations or safety.

[7] *Manual on Uniform Traffic Control Devices, Millennium Edition*, U. S. Department of Transportation, Federal Highway Administration, December 2000.

The forecast 2014 afternoon peak hour conditions at the Olani Street intersection with Aliinui Drive were assessed to determine if these conditions satisfied either category A or B of Warrant 3, Peak Hour conditions, since it applies to forecast conditions:

- **Warrant 3 Category A**

  All three conditions of this criteria must be satisfied by the same one-hour period: 1) the vehicles on one minor street approach must experience total delay of at least four vehicle hours for a single-lane approach and five vehicle hours for a two-lane approach; 2) the peak hour volume on the minor street approach must equal or exceed 100 vehicles for an approach with one moving lane and 150 vehicles with two moving lanes; and 3) the total number of vehicles entering the intersection in the peak hour must exceed 650 for an intersection with three approaches or 800 for four approaches. The mauka-bound Olani Street approach is striped to provide separate left/through- and right-turn lanes, therefore the requirements and forecast values for the afternoon peak hour period are as follows:

Peak Hour Criteria	Minimum Requirement	Forecast Amount	Satisfy Requirement
Minor Street Delay	5 hours	13.3hours	Yes
Minor Street Volume	150 vehicles	185 vehicles	Yes
Total Intersection Volume	800 vehicles	1,906 vehicles	Yes

  The forecast intersection conditions in 2014 would satisfy the requirements to permit installation of a traffic signal at this location.

- **Warrant 3 Category B**

  For the number of lanes at this intersection and the afternoon peak hour volumes along Aliinui Drive, this warrant would require a minimum of 150 vehicles exiting one of the two driveways in the peak hour.

  Olani Street, with a forecast 185 vehicles in the afternoon peak hour, has more than the minimum volume requirement and satisfies this part of the warrant.

Based on the forecast volumes and conditions in the afternoon peak hour, a traffic signal may be appropriate at this intersection in year 2014. With the installation of a traffic signal, the existing lanes would accommodate the forecast 2014 traffic at acceptable levels as summarized below:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.42	16.7	B
Afternoon	0.59	20.8	C

H-1 Freeway – The planned development between 2003 and 2014 is estimated to increase the total two-way peak hour traffic on the H-1 Freeway east of the Makakilo Interchange by about 38% in the morning peak hour and 44% in the afternoon peak hour. As summarized in Table 3-2, the planned development is also projected to result in a substantial shift in travel direction. At present, about 55% of the traffic in each peak hour travels in the peak direction – Honolulu-bound in the morning and Waianae-bound in the afternoon. The planned new development would result in more-Kapolei-bound trips in the morning and Honolulu-bound trips in the afternoon, with the change resulting in a nearly even split in travel direction on the H-1 Freeway in each peak hour.

With the changes in directional flow, the peak hour traffic conditions are estimated at LOS C in both travel directions on the H-1 Freeway east of the Makakilo Interchange, with the estimated average travel speeds (62 mph) very near free-flow speeds. Traffic volumes would be at 65% or less of the estimated freeway capacity.

2020 TRAFFIC CONDITIONS

The weekday peak hour traffic volumes were forecast for 2020 without the Kapolei West development based on the new developments and roadways described in the preceding sections. The peak hour traffic conditions were analyzed for the key locations that would be affected by traffic traveling to/from the Kapolei West Project, which is planned for full development by 2020.

Table 3-2
2014 H-1 FREEWAY CONDITIONS
WITHOUT KAPOLEI WEST PROJECT

Peak Hour	Direction	Volumes	Lanes	Density (vphpl)	Speed (mph)	Level of Service
Location: East of Makakilo Interchange						
Morning	Eastbound	4,251	3	23.5	62.0	C
	Westbound	4,119	3	23.5	62.0	C
Afternoon	Eastbound	4,425	3	25.0	62.0	C
	Westbound	4,561	3	25.5	62.0	C

vphpl = vehicles per hour per lane
mph = miles per hour

Wilbur Smith Associates; November 23, 2004.

Trip Generation

As described for 2014, the numbers of vehicle trips generated by the new development within and near the City of Kapolei were based on standard trip rates compiled by the Institute of Transportation Engineers (ITE).[8] The vehicle trip generation rates and estimated vehicle trips for the various areas and types of developments are presented for 2020 in Appendix B.

Most of the City of Kapolei is expected to be developed by 2014 and, therefore, the 2020 trip generation indicates little increase in vehicles trips from the 2014 forecasts. The additional development during 2015-2020 is estimated to generate a total of approximately 800 and 900 vehicle trips in the morning and afternoon peak hours, respectively.

Additional trips are also forecast to/from the existing development within the City of Kapolei as a result of the growth in residential and commercial uses near the City of Kapolei. Approximately 2,800 and 3,800 new vehicle trips are expected to be generated in the morning and afternoon peak hours, respectively, by the new development near the City of Kapolei during the 2015-2020 period.

2020 Peak Hour Traffic Volumes

The forecast 2020 weekday traffic volumes without the Kapolei West project are depicted in Figures 3-5 and 3-6 for the morning and afternoon peak traffic hours, respectively. The projected traffic volumes reflect several additional roadway projects that will significantly affect circulation patterns and traffic volumes in the City of Kapolei:

1. Extension of the Kapolei Parkway westward to connect to Aliinui Drive;

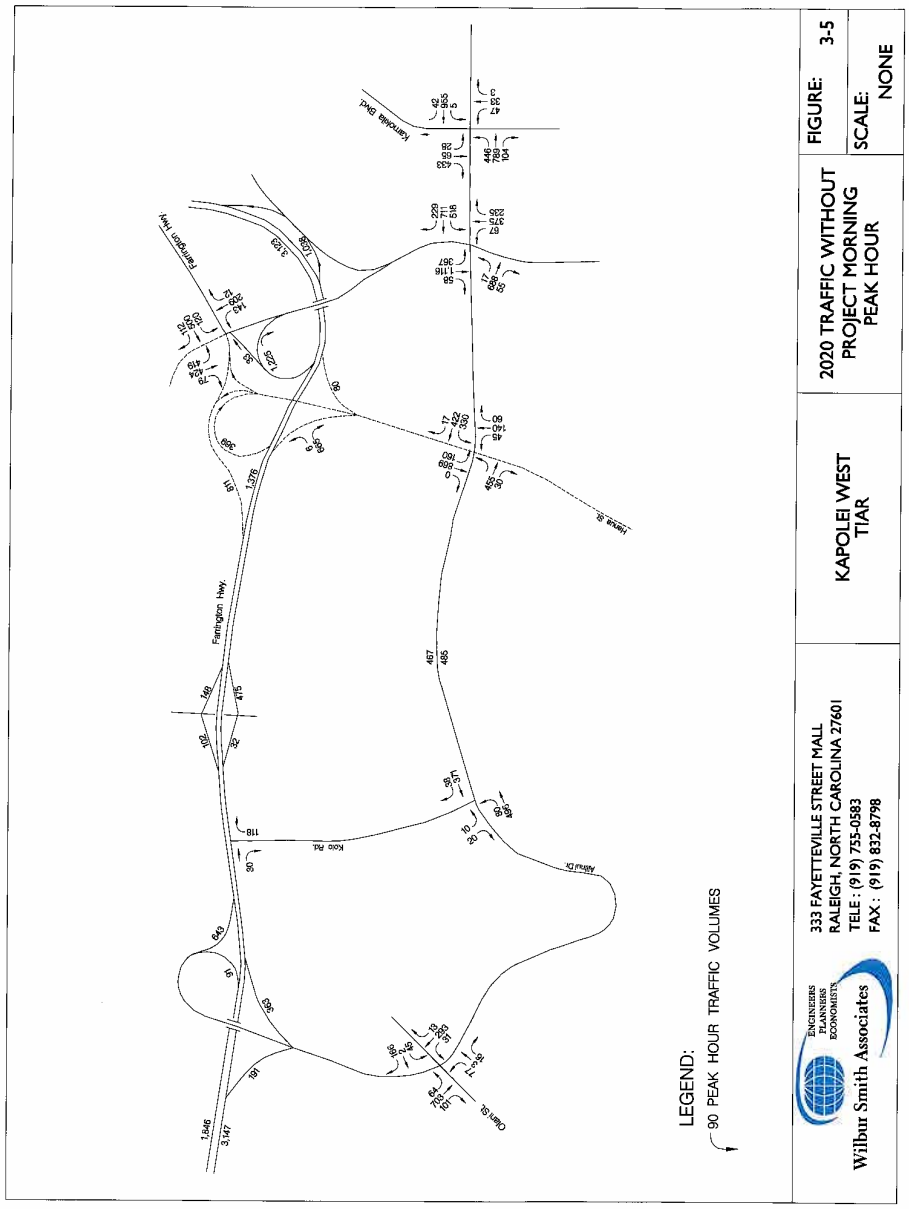
2. Construction of the Makaiwa Hills Interchange, which will divert substantial Makaiwa Hills traffic away from use of the existing Palailai Intersection: and

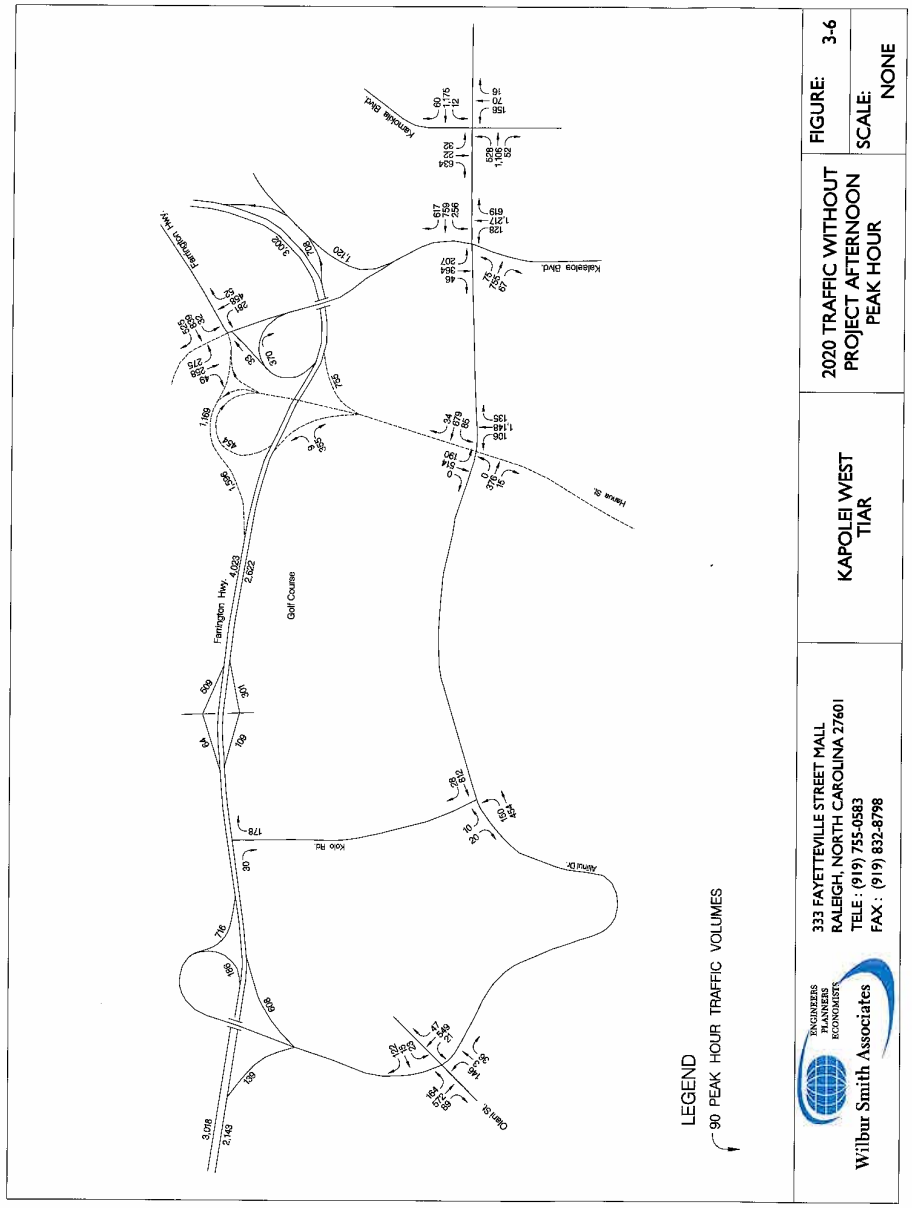
3. Extension of Hanua Street mauka to provide access to the H-1 Freeway at a reconstructed Palailai Interchange, which will divert substantial traffic that would otherwise use Kalaeloa Boulevard.

An estimated 950 and 1,200 vehicles would use the Kapolei Parkway for travel between Ko Olina and the Kalaeloa Boulevard corridor in the morning and afternoon peak hour, respectively. This connection would divert about 15% to 20% of peak hour traffic from the parallel sections of Farrington Highway.

The Makaiwa Hills Interchange would attract use by an estimated 800 and 1,000 vehicles in the 2020 morning and afternoon peak hours, respectively, all of which would otherwise have used the Palailai Interchange.

[8] *Trip Generation, Sixth Edition*, Institute of Transportation Engineers, 1997.





The Hanua Street Extension is estimated to attract about 1,200 through trips to/from the Campbell Industrial Park, Barbers Point Harbor, and Kapolei Business Park areas in the morning peak hour, and about 1,800 trips in the afternoon peak hour. This would reduce the forecast traffic along Kalaeloa Boulevard by about 30% to 40% from the traffic volumes if the Hanua Street extension were not in place.

The section of Kalaeloa Boulevard between the Kapolei Parkway and the Palailai Interchange would attract peak hour volumes of 2,800 and 2,500 vehicles in the morning and afternoon peak hours, respectively.

2020 Peak Hour Traffic Conditions

Traffic conditions for the year 2020 weekday morning and afternoon peak hours without the traffic generated by Kapolei West are summarized for the key intersections in Table 3-3. Traffic conditions are presented for those key intersections that would be most directly affected by the Kapolei West project.

Hanua Street Extension-Kapolei Parkway – The initial intersection analyses were based on the provision of two through lanes and a left-turn lane on each of the four approaches to the intersection. The traffic forecasts for the morning peak hour approximate 85% of intersection capacity, while the afternoon peak hour traffic would amount to 95% of the intersection capacity. The average vehicle delay in both peak hours would be at LOS D.

The high level of capacity use in the afternoon peak hour could be improved by the provision of a right-turn lane on mauka-bound Hanua Street at the intersection, which would result in the afternoon peak hour traffic amounting to 89% of the increased intersection capacity. Also, the very high volume of left turns from the Waianae-bound Kapolei Parkway approach onto makai-bound Hanua Street is estimated at 330 vehicles, which exceeds levels (250 to 300 left turns per hour) that typically warrant double left-turn lanes to provide efficient intersection operations. Thus, the intersection should have the following lanes to serve the 2020 traffic volumes without the Kapolei West Project:

- Two through lanes on each approach
- Double left-turn lanes on the Waianae-bound approach and single left-turn lanes on the other approaches
- A separate right-turn lane on the mauka-bound approach.

With these lanes, the intersection conditions with the 2020 traffic without the Project would:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.73	46.4	D
Afternoon	0.86	44.2	D

Table 3-3
2020 TRAFFIC CONDITIONS AT KEY INTERSECTIONS
WITHOUT KAPOLEI WEST PROJECT

Intersections	Weekday Morning Peak Hour			Weekday Afternoon Peak Hour		
	V/C	ADPV	LOS	V/C	ADPV	LOS
Kalaeloa Blvd.-Farrington Hwy	0.74	43.8	D	1.04	67.4	E
Kapolei Pkwy.-Kamokila Blvd.	0.72	32.4	C	1.01	80.2	F
Kapolei Pkwy.-Kalaeloa Blvd.	0.90	53.2	D	0.91	48.6	D
Kapolei Pkwy.-Hanua St. Ext.	0.89	70.6	E	1.04	88.2	F
Aliinui Dr.-Koio Dr.						
Makai-bound Left Turn	0.03	14.5	B	0.05	23.1	C
Aliinui Dr.-Olani St.						
Mauka-bound Left Turn	0.46	38.7	E	1.24	220.5	F
Makai-bound Left Turn	0.17	19.6	C	0.24	32.8	D

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.

Wilbur Smith Associates; November 22, 2004.

Kalaeloa Boulevard-Kapolei Parkway – The analyses of the 2020 conditions without the Kapolei West Project were made with the lanes proposed for the 2014 scenario without the Project. In addition to the widening of Kalaeloa Boulevard to provide three through lanes in each direction, the proposed improvements included the following auxiliary lanes at the intersection:

- Double left-turn lanes on the Waianae-bound approach of Kapolei Parkway
- Double left-turn lanes on the makai-bound approach of Kalaeloa Boulevard
- Right-turn lane on the mauka-bound approach of Kalaeloa Boulevard
- Right-turn lane on the Waianae-bound approach of Kapolei Parkway.

With these lanes, the forecast 2020 traffic would approximate 90-91% of the intersection capacity in both the morning and afternoon peak hours, with average delays at LOS D. These

conditions approximate those projected in 2014 without the Kapolei West Project. The Hanua Street Extension is estimated to divert sufficient traffic from Kalaeloa Boulevard to offset the increases of traffic along the Kapolei Parkway.

Kapolei Parkway-Kamokila Boulevard – The increase in through traffic along the Kapolei Parkway would result in conditions approximating the intersection capacity in the afternoon peak hour with long delays for traffic traveling through the intersection (LOS F). The intersection could be improved to acceptable conditions with the provision of a second (double) right-turn lane on the makai-bound approach of Kamokila Boulevard to accommodate the high volume of turns forecast for this approach. This would improve the conditions to the following:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.72	29.2	C
Afternoon	0.93	44.8	D

Kalaeloa Boulevard-Farrington Highway – The extension of the Kapolei Parkway westward to connect to Aliinui Drive and provide a second through route paralleling Farrington Highway between Kapolei and Ko Olina would reduce the traffic through this intersection. However, the conflicting high volumes of the westbound through traffic on Farrington Highway and the left-turn from northbound Kalaeloa Boulevard, combined with the addition of the mauka leg (access to Makaiwa Hills) to this intersection, would exceed the intersection capacity by about 4% in the afternoon peak hour, with average overall vehicle delay at LOS E.

The deficiency could be addressed by adding a second through lane on westbound Farrington Highway onto the H-1 Freeway On-Ramp, adding a second left-turn lane on mauka-bound Kalaeloa Highway, or adding a second through lane on the new mauka leg of the Kalaeloa Boulevard, or a combination of these. The most effective modification would be the widening of the westbound approach of Farrington Highway and the On-Ramp to accommodate a second westbound through lane, which would improve conditions as follows:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.59	37.6	D
Afternoon	0.79	40.5	D

Aliinui Drive-Olani Street – The intersection was initially analyzed with the continuation of the present STOP sign control. The forecast 2020 afternoon peak hour traffic would result in very long delays (LOS F) for vehicles turning left from the mauka-bound approach of Olani Street as well as long delays (LOS E) for these left turns in the morning peak hour.

As discussed for the 2014 conditions, the very long delays for vehicles turning left onto Aliinui Drive in the afternoon peak hour could be addressed by the installation of a traffic signal. The

forecast 2020 afternoon peak hour conditions were assessed to determine if these conditions satisfied either category A or B of Warrant 3, Peak Hour conditions, to allow consideration of a traffic signal at this location.

- **Warrant 3 Category A**

  All three conditions of these criteria must be satisfied by the same one-hour period. The requirements and forecast values for the afternoon peak hour period are as follows:

Peak Hour Criteria	Minimum Requirement	Forecast Amount	Satisfy Requirement
Minor Street Delay	5 hours	9.2 hours	Yes
Minor Street Volume	150 vehicles	185 vehicles	Yes
Total Intersection Volume	800 vehicles	1,787 vehicles	Yes

  The forecast intersection conditions in 2020 would satisfy the requirements to permit installation of a traffic signal at this location.

- **Warrant 3 Category B**

  For the number of lanes at this intersection and the afternoon peak hour volumes along Aliinui Drive, this warrant would require a minimum of 150 vehicles exiting one of the two driveways in the peak hour.

  Olani Street, with a forecast 185 vehicles in the afternoon peak hour, has more than the minimum volume requirement and satisfies this part of the warrant.

Based on the forecast volumes and conditions in the afternoon peak hour, a traffic signal may be appropriate at this intersection in year 2020. With the installation of a traffic signal, the forecast 2020 traffic would result in very acceptable traffic conditions with the existing lanes as summarized below.

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.42	16.9	C
Afternoon	0.54	20.8	C

H-1 Freeway – The traffic volumes on the H-1 Freeway east of the Makakilo Interchange are estimated to increase by about 60% over 2003 morning peak hour volumes and 73% over afternoon peak hour volumes. As indicated for 2014, the planned land uses would result in larger increases in morning travel towards Kapolei and afternoon travel away from the Kapolei

area, with the shift sufficient to result in a nearly even split of traffic in each travel direction in the 2020 peak commute hours.

The traffic increases projected for 2020 would result in LOS D travel conditions, versus LOS C estimated for the 2014 traffic volumes. The projected traffic volumes would amount to 77% or less of freeway capacity. The 2020 traffic volumes would constrain lane-changing and result in average speeds of about 3 to 4 mph below free-flow speeds.

Table 3-4
2020 H-1 FREEWAY CONDITIONS
WITHOUT KAPOLEI WEST PROJECT

Peak Hour	Direction	Volumes	Lanes	Density (vphpl)	Speed (mph)	Level of Service
Location: East of Makakilo Interchange						
Morning	Eastbound	4,842	3	26.9	61.9	D
	Westbound	4,854	3	27.8	61.8	D
Afternoon	Eastbound	5,307	3	30.5	61.0	D
	Westbound	5,453	3	31.2	60.7	D

vphpl = vehicles per hour per lane
mph = miles per hour

Wilbur Smith Associates; November 23, 2004.

Chapter 4
2014 WITH THE URBANIZED AREA LAND USES

Aina Nui Corporation, an affiliated company of the Estate of James Campbell, is seeking to zone the urban area lands along the future extension of the Kapolei Parkway west of the City of Kapolei. The approximately 372.6 acres that have already received State LUC approval for urban development, but have not yet received City zoning approval, are referred to herein as the Project Urbanized Area lands. The locations of these parcels are depicted in Figure 1-1.

DESCRIPTION OF THE PROJECT

The Urbanized Area development area extends along the mauka side of the future Kapolei Parkway alignment from the new Gannett Advertiser facility to Koio Drive. The Urbanized Area also includes two parcels along the makai side of the future Kapolei Parkway, with Parcel L located between the Advertiser facility and the future alignment of the Hanua Street Extension, and Parcel B located west of the Hanua Street Extension. Initial development of this area is expected to occur in 2008. At the projected development rate of 183 residential units per year, the entire Urbanized Area could be fully developed and occupied by yearend 2014.

A 23-acre regional commercial center is planned for the easternmost parcel on the mauka side of the Kapolei Parkway. The commercial center is estimated to contain approximately 255,000 square feet of building floor area, which may include a mix of retail uses, offices, and service establishments. Access would be provided to the Kapolei Parkway.

Parcel L, located makai of the Kapolei Parkway across from the regional commercial center, is planned as a mixed-use development with a transit center. The transit center is expected to provide bus loading platform and bus bays. The initial plans envision a commercial area with about 100,000 square feet of building floor area, with a mix of retail, service, and office uses. An estimated 150 apartment or condominium units would be located on the site. Access would be provided to the Kapolei Parkway via an intersection shared with the Regional Center.

Parcels A, B, C, D, I, and J are planned for development with low- to medium-density residential units, ranging from two-story cluster-type housing units to three- to five-story multi-family units. The units are expected to be primarily marketed for year-round residents although some units are expected to be purchased by part-time residents. The number and type of housing units are listed by parcel in Table 4-1, which includes an initial market study's estimate of the split between full-time and part-time residences.

Table 4-1
PLANNED RESIDENTIAL UNITS FOR 2014 URBANIZED AREA SCENARIO

Parcel	Type of Units	Units per Acre	Units by Type of Residents		
			Full-Time	Part-Time	Total
A	Cluster Single-Family	8	162	28	190
B	Multi-family 2-3 floors	10	208	37	245
C	Cluster Single-Family	8	112	38	150
D	Cluster Single-Family	8.7	263	47	310
I	Cluster Single-Family	7	63	77	140
J	Cluster Single-Family	7	31	37	68
L	Multi-family 3+ floors	15	135	15	150
	Totals		974	279	1,253

Wilbur Smith Associates; November 12, 2004

The preliminary market analysis indicates that the annual absorption rate would result in a demand for 497 units by part-time residents through 2014 and 784 by full-time residents. The projected split of full-time/part-time units among the parcels included in the more eastern parcels within the area with State LUC approval would result in fewer units likely to be sold to part-time residents (279) than the projected absorption rate.

Parcel B is planned to include a middle school with an anticipated enrollment of 600 students. It is assumed that the access to the Middle School would be provided via the Parcel B access roadway.

Parcel D is planned to include a two-acre neighborhood commercial development to serve the surrounding residential areas. The center would include about 21,800 square feet of building floor area. Access would be provided from planned Road D.

An 18-hole golf course with clubhouse and driving range would also be included within the Urbanized Area. Road H would provide access to the golf course facilities as well as to the Parcel C residential area.

The Kapolei Parkway is expected to be completed through the Project area and connected to Aliinui Drive by 2014. Ultimately, the Parkway would be extended as a four-lane roadway with landscaped median and turn lanes at key intersections. The key access connections/intersections with the Kapolei Parkway would include:

Regional Commercial Center-Parcel L Driveways, which would connect via a common intersection with the Kapolei Parkway

Parcel A-Parcel B Access Roadways, with this intersection also being used for access to the Middle School

Road H access to the golf course and Parcel C

Road D which provides access to the Parcels D, I, and J residential areas, and to the neighborhood commercial parcel.

All of the above intersections are assumed to have the approaches to Kapolei Parkway controlled by STOP signs. All are proposed to provide separate through/left-turn lanes and right-turn lanes on the side-street approaches to the Kapolei Parkway.

Road D may be extended mauka to connect to the planned Makaiwa Hills Interchange when that facility is constructed in the future. Since the timing of the Makaiwa Hills facility is uncertain, the Road D connection has not been incorporated into the assessment of the Kapolei West traffic impacts. The connection of Road D to the Makaiwa Hills Interchange would be expected to attract use of Road D by many of those Kapolei West and Ko Olina vehicles that would otherwise use Koio Drive, Aliinui Drive, Hanua Street Extension, or Kalaeloa Boulevard to access Farrington Highway/H-1 Freeway. This diversion of Kapolei West and Ko Olina trips to the Road D connection would reduce the numbers of vehicles using the parallel sections of Kalaeloa Boulevard, Hanua Street, Koio Drive, and Aliinui Drive from those presented in the Kapolei West traffic assessment.

As an interim measure, Road D could be connected to Farrington Highway without construction of the Makaiwa Hills Interchange. This right-turn in/out connection would primarily divert traffic from the Koio Drive connection to Farrington Highway and, to a lesser extent, from the Hanua Street Extension connection. This connection was not included in order to provide a conservative assessment of the Project impacts.

PROJECT TRIP GENERATION

The numbers of vehicle trips generated by the Project were based on standard trip rates compiled by the Institute of Transportation Engineers (ITE).[1] The trip rates for a Shopping Center (ITE Land Use Category #820) were used for the commercial development in the Regional Commercial Center. The trip rates for Specialty Retail Center (ITE Land Use Category #814) were used for the commercial developments in the Parcel L mixed-used development and the Neighborhood Commercial Center. Since the ITE *Trip Generation* does not provide trip generation rates for the Specialty Retail Center use in the morning peak hour, the morning trip rates were estimated by WSA using the relationship between the morning and afternoon trip rates for Shopping Centers (ITE Land Use Category #820). The trip rates and estimated numbers of

[1] *Trip Generation, Sixth Edition*, Institute of Transportation Engineers, 1997.

vehicle trips are summarized in Appendix B, with the trip generation presented for each sub-area and use.

The numbers of vehicle trips entering or exiting a commercial development include both new vehicle trips and additional stops by vehicles that would be traveling through the area whether or not the Project is developed. These additional stops by traffic passing the site to use the retail and services uses are referred to as "pass-by trips." The ITE *Trip Generation Handbook*[2] provides a methodology and equation for estimating the proportion of the Project vehicle trip ends that are pass-by trips. For the Regional Commercial Center, approximately 30% of the vehicle trips would be pass-by trips, with the balance as new trips added to the roadway network. The pass-by trips would comprise 40% of the total trips estimated for the Mixed-Use commercial area and 70% of the total trips for the Neighborhood Commercial Center.

The vehicle trips for the Middle School were based on the ITE trip rates for this category (#522). About 25% of the students are estimated to come from the Project residential parcels. Therefore, 25% were treated as pass-by trips reflected in the trip generation for the residential uses and 75% as new trips added to the area roadways.

The residential trips generated by the full-time occupants were based on rates for either single-family homes (#210) or medium density housing (#230 townhouses/condominiums). The trip estimates for the part-time residences were based on the rate for recreational homes (#260).

Based on these trip rates, the Kapolei West Project development for the 2014 Urbanized Area Scenario is estimated to generate a total of 1,342 vehicle trips to or from the Project land uses in the morning peak hour and 2,013 vehicle trips in the afternoon peak hour, as summarized in Table 4-2. In the afternoon peak hour, 2,404 of these would be additional trips added to the area roadway system and 431 would be pass-by trips.

Note that the forecast trips reflect the split of full-time/part-time residents as projected for the individual parcels. The preliminary market study indicated that the market demand from 2008 through 2014 would be for 497 part-time resident units, versus the 279 units reflected in the forecasts of vehicle trips. Since the average trip rates for full-time residents is substantially higher than those for part-time residents, the sales of more than 279 of the units to part-time residents would likely reduce the number of vehicle trips generated by the Urbanized Area scenario. If a total of 497 units were to be sold to part-time units, this could reduce the total number of trips generated by the Project by about 75 and 115 trips in the morning and afternoon peak hours, respectively.

[2] *Trip Generation Handbook, An ITE Proposed Recommended Practice*, Institute of Transportation Engineers, October 1998.

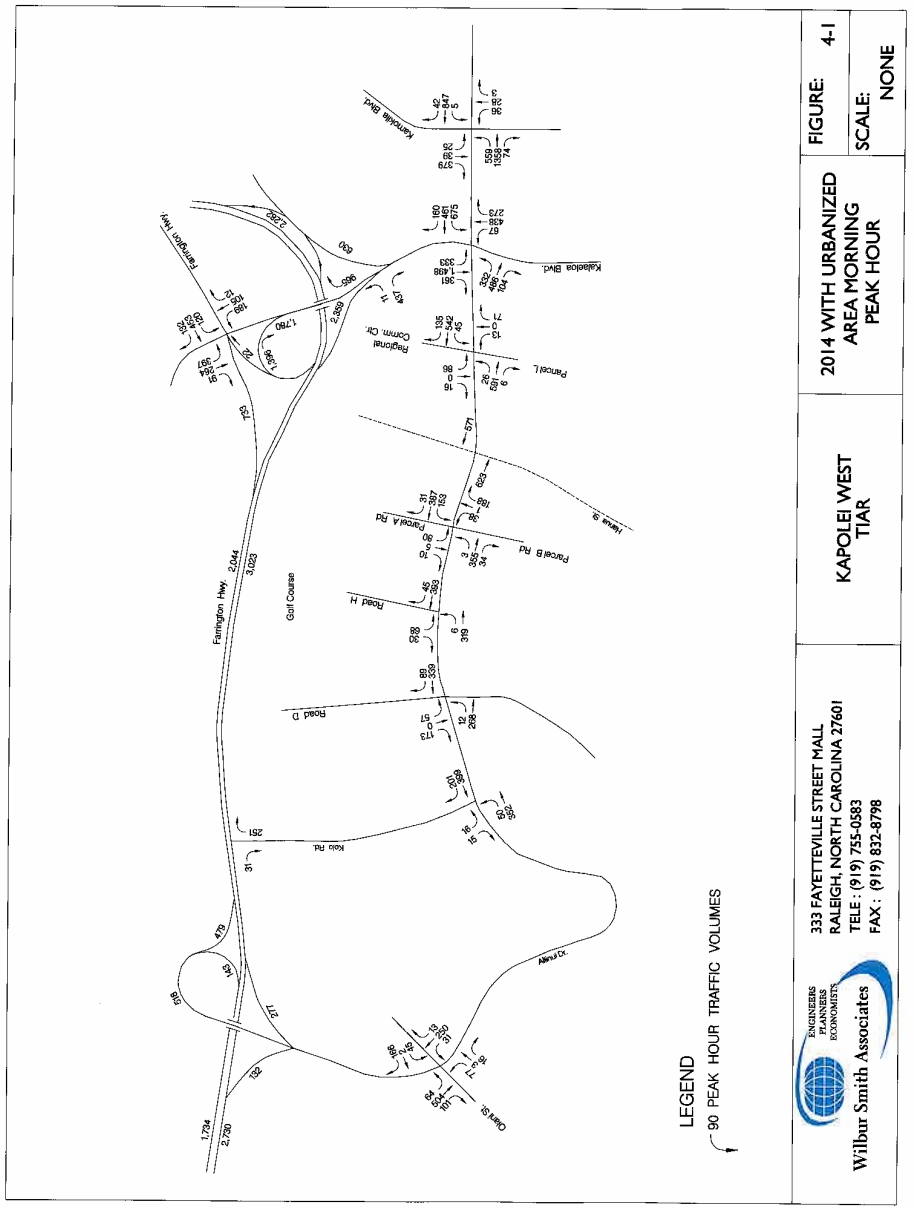
Table 4-2
VEHICLE TRIP GENERATION
FOR 2014 URBANIZED AREA SCENARIO

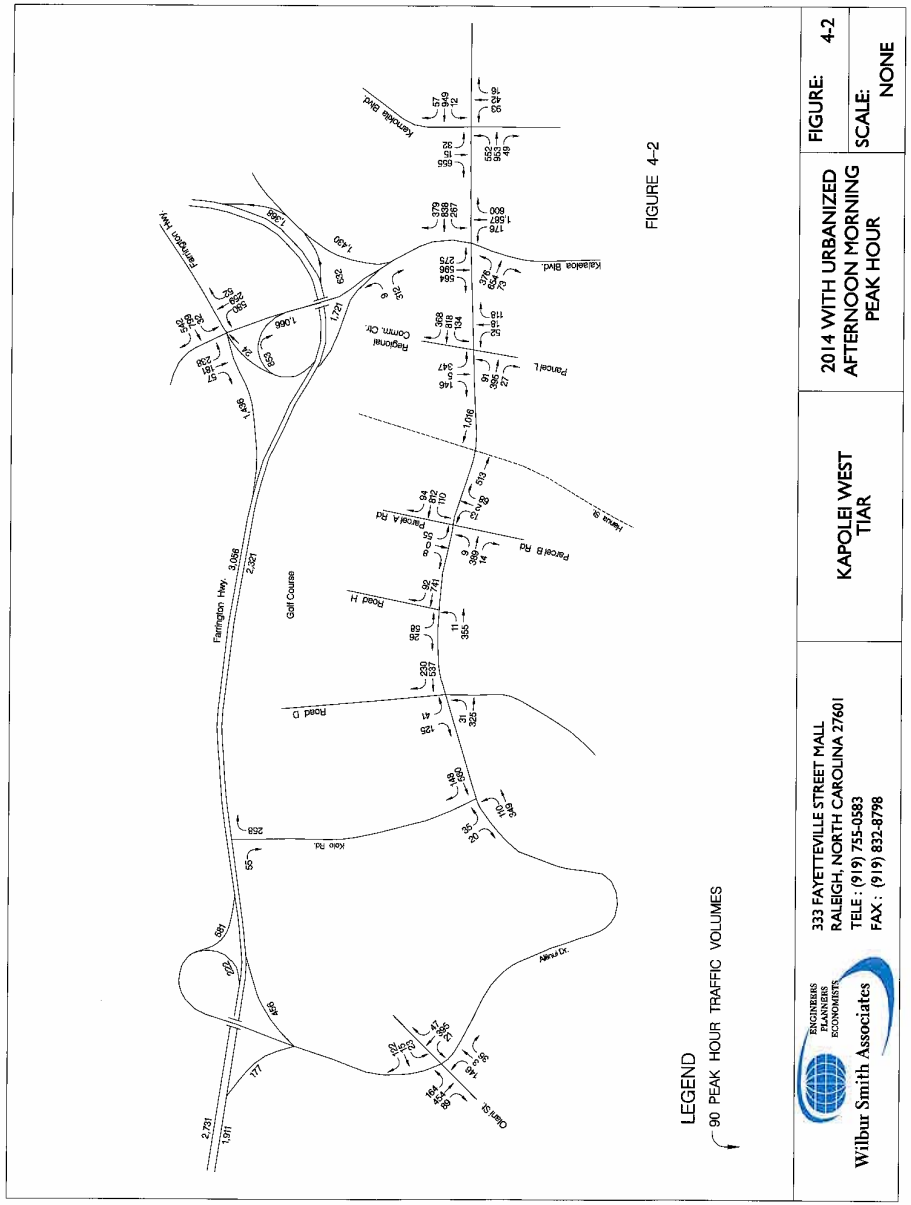
Item	Morning Peak Hour			Afternoon Peak Hour		
	Total	Enter	Exit	Total	Enter	Exit
Weekday Vehicle Trip Rates						
Shopping Center per 1,000 sq. ft. of Floor Area	1.03	0.63	0.40	3.75	1.80	1.95
Specialty Retail per 1,000 sq. ft. of Floor Area	0.71	0.43	0.28	2.59	1.11	1.48
Golf Course (per hole)	3.01	1.41	1.60	3.56	1.53	2.03
Middle School per student	0.53	0.29	0.24	0.15	0.07	0.08
Single-Family housing units	0.75	0.19	0.56	1.01	0.65	0.36
Mid-Rise Apartments	0.30	0.09	0.21	0.23	0.23	0.16
Recreational Homes	0.30	0.15	0.15	0.31	0.14	0.17
Total Weekday Vehicle Trips by Parcel (Includes Pass-By Trips)						
Regional Commercial Center	263	161	102	956	459	497
A	131	35	95	173	109	63
B	421	195	227	213	128	85
C	96	27	69	126	78	47
D, I, and J combined	323	96	227	437	265	171
L	137	54	84	259	111	148
Golf Course	54	25	29	64	28	37
Totals	1,424	592	832	2,309	1,233	1,076
New Vehicle Trips (Without Pass-By Trips)						
Less Commercial and School Pass-by Trips	1,344	548	796	1,878	1,031	847

Wilbur Smith Associates; November 19, 2004

PEAK HOUR TRAFFIC VOLUMES

The new vehicle trips to/from the Kapolei West land uses were distributed to surrounding areas based on the percentages presented in Appendix A. The forecast traffic movements at the access points to the parcels included in the Project Urbanized Area scenario were adjusted to reflect the numbers of "pass-by trips" that would turn into and out of the Project during their trip past the site. The resultant forecast of weekday commute peak hour traffic volumes on the roadways near the Project are depicted in Figure 4-1 and 4-2 for the year 2014 morning and afternoon peak hours, respectively.





Traffic volumes near the eastern end of the new connection of the Kapolei Parkway to Aliinui Drive are estimated at about 1,850 vehicles in the morning peak hour and 2,500 in the afternoon peak hour. The traffic volumes at the Waianae end near the intersection with Road D are much lower, with about 950 and 1,050 vehicles in the morning and afternoon peak hours, respectively. The much larger increase in the afternoon peak hour results from the higher traffic volumes to/from the Project's regional commercial center in the afternoon peak hour.

Traffic volumes on Kalaeloa Boulevard between the Kapolei Parkway and the Palailai Interchange are forecast at about 3,100 vehicles in the morning peak hour, which represents a 7.5% increase over the traffic without the Kapolei West development. The afternoon peak hour volume of about 3,700 vehicles would be about 11.7% more than the forecast volumes without the Project. The increase along Kalaeloa Boulevard is limited by the diversion of some east-west trips from Farrington Highway to the extension of the Kapolei Parkway through to Ko Olina.

The completion of the Kapolei Parkway between the Kalaeloa Boulevard corridor and Ko Olina is projected to reduce the traffic volumes along Aliinui Drive near the Farrington Highway interchange, as compared to the forecast volumes without the Kapolei West Project. Many of the trips between the eastern portions of Ko Olina and the Campbell Industrial Park, Kapolei Business Park, and City of Kapolei are expected to travel via the new connection rather than use Farrington Highway.

PEAK HOUR INTERSECTION CONDITIONS

Traffic conditions for the key intersections near the Project site, with the Urbanized Area scenario traffic, are summarized for the weekday morning and afternoon commute peak hours in Table 4-3. For comparison, year 2014 conditions without the Project are presented in Table 3-1.

Kalaeloa Boulevard-Kapolei Parkway – The intersection improvements identified for the Without Project Scenario for 2014 (Chapter 3) would not accommodate the addition of the Kapolei West Project traffic. The forecast traffic volumes would exceed expanded intersection capacity by 8% and 10% in the morning and afternoon peak hours, respectively. Average vehicle delays would be at undesirable levels (LOS E or F) in both peak hours.

Further improvements would be appropriate at this intersection to mitigate the impacts of the Project traffic on 2014 peak hour traffic conditions.

Kalaeloa Boulevard-Farrington Highway – Traffic conditions at the Kalaeloa Boulevard intersection with Farrington Highway would be improved by the connection of the Kapolei Parkway to Aliinui Drive, completed in conjunction with the Project. The Kapolei Parkway connection would divert substantially more traffic from this intersection than would be added by the Kapolei West land uses. However, the traffic volumes in the afternoon peak hour would still approach the intersection capacity (97%), with average delays at LOS E.

Table 4-3
2014 TRAFFIC CONDITIONS AT KEY INTERSECTIONS
WITH KAPOLEI WEST URBANIZED AREA

Intersection	Scenario	Morning Peak Hour			Afternoon Peak Hour		
		V/C	ADPV	LOS	V/C	ADPV	LOS
Kalaeloa Blvd.- Farrington Hwy.	Existing	0.44	25.7	D	1.97	476.8	F
	No Project	0.49	37.6	D	0.70	35.8	D
	Urbanized Area	0.62	35.9	D	0.97	57.0	E
Kapolei Pkwy.- Kamokila Blvd.	Existing	0.68	21.7	C	0.59	16.9	B
	No Project	0.53	25.1	C	0.75	30.0	C
	Urbanized Area	0.59	26.4	C	0.86	33.0	C
Kapolei Pkwy.- Kalaeloa Blvd.	Existing	0.63	34,6	C	0.73	28.8	C
	No Project	0.91	53.4	D	0.86	44.6	D
	Urbanized Area	1.08	100.2	F	1.10	73.4	E
	With Mitigation	0.87	49.6	D	0.92	47.5	D
Kapolei Pkwy.- Commercial Dwy.	Urbanized Area	0.41	30.5	D	4.53	1690	F
	With Mitigation	0.36	26.4	C	0.84	43.5	D
Kapolei Pkwy.- Parcels A/B Rd.	Urbanized Area	0.43	34.2	D	0.42	47.2	E
Kapolei Pkwy.- Rd. H	Urbanized Area	0.15	13.7	B	0.21	20.0	C
Kapolei Pkwy.- Rd D/F	Urbanized Area	0.13	13.8	B	0.15	18.8	C
Aliinui Dr.- Koio Dr.	Existing	NA	NA	NA	NA	NA	NA
	No Project	0.01	10.9	B	0.02	12.3	B
	Urbanized Area	0.04	14.4	B	0.13	18.9	C
Aliinui Dr.- Olani St.	Existing	0.10	11.5	B	0.13	14.0	B
	No Project	0.46	38.7	E	1.46	318.3	F
	Urbanized Area	0.35	26.4	D	0.95	108.7	F

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.
NA = Not Analyzed
Urbanized Area = Eastern and mauka portions of Kapolei West area that have received prior approval for development with urban uses.

Wilbur Smith Associates; June 1, 2005.

The afternoon conditions could be improved to acceptable levels by the addition of a second Waianae-bound through lane on Farrington Highway through the intersection onto the on-ramp. This would improve the intersection to 74% of capacity and delays to LOS D. However, since action would be needed either with or without the Project, this additional lane is not included as a mitigative action for the Project.

Kapolei West Intersections – The Kapolei Parkway intersections with the collector streets providing access to the residential development parcels and the golf course would operate at very acceptable conditions with STOP sign controls on the side street approaches. The worst conditions would occur at the makai-bound approach of the Parcel A Access Road in the afternoon when the estimated delays are at LOS E, with traffic approximating 41% of capacity for the movement. This condition would not be sufficient to warrant installation of traffic signal controls.

The projected traffic volumes exiting from the Regional Commercial Center Driveway in the afternoon peak hour would substantially exceed the capacity for this movement with STOP sign control at the intersection. Very long delays would be anticipated for vehicles turning left from the Driveway towards Kalaeloa Boulevard. Long delays (LOS F) would also be expected for vehicles turning left from the Parcel L Driveway. Mitigative actions would be needed for this intersection.

Ko Olina Intersections – Traffic conditions would remain at acceptable levels at the Koio Drive intersection with the Kapolei Parkway/Aliinui Drive with STOP sign controls. Low volumes are forecast for Koio Drive since the connection with Farrington Highway is assumed to be limited to right-in/right-out movements and there are no driveway connections planned to Koio Drive.

The connection of Aliinui Drive to the Kapolei Parkway would result in a net reduction of traffic volumes along the section of Aliinui Drive between Olani Street and Farrington Highway as many of the trips would use the Kapolei Parkway to travel to/from the Kalaeloa Boulevard corridor instead of Farrington Highway. However, traffic levels are projected to remain near capacity for the left-turn movement from the mauka-bound approach of Olani Street in the afternoon peak hour, with long delays (LOS F). The extension of the Kapolei Parkway would reduce the Aliinui Drive traffic and the resultant delays to levels that would not satisfy Category A of MUTCD Warrant #3 to allow consideration of a traffic signal (4.6 hours of delay versus minimum of 5 to satisfy Category A). The volumes would satisfy Category B. Therefore it is less likely that a signal may be needed at this intersection.

PEAK HOUR FREEWAY CONDITIONS

The development of the Kapolei West Urbanized Area is projected to add approximately 320 vehicles, for about a 7% increase, to the Honolulu-bound direction traffic on the H-1 Freeway in the morning peak hour, with the Waianae-bound traffic increased by about 210 vehicles. In the afternoon peak hour, the Project would increase the Waianae-bound volumes by about 360

vehicles (7% increase), while the Honolulu-bound volume would be increased by about 170 vehicles.

The analysis of the section of the H-1 Freeway east of the Makakilo Interchange indicates that the morning peak hour traffic conditions should be little affected by the Project traffic, as summarized in Table 4-4. The conditions are estimated to remain at LOS C with traffic at about 67% of capacity.

The addition of the Project traffic is estimated to result in the afternoon peak hour conditions worsening to LOS D from LOS C without the Project. The Project is forecast to increase the average traffic density from about 25 vehicles per lane per mile without the Project, to 26 or 27 vehicles with the Project. Since the criteria for LOS D ranges from 26 to 35 vehicles, this increase results in the lower designation of conditions. The analysis indicates that average speeds would decline by 0.2 mph or less as a result of the Project traffic increase. The Honolulu-bound traffic would approximate 70% of the estimated capacity.

PUBLIC TRANSIT AND BICYCLE TRAVEL

The extension of the Kapolei Parkway through the Kapolei West Project would provide a route for both fixed-route bus service and bicycles. The roadway is expected to include bicycle lanes.

Public Transit

Parcel L is proposed to include a transit center as part of a mixed-use development. The Parcel L developer should coordinate the planning of this parcel with City DTS and TheBus operations staffs to ensure the development of an efficient layout for the transit center.

Table 4-4
2014 H-1 FREEWAY CONDITIONS
WITH KAPOLEI WEST URBANIZED AREA

Peak Hour	Direction	Volumes	Lanes	Density (vphpl)	Speed (mph)	Level of Service
Location: East of Makakilo Interchange						
Morning	Eastbound	4,570	3	25.3	62.0	C
	Westbound	4,329	3	24.7	62.0	C
Afternoon	Eastbound	4,599	3	26.0	62.0	D
	Westbound	4,920	3	27.6	61.8	D

vphpl = vehicles per hour per lane
mph = miles per hour

Wilbur Smith Associates; November 23, 2004.

Bus pullouts and shelters should be provided along the Kapolei Parkway. In particular, shelters would encourage use by the residents, employees, and visitors to the adjacent land uses within the Kapolei West development area. The Project Concept Plan should be reviewed with City DTS and TheBus staffs to identify the location for these transit amenities.

Each parcel should be laid out with a street system and pedestrian linkages that provide an efficient network of pedestrian routes to the bus stop locations.

Bicycles

A network of bicycle lanes and greenways should link the residential areas to the middle school and nearby elementary school sites to encourage the use of bicycle transportation by students.

The collector and local streets within the residential parcels should be designed to maintain low speeds of about 20 miles per hour to maintain a safe environment for shared use by bicycles.

Bicycle storage facilities should be provided at the commercial developments and parks to encourage use of bicycles for access.

PROPOSED MITIGATIVE ACTIONS

The following paragraphs identify potential roadway improvements to mitigate the impacts at those intersections substantially affected by the Kapolei West traffic in 2014.

Regional Commercial Center Driveway-Kapolei Parkway – The left turns from both mauka and makai driveways would experience extremely long delays with STOP sign controls. The conditions were compared to the MUTCD Warrant #3 for consideration of a traffic signal.

- **Warrant 3 Category A**
  All three conditions of this criteria must be satisfied by the same one-hour period: 1) the vehicles on one minor street approach must experience total delay of at least four vehicle hours for a single-lane approach and five vehicle hours for a two-lane approach; 2) the peak hour volume on the minor street approach must equal or exceed 100 vehicles for an approach with one moving lane and 150 vehicles with two moving lanes; and 3) the total number of vehicles entering the intersection in the peak hour must exceed 650 for an intersection with three approaches or 800 for four approaches. The Regional Commercial Center driveway approach would be striped to provide separate left/through- and right-turn lanes, therefore the requirements and forecast values for the afternoon peak hour period are summarized in the following table.

Peak Hour Criteria	Minimum Requirement	Forecast Amount	Satisfy Requirement
Minor Street Delay	5 hours	1,653 hours	Yes
Minor Street Volume	150 vehicles	498 vehicles	Yes
Total Intersection Volume	800 vehicles	2,506 vehicles	Yes

The forecast intersection conditions in 2014 would satisfy the requirements to permit installation of a traffic signal at this location.

- **Warrant 3 Category B**

  For the number of lanes at this intersection and the afternoon peak hour volumes along Kapolei Parkway, this warrant would require a minimum of 150 vehicles exiting one of the two driveways in the peak hour.

  The Regional Commercial Center driveway, with a forecast 498 vehicles in the afternoon peak hour, has more than the minimum volume requirement and satisfies this part of the warrant.

Based on the forecast volumes and conditions in the afternoon peak hour, a traffic signal may be appropriate at this intersection in year 2014. With the installation of a traffic signal and the existing lanes, the forecast 2014 traffic would amount to about 36% and 84% of intersection capacity in the morning and afternoon peak hours, respectively. Average delay per vehicle would be at LOS C and LOS D in the morning and afternoon peak hours, respectively.

A traffic signal at this driveway would be located about 700 feet east of the future Kapolei Parkway intersection with the Hanua Street extension and about 1,400 feet west of the Kalaeloa Boulevard intersection. The traffic exiting the commercial property located between the Regional Commercial Center and Kalaeloa Boulevard would also likely satisfy the warrant for installation of traffic controls at that driveway. This would result in average spacing of about 700 feet between the four potential traffic signal locations.

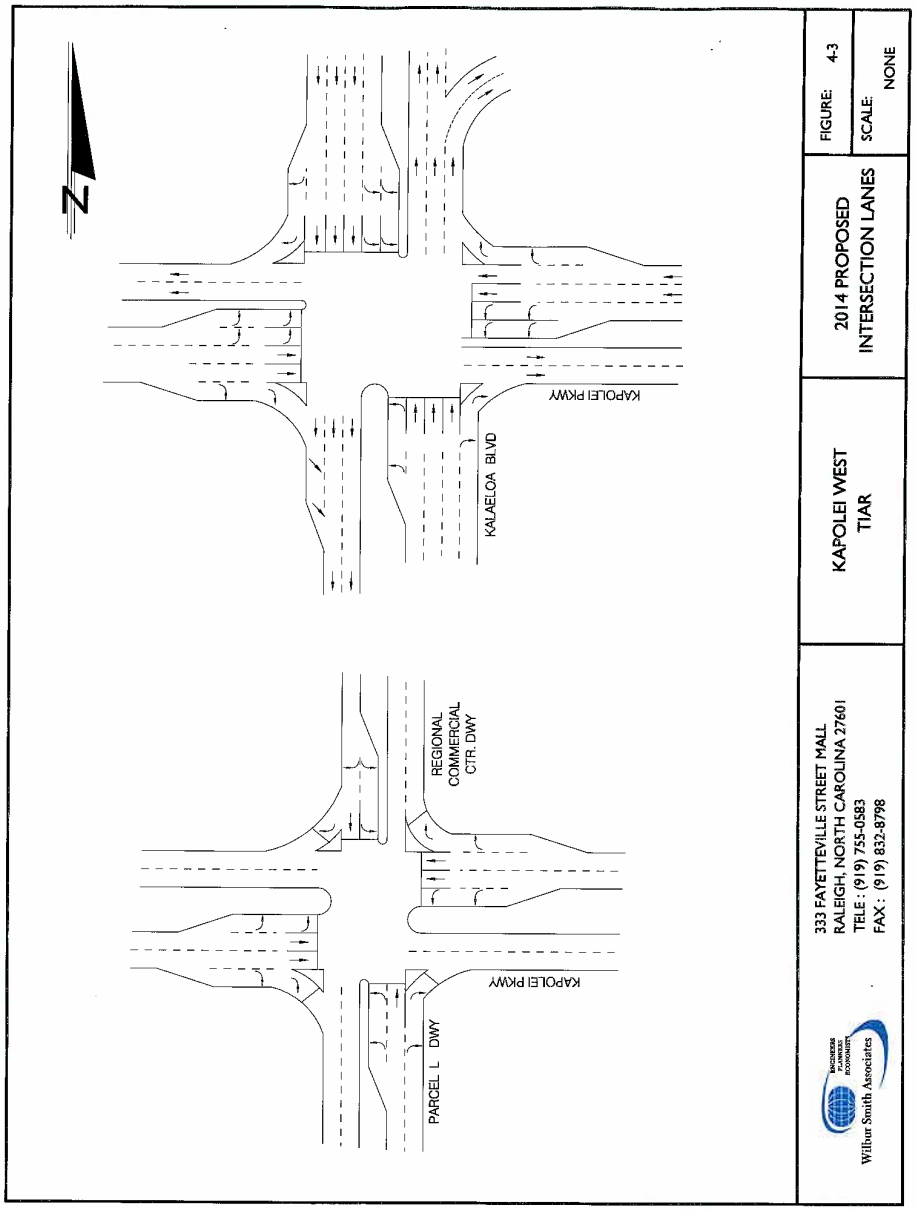
The location of a single signal-controlled intersection midway between the Kalaeloa Boulevard and Hanua Street Extension intersections should be considered. This would provide a spacing of 1,000 feet between signals and would permit better coordination between signals, fewer stops, and higher average speeds along Kapolei Boulevard. Additional partial intersections could be provided midway between this signal-controlled intersection and the Kalaeloa Boulevard and Hanua Street intersections. These midpoint intersections could provide right-turns into and out of the developments, as well as provide a median opening and left-turn lane to accommodate left-turns into each property from eastbound Kapolei Parkway.

The proposed numbers of lanes for the intersection are depicted in Figure 4-3. The driveway for the Regional Commercial Center should provide sufficient right-of-way width to permit the

widening to add a second left-turn lane (double left-turn lanes) if the additional capacity is needed in the future.

Kalaeloa Boulevard-Kapolei Parkway – The addition of right-turn lanes on makai-bound Kalaeloa Boulevard and Honolulu-bound Kapolei Parkway approaches, combined with the provision of double left-turn lanes on the Honolulu-bound Kapolei Parkway approach, would be needed to provide acceptable conditions with the Project traffic from the Urbanized area. With these lanes, the forecast traffic would amount to 87% and 92% of intersection capacity in the morning and afternoon peak hours, respectively, with average vehicle delay at LOS D.

The proposed numbers of lanes at the intersection are depicted in Figure 4-3.



Chapter 5
2014 WITH THE PROJECT PETITION AREA

Aina Nui Corporation, an affiliated company of the Estate of James Campbell, is seeking to State Land Use Commission (LUC) approval to designate 174.2 acres of vacant agricultural lands along the makai side of the Kapolei Parkway as urban lands. These Petition Area lands are identified as Parcels E, F, G, H, and K in Figure 1-1. Aina Nui Corporation also seeks to have these lands zoned for residential development.

The preliminary market study indicates that these lands would likely be more marketable to part-time residents than the Kapolei West lands further to the east. Therefore the approval of these lands for residential development would likely shift a portion of the development between 2008 and 2014 to these parcels that may otherwise occur in the parcels further to the east.

This "Petition Area" scenario reflects the development in both the area with LUC approval and the petition area for LUC approval. This Petition Area Scenario includes only the projected absorption of residential units between 2008 and 2014 (183 units per year), for a total of about 1,281 units. However, this scenario locates a sizable portion of the residential development in the areas makai of the Kapolei Parkway and increases the proportions that are assumed to be used by part-time residents from that in the Zoning-Only Scenario.

DESCRIPTION OF THE PROJECT

With the Petition Area Scenario, the residential development prior to 2014 would include much of the area along the makai side of the future Kapolei Parkway. Conversely, portions of the parcels included within the Zoning Only area would not be fully developed by 2014. The assumed development for this scenario is outlined in the following paragraphs, and an overview of the residential parcels is provided in Table 5-1.

The Regional Commercial Center is included within the 2014 development since there potential developers have already expressed interest in this parcel.

The Golf Course is included within the scenario since it is regarded as an amenity needed to promote the residential sales.

The scenario includes full development of the easternmost residential lower-density areas (Parcels A, B, and C). These would be closest to the City of Kapolei employment and shopping areas, and would require the least infrastructure to support at the beginning of the development period. The Middle School in the Parcel B area is included within the scenario.

Parcels I and J are assumed to be fully developed since these parcels provide view lots and have a high marketability to both full- and part-time residents.

Table 5-1
PLANNED RESIDENTIAL UNITS FOR 2014 PETITION AREA SCENARIO

Parcel	Type of Units	Units per Acre	Units by Type of Residents		
			Full-Time	Part-Time	Total
A	Cluster Single-Family	8	162	28	190
B	Multi-Family 2-3 floors	10	208	37	245
C	Cluster Single-Family	8	112	38	150
E	Multi-Family, 2-3 floors	10	140	25	165
F	Multi-Family 3-5 floors	18	64	248	312
I	Cluster Single-Family	7	63	77	140
J	Cluster Single-Family	7	31	37	68
K	Townhouse	1	4	7	11
	Totals		784	497	1,281

Wilbur Smith Associates; November 16, 2004

The remaining residential units would be provided in Parcels E, F, and K which would provide the units more marketable to part-time residents. All of Parcel K and 61% of Parcels E and F are assumed to be developed to reach the total absorption of 1,281 units estimated for 2014 yearend.

The neighborhood commercial area at Road D is included to provide services to the surrounding residential developments.

No development is included within either Parcel D or Parcel L for this scenario.

The Kapolei Parkway is expected to be extended through the Kapolei West development area by 2014, as described for the Zoning-Only Scenario. As discussed in Chapter 4, Road D is not assumed to be connected to Farrington Highway in this traffic assessment.

PROJECT TRIP GENERATION

The Petition Area Scenario is estimated to generate a total of 1,208 and 1,643 vehicle trips in the morning and afternoon peak hours, respectively, as outlined in Table 5-2. This is 134 fewer trips, or about 10% less, than the estimated trip generation in the morning peak hour for the Urbanized Area Scenario. In the afternoon peak hour, the Petition Area Scenario would generate about 370 fewer trips (18% less) than the Urbanized Area Scenario. The larger reduction in the afternoon peak hour results from the absence of the Parcel L commercial uses in the Petition Area Scenario.

Table 5-2
VEHICLE TRIP GENERATION
FOR 2014 PETITION AREA SCENARIO

Item	Morning Peak Hour			Afternoon Peak Hour		
	Total	Enter	Exit	Total	Enter	Exit
Weekday Vehicle Trip Rates						
Shopping Center per 1,000 sq. ft. of Floor Area	1.03	0.63	0.40	3.75	1.80	1.95
Specialty Retail per 1,000 sq. ft. of Floor Area	0.71	0.43	0.28	2.59	1.11	1.48
Golf Course (per hole)	3.01	1.41	1.60	3.56	1.53	2.03
Middle School per student	0.53	0.29	0.24	0.15	0.07	0.08
Single-Family housing units	0.75	0.19	0.56	1.01	0.65	0.36
Mid-Rise Apartments	0.30	0.09	0.21	0.23	0.23	0.16
Recreational Homes	0.30	0.15	0.15	0.31	0.14	0.17
Total Weekday Vehicle Trips by Parcel (Includes Pass-By Trips)						
Regional Commercial Center	263	161	102	956	459	497
A	131	35	95	173	109	63
B	421	195	227	213	128	85
C	96	27	69	126	78	47
I, J and Neighborhood Commercial combined	112	39	73	156	88	68
E, F, and K combined	214	70	146	250	137	110
Golf Course	54	25	29	64	28	37
Totals	1,290	550	740	1,939	1,028	910
New Vehicle Trips (Without Pass-By Trips)						
Less Commercial and School Pass-by Trips	1,210	506	704	1,612	870	741

Wilbur Smith Associates; November 19, 2004

PEAK HOUR TRAFFIC VOLUMES

The new vehicle trips to/from the Kapolei West land uses were distributed to surrounding areas based on the percentages presented in Appendix A. The forecast traffic movements at the access points to the parcels included in the Project Petition Area scenario were adjusted to reflect the numbers of "pass-by trips" that would turn into and out of the Project during their trip past the site. The resultant forecast of weekday commute peak hour traffic volumes on the roadways near

the Project are depicted in Figure 5-1 and 5-2 for the year 2014 morning and afternoon peak hours, respectively.

Traffic volumes on the Kapolei Parkway near Kalaeloa Boulevard would total about 1,625 vehicles in the morning peak hour, or about 115 fewer than with the Urbanized Area scenario uses. In the afternoon peak hour, the Petition Area Scenario would result in an estimated 2,260 vehicles on Kapolei Parkway, or about 245 fewer than with the Urbanized Area Scenario.

There would be little difference or an increase with the Petition Area Scenario, as compared to the Urbanized Area Scenario, to traffic volumes along the Kapolei Parkway at the western end of the Kapolei West area since the Petition Area Scenario shifts more development to the Ko Olina end of the Project area.

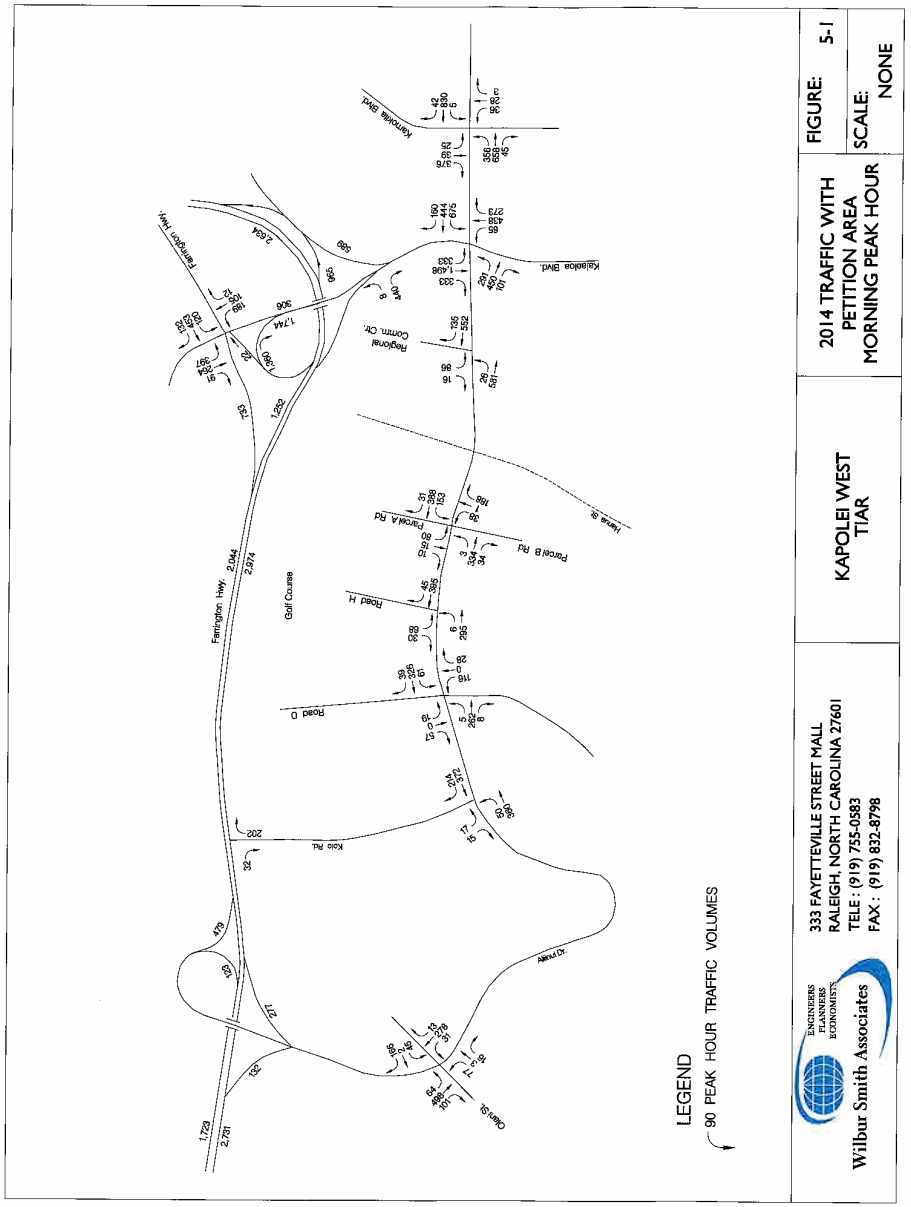
PEAK HOUR TRAFFIC CONDITIONS

Overall, the area traffic with the Petition Area Scenario, with slightly lower traffic volumes as compared to the Urbanized Area Scenario, would result in similar locations and level of traffic problems as described in Chapter 4 for the Urbanized Area Scenario. Traffic conditions for the key intersections near the Project site, with the combined urbanized plus petition areas scenario traffic, are summarized for the weekday morning and afternoon commute peak hours in Table 5-3. For comparison, year 2014 conditions without the Project are presented in Table 3-1 and conditions with the Urbanized Area scenario are presented in Table 4-3.

The reduced traffic volumes would exceed the capacity of the Kapolei Parkway intersection with Kalaeloa Boulevard by 6% and 4% in the morning and afternoon peak hours, respectively, with average delay per vehicle at LOS E in both peak hours. These conditions are slightly improved versus those with development only of the urbanized area, but these conditions would also warrant mitigative actions to minimize traffic impacts at the intersection.

The absence of the makai leg (Parcel L driveway) would reduce overall traffic volumes and reduce the conflicting traffic movements at the intersection of the Kapolei Parkway with the Regional Commercial Center Driveway. This would result in less congested conditions for vehicles turning left from the Regional Commercial Center Driveway onto the Kapolei Parkway. However, the estimated volume of left turns would still more than double the estimated capacity for this movement, with resultant extremely long delays estimated for the traffic exiting the driveway in the afternoon peak hour. Improvement actions would be warranted at this intersection.

The slightly lower increases in through traffic along Aliinui Drive would result in reduced delays for traffic exiting Olani Street. However, the afternoon conditions would remain at LOS F with an estimated delay of 99 seconds per vehicle turning left from the mauka-bound approach of Olani Street, versus 108 seconds with the Urbanized Area scenario and 318 seconds with the No Project/No Kapolei Parkway extension scenario.



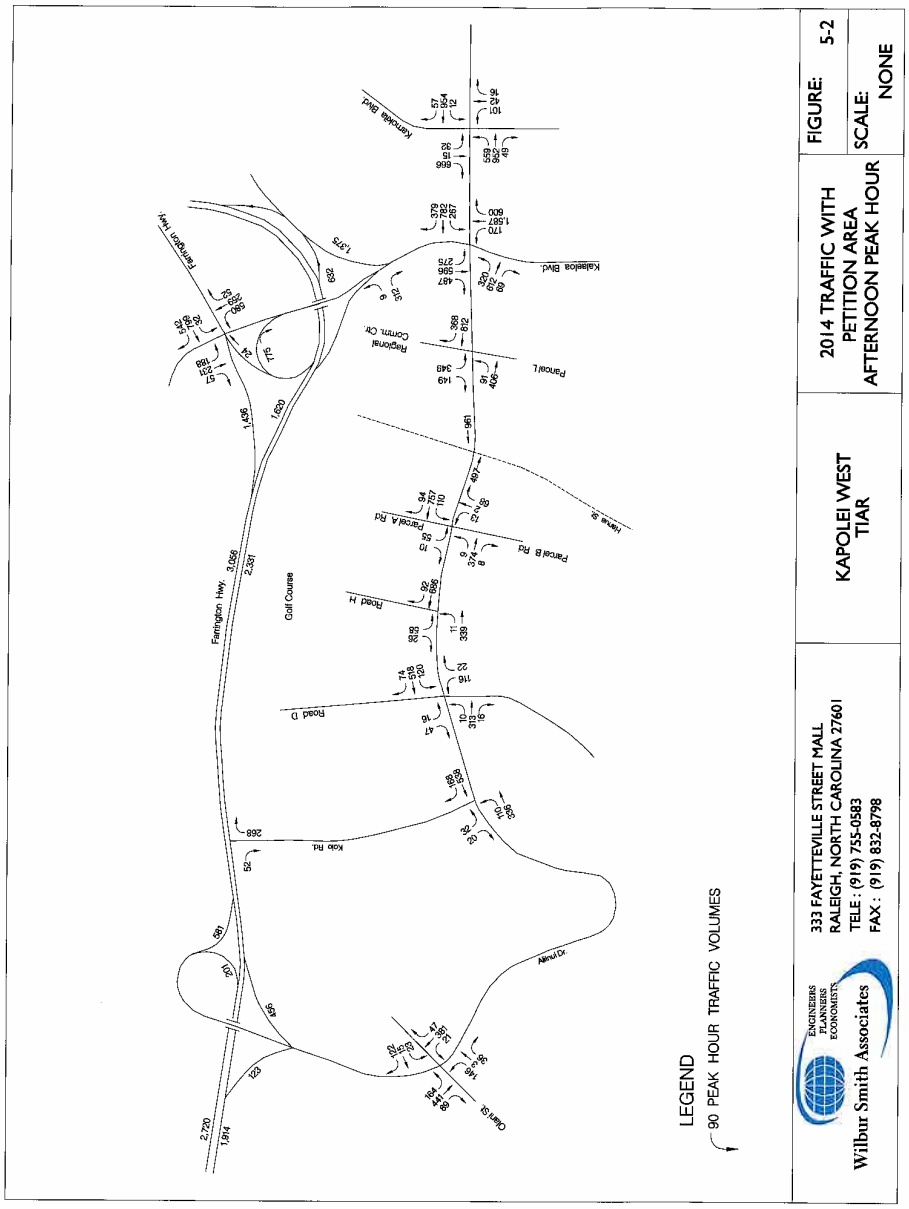


Table 5-3
2014 TRAFFIC CONDITIONS AT KEY INTERSECTIONS
WITH KAPOLEI WEST PETITION AREA SCENARIO

Intersection	Scenario	Morning Peak Hour			Afternoon Peak Hour		
		V/C	ADPV	LOS	V/C	ADPV	LOS
Kalaeloa Blvd.- Farrington Hwy.	Existing	0.44	25.7	D	1.97	476.8	F
	No Project	0.49	37.6	D	0.70	35.8	D
	Petition Area	0.62	35.9	D	0.97	57.0	E
Kapolei Pkwy.- Kamokila Blvd.	Existing	0.68	21.7	C	0.59	16.9	B
	No Project	0.53	25.1	C	0.75	30.0	C
	Petition Area	0.58	26.2	C	0.88	34.3	C
Kapolei Pkwy.- Kalaeloa Blvd.	Existing	0.63	34,6	C	0.73	28.8	C
	No Project	0.91	53.4	D	0.86	44.6	D
	Petition Area	1.06	74.8	E	1.04	61.7	E
	With Mitigation	0.92	51.3	D	0.92	53.9	D
Kapolei Pkwy.- Commercial Dwy.	Petition Area	0.32	23.0	C	2.36	674.8	F
	With Mitigation	0.32	16.4	B	0.74	28.5	C
Kapolei Pkwy.- Parcels A/B Rd.	Petition Area	0.43	33.5	D	0.39	41.8	E
Kapolei Pkwy.- Rd. H	Petition Area	0.15	13.6	B	0.20	18.7	C
Kapolei Pkwy.- Rd D/F	Petition Area	0.30	16.8	B	0.33	23.2	C
Aliinui Dr.- Koio Dr.	Existing	NA	NA	NA	NA	NA	NA
	No Project	0.01	10.9	B	0.02	12.3	B
	Petition Area	0.04	14.3	B	0.12	18.5	C
Aliinui Dr.- Olani St.	Existing	0.10	11.5	B	0.13	14.0	B
	No Project	0.46	38.7	E	1.46	318.3	F
	Petition Area	0.35	26.6	D	0.92	99.0	F

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.
NA = Not Analyzed
Petition Area = Makai portions of Kapolei West area that have not received prior approval for development with urban uses.

Wilbur Smith Associates; June 1, 2005.

Conditions at the other intersections would slightly improved or similar to the conditions with the Urbanized Area scenario.

PEAK HOUR FREEWAY CONDITIONS

The Petition Area Scenario would have a similar effect on the morning peak hour traffic as the Urbanized Area Scenario while the afternoon impact would be slightly less than that of the Urbanized Area Scenario.

The development of the Kapolei West Petition Area scenario is projected to add approximately 320 vehicles, for about a 7% increase, to the Honolulu-bound direction traffic on the H-1 Freeway in the morning peak hour, with the Waianae-bound traffic increased by about 200 vehicles. In the afternoon peak hour, the Project would increase the Waianae-bound volumes by about 320 vehicles (7% increase), while the Honolulu-bound volume would be increased by about 150 vehicles.

The analysis of the section of the H-1 Freeway east of the Makakilo Interchange indicates that the morning peak hour traffic conditions should be little affected by the Project traffic, as summarized in Table 5-4. The conditions are estimated to remain at LOS C with traffic at about 67% of capacity.

The addition of the Project traffic is estimated to result in the afternoon peak hour conditions for the Waianae-bound traffic worsening to LOS D from LOS C without the Project. The Project is forecast to increase the average traffic density from about 25 vehicles per lane per mile without the Project, to 27 vehicles with the Project. The analysis indicates that average speeds would decline by 0.1 mph as a result of the Project traffic increase. The Honolulu-bound traffic would approximate 69% of the estimated capacity. With the Petition Area Scenario, the conditions for the Honolulu-bound direction traffic would remain at LOS C.

Table 5-4
2014 H-1 FREEWAY CONDITIONS
WITHOUT KAPOLEI WEST PROJECT

Peak Hour	Direction	Volumes	Lanes	Density (vphpl)	Speed (mph)	Level of Service
Location: East of Makakilo Interchange						
Morning	Eastbound	4,539	3	25.1	62.0	C
	Westbound	4,317	3	24.7	62.0	C
Afternoon	Eastbound	4,573	3	25.9	62.0	C
	Westbound	4,871	3	27.3	61.9	D

vphpl = vehicles per hour per lane
mph = miles per hour

Wilbur Smith Associates; November 23, 2004.

PROPOSED MITIGATIVE ACTIONS

The following paragraphs identify potential roadway improvements to mitigate the impacts at those intersections substantially affected by the Kapolei West Petition Area Scenario traffic in 2014.

Regional Commercial Center Driveway-Kapolei Parkway – The left turns from the driveway would experience extremely long delays with STOP sign control. The conditions were compared to the MUTCD Warrant #3 for consideration of a traffic signal.

- **Warrant 3 Category A**
  All three conditions of this criteria must be satisfied by the same one-hour period: 1) the vehicles on one minor street approach must experience total delay of at least four vehicle hours for a single-lane approach and five vehicle hours for a two-lane approach; 2) the peak hour volume on the minor street approach must equal or exceed 100 vehicles for an approach with one moving lane and 150 vehicles with two moving lanes; and 3) the total number of vehicles entering the intersection in the peak hour must exceed 650 for an intersection with three approaches or 800 for four approaches. The Regional Commercial Center driveway approach would be striped to provide separate left/through- and right-turn lanes, therefore the requirements and forecast values for the afternoon peak hour period are as follows:

Peak Hour Criteria	Minimum Requirement	Forecast Amount	Satisfy Requirement
Minor Street Delay	5 hours	5.7 hours	Yes
Minor Street Volume	150 vehicles	498 vehicles	Yes
Total Intersection Volume	650 vehicles	2,175 vehicles	Yes

  The forecast intersection conditions in 2014 would satisfy the requirements to permit installation of a traffic signal at this location.

- **Warrant 3 Category B**
  For the number of lanes at this intersection and the afternoon peak hour volumes along Kapolei Parkway, this warrant would require a minimum of 150 vehicles exiting one of the two driveways in the peak hour.

  The Regional Commercial Center driveway, with a forecast 498 vehicles in the afternoon peak hour, has more than the minimum volume requirement and satisfies this part of the warrant.

Based on the forecast volumes and conditions in the afternoon peak hour, a traffic signal may be appropriate at this intersection in year 2014. With the installation of a traffic signal and separate right- and left-turn lanes on the Driveway, the forecast 2014 traffic would amount to about 32 % and 74% of intersection capacity in the morning and afternoon peak hours, respectively. Average delay per vehicle would be at LOS B and LOS C in the morning and afternoon peak hours, respectively.

Kalaeloa Boulevard-Kapolei Parkway – The addition of a right-turn lane on the makai-bound Kalaeloa Boulevard and Honolulu-bound Kapolei Parkway approach, combined with the provision of double left-turn lanes on the Honolulu-bound Kapolei Parkway approach, would be needed to provide acceptable conditions with the Project traffic from the combined Petition and Urbanized Areas. With these lanes, the forecast traffic would amount to 92% of intersection capacity in both the morning and afternoon peak hours, with average vehicle delay at LOS D.

Chapter 6
2020 WITH THE PROJECT AREA BUILD-OUT

The entire 546-acre Kapolei West Project area could be fully developed in 2020. This chapter assesses the transportation impacts with the full development of the combined Urbanized and Petition areas.

DESCRIPTION OF THE PROJECT

With the area Build-Out Scenario, both the Urbanized portion and Petition portion of the Kapolei West Project area would be fully developed and occupied by the end of 2010.

Land Uses

The area would be developed with the uses described in Chapters 4 and 5. These areas, depicted in Figure 1-1, would include the following:

- Regional Commercial Parcel, a 23.2-acre shopping center with 255,000 square feet of building floor area
- Parcel L, a mixed-use development with 100,000 square feet of commercial floor area and 150 housing units, plus a transit center, on 15.8 acres
- Parcel A, a 23.8-acre area with single-family homes
- Parcel B, a 30.6-acre area with multi-family housing and a middle school with capacity for 600 students
- Parcel C, an 18.8-acre area with single-family homes
- An 18-hole golf-course with club house and driving range
- Parcel D, a 38.7-acre area with single-family homes and a neighborhood commercial area with 10,000 square feet of building floor area
- Parcel E, a 27.1-acre area with multi-family housing
- Parcel F, a 28.3-acre area with multi-family housing
- Parcel G, a 10-acre area with multi-family housing
- Parcel H, an 8.1-acre area with multi-family housing
- Parcel I, a 20-acre area with single-family homes
- Parcel J, a 9.7-acre area with single-family homes
- Parcel K, a 9.3-acre area with single-family homes

An overview of the residential uses is provided in Table 6-1, which includes a preliminary market study's estimate of the number of units likely to be purchased by full-time residents and by part-time residents.

Table 6-1
PLANNED RESIDENTIAL UNITS FOR 2020 COMBINED AREAS SCENARIO

Parcel	Type of Units	Units per Acre	Units by Type of Residents		
			Full-Time	Part-Time	Total
A	Cluster Single-Family	8	162	28	190
B	Multi-Family 2-3 floors	10	208	37	245
C	Cluster Single-Family	8	112	38	150
D	Cluster Single-Family	8.7	263	47	310
E	Multi-Family, 2-3 floors	10	140	25	165
F	Multi-Family 3-5 floors	18	64	248	312
G	Multi-Family 3-5 floors	18	54	126	180
H	Multi-Family 3-5 floors	18	36	109	146
I	Cluster Single-Family	7	63	77	140
J	Cluster Single-Family	7	31	37	68
K	Townhouse	1	4	7	11
L	Multi-family 3+ floors	15	135	15	150
	Totals		1,272	794	2,370

Wilbur Smith Associates; November 16, 2004

Roadways

Access to all of the development parcels would be provided by the Kapolei Parkway which would be a four-lane roadway with a median and turn lanes at the major side streets and driveway connections. Roads D, G, and H would be constructed as two-lane roadways. Each of the cross streets and major driveways would have a separate turn lane on the approaches to the intersections with the Kapolei Parkway.

Traffic signal controls are assumed to be in place at the intersection of the Kapolei Parkway with the Regional Commercial Center/Parcel L driveways since the 2014 traffic conditions satisfied the warrant for installation of signal controls and indicated severely congested conditions with STOP sign control. All other intersections of Project roadways with the Kapolei Parkway are assumed to be controlled by STOP signs.

PROJECT TRIP GENERATION

The Project Area Build-Out Scenario is estimated to generate a total of 1,881 and 2,835 vehicle trips in the morning and afternoon peak hours, respectively, as outlined in Table 6-2. This is 457 more trips, or about a 22% increase, than the estimated trip generation in the morning peak hour

for the Urbanized Area Scenario in 2014. In the afternoon peak hour, the 2020 Build-Out Scenario would generate about 526 more trips (+23%) than the Urbanized Area Scenario in 2014. The Petition Area would contribute approximately 24% of the total trips generated by the Build-Out Project in the morning peak hour and 18.5% of the Build-Out Project trips in the afternoon peak hour. The trip rates and estimated trips for each use are summarized in Appendix C, which also indicates the pass-by trip rates used for the non-residential uses.

After allowance of pass-by trips, the Project would result in an estimated total increase of 1,801 and 2,404 additional vehicle trips on the area roadways in the morning and afternoon peak hours, respectively. The Petition Area would comprise 25% of the additional trips in the morning peak hour and 22% in the afternoon peak hour.

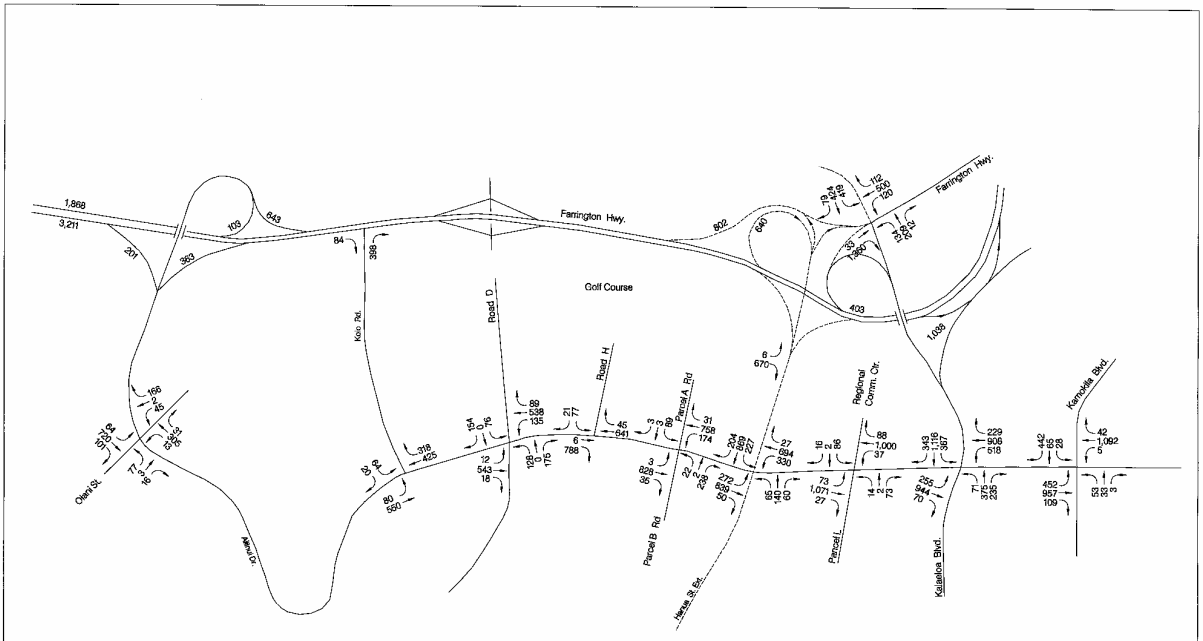
PEAK HOUR TRAFFIC VOLUMES

The new vehicle trips to/from the Kapolei West land uses were distributed to surrounding areas based on the percentages presented in Appendix A. The forecast traffic movements at the access points to the parcels included in the Project Combined Areas scenario were adjusted to reflect the numbers of "pass-by trips" that would turn into and out of the Project during their trip past the site. The forecast of weekday commute peak hour traffic volumes on the area roadways are depicted in Figure 6-1 and 6-2 for the year 2020 morning and afternoon peak hours, respectively.

Table 6-2
VEHICLE TRIP GENERATION
FOR 2020 PROJECT BUILD-OUT SCENARIO

Area	Morning Peak Hour			Afternoon Peak Hour		
	Total	Enter	Exit	Total	Enter	Exit
Regional Commercial Center	263	161	102	956	459	497
A	131	35	95	173	109	63
B (includes School)	421	195	227	213	128	85
C	96	27	69	126	78	47
D, I and J	323	96	227	437	265	171
E, F, G, H, and K	458	153	305	527	288	238
L	137	54	84	259	111	148
Golf Course	54	25	29	64	28	37
Totals	1,881	745	1,136	2,835	1,522	1,313
New Vehicle Trips (Without Pass-By Trips)						
Less Commercial Area and School Pass-by Trips	1,801	701	1,100	2,404	1,320	1,084

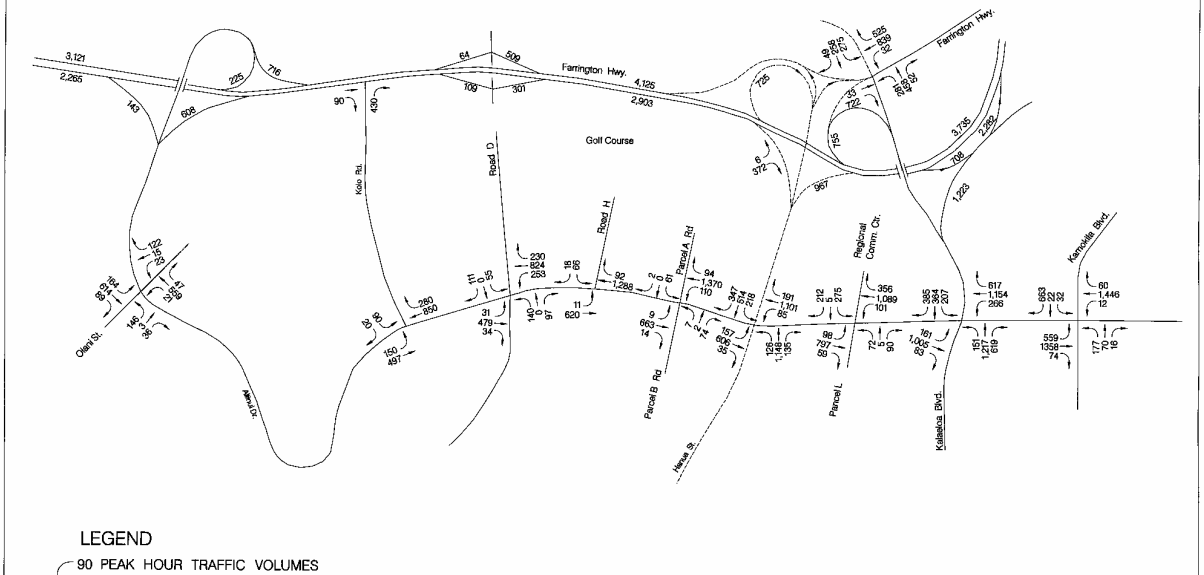
Wilbur Smith Associates; November 16, 2004



LEGEND

90 PEAK HOUR TRAFFIC VOLUMES

Wilbur Smith Associates ENGINEERS PLANNERS ECONOMISTS	333 FAYETTEVILLE STREET MALL RALEIGH, NORTH CAROLINA 27601 TELE : (919) 755-0583 FAX : (919) 832-8798	KAPOLEI WEST TIAR	2020 WITH PROJECT BUILDOUT MORNING PEAK HOUR	FIGURE: 6-1 SCALE: NONE



LEGEND

90 PEAK HOUR TRAFFIC VOLUMES

Wilbur Smith Associates ENGINEERS PLANNERS ECONOMISTS	333 FAYETTEVILLE STREET MALL RALEIGH, NORTH CAROLINA 27601 TELE : (919) 755-0583 FAX : (919) 832-8798	KAPOLEI WEST TIAR	2020 TRAFFIC WITH PROJECT BUILDOUT AFTERNOON PEAK HOUR	FIGURE: 6-2 SCALE: NONE

Traffic volumes along the Kapolei Parkway near Kalaeloa Boulevard would total about 2,600 vehicles in the morning peak hour, or almost 1,000 more vehicles than for the 2020 Without Project scenario. In the afternoon peak hour, the Project Build-Out Scenario would result in an estimated 2,940 vehicles on Kapolei Parkway, or about 1,100 more vehicles than with the Without Project Scenario.

Along the Kapolei Parkway at the Waianae end of the Project Area, the morning peak hour traffic would total about 1,330 vehicles, or about 50% more than the 950 vehicles without the Project. In the afternoon peak hour, the Kapolei Parkway traffic would total slightly more than 1,600 vehicles, or about 25% more than the traffic without the Project.

The Kapolei West Project would add about 650 vehicles (+45%) to the morning peak hour traffic along Hanua Street between the Kapolei Parkway and the freeway. In the afternoon peak hour, the Project would add about 690 vehicles, or a 36% increase to the Hanua Street volumes.

The traffic forecasts do not reflect the extension of Road D mauka to connect to the planned Makaiwa Hills Interchange. The connection of Road D to the Makaiwa Hills Interchange would be expected to attract use of Road D by many of those Kapolei West and Ko Olina vehicles that are included in the 2020 forecast volumes using Koio Drive, Aliinui Drive, Hanua Street Extension, or Kalaeloa Boulevard to access Farrington Highway/H-1 Freeway. This diversion of Kapolei West and Ko Olina trips to the Road D connection would reduce the numbers of vehicles using the parallel sections of Kalaeloa Boulevard, Hanua Street, Koio Drive, and Aliinui Drive from those presented in Figures 6-1 and 6-2.

If Road D were to be connected to Farrington Highway without construction of the Makaiwa Hills Interchange, this connection would primarily divert traffic from the Koio Drive connection to Farrington Highway and, to a lesser extent, from the Hanua Street Extension connection.

PEAK HOUR TRAFFIC CONDITIONS

Traffic conditions for the key intersections near the Project site, with the Project Build-Out Scenario traffic, are summarized for the 2020 weekday morning and afternoon commute peak hours in Table 6-3. For comparison, year 2020 conditions without the Project are presented in Table 3-2.

Kalaeloa Boulevard-Farrington Highway – The intersection improvements identified for the Without Project Scenario (Chapter 3) would be sufficient to accommodate the addition of the Kapolei West Build-out traffic in 2020.

Kapolei Parkway-Kamokila Boulevard – The intersection improvements identified for the 2020 Without Project Scenario (provide double right-turn lanes on makai-bound Kamokila Boulevard) would not be sufficient to accommodate the addition of the Kapolei West Build-out traffic in 2020. The addition of the Project Build-out traffic would exceed the intersection capacity in the afternoon peak hour by 6%, with delays at LOS F. The deterioration in traffic

conditions would result primarily from the increase in through traffic along the Kapolei Parkway, and to a lesser extent, the increase in traffic turning between the west leg of the Kapolei Parkway and the mauka leg of Kamokila Boulevard.

Additional improvements would be needed to offset the Project impacts.

Kapolei Parkway-Kalaeloa Boulevard – The intersection improvements identified for the Without Project Scenario (Chapter 3) would not be sufficient to accommodate the addition of the Kapolei West Build-out traffic in 2020. The forecast traffic volumes would exceed the expanded intersection capacity by 8% in the morning peak hour, with the afternoon peak hour traffic at 98% of capacity. Average delay per vehicle would worsen to LOS F in the morning peak hour. The forecast Project increases to the makai-bound right-turn volume and the eastbound through traffic in the morning peak hour and to the Kapolei Parkway through traffic in the afternoon peak hour would be the primary contributors to the worsening traffic conditions.

Further improvements would be appropriate at this intersection to mitigate the impacts of the Project Build-out traffic on 2020 peak hour traffic conditions.

Kapolei Parkway-Hanua Street Extension – A double left-turn lane on the Waianae-bound approach of the Kapolei Parkway and a right-turn lane on the mauka-bound approach of Hanua Street were proposed to accommodate the traffic forecast for the Without Project Scenario. With the addition of the Kapolei West Project traffic, the morning peak hour traffic is forecast to approximate 97% of intersection capacity with these additional lanes, with the average vehicle delay at LOS E. In the afternoon peak hour, the forecast traffic would exceed the intersection capacity by 12%, with conditions at LOS F. In the afternoon peak hour, the critical conflicting movements are the left-turn movement from Honolulu-bound Kapolei Parkway, the Waianae-bound through/right-turn traffic on the Kapolei Parkway, and the mauka-bound traffic on the Hanua Street Extension.

Further improvements would be appropriate at this intersection to accommodate the Project Build-out traffic with forecast 2020 peak hour traffic.

Kapolei Parkway-Regional Commercial Center/Parcel L Driveways – This intersection would operate at acceptable conditions with the planned lanes and the installation of traffic signal controls.

The high volume of vehicles turning right into the Regional Commercial Center would warrant the provision of a separate right-turn lane to allow vehicles to decelerate with minimum delay to through traffic.

Kapolei West Residential Area Intersections – The analysis of the residential street intersections with the Kapolei Parkway reflected the provision of STOP sign control on the side street approaches.

Table 6-3
2020 TRAFFIC CONDITIONS AT KEY INTERSECTIONS
WITH KAPOLEI WEST BUILDOUT

Intersection	Scenario	Morning Peak Hour			Afternoon Peak Hour		
		V/C	ADPV	LOS	V/C	ADPV	LOS
Kalaeloa Blvd.- Farrington Hwy.	Existing	0.44	25.7	D	1.97	476.8	F
	No Project	0.59	37.6	D	0.79	40.5	D
	Build-out	0.59	37.6	D	0.79	40.5	D
Kapolei Pkwy.- Kamokila Blvd.	Existing	0.68	21.7	C	0.59	16.9	B
	No Project	0.72	29.2	C	0.93	44.8	D
	Build-out	0.78	28.5	C	1.06	100.6	F
	With Mitigation	0.62	27.7	C	0.88	37.3	D
Kapolei Pkwy.- Kalaeloa Blvd.	Existing	0.63	34.6	C	0.73	28.8	C
	No Project	0.90	53.2	D	0.91	48.6	D
	Build-out	1.08	107.2	F	0.98	54.7	D
	With Mitigation	0.92	52.0	D	0.93	52.6	D
Kapolei Pkwy.- Commercial Dwy.	Build-out	0.53	20.8	C	0.87	40.7	D
Kapolei Pkwy.- Hanua St. Ext.	Build-out	0.97	60.0	E	1.10	83.9	F
	With Mitigation	0.79	44.2	D	0.93	45.7	D
Kapolei Pkwy.- Parcels A/B Rd.	Build-out	1.80	541.4	F	1.18	294.6	F
	With Mitigation	0.52	22.9	C	0.66	19.4	B
Kapolei Pkwy.- Rd. H	Build-out	0.27	20.9	C	0.51	53.3	F
Kapolei Pkwy.- Rd D/F	Build-out	0.76	68.5	F	1.87	516.6	F
	With Mitigation	0.44	27.5	C	0.57	29.3	C
Aliinui Dr.- Koio Dr.	Existing	NA	NA	NA	NA	NA	NA
	No Project	0.03	14.5	B	0.05	23.1	C
	Build-out	0.23	20.1	C	0.60	53.8	F
Aliinui Dr.- Olani St.	Existing	0.10	11.5	B	0.13	14.0	B
	No Project	0.46	38.7	E	1.24	220.5	F
	Build-out	0.47	40.6	E	1.32	255.1	F

V/C = Ratio of the traffic volume to the theoretical capacity of the intersection.
ADPV = Average delay per vehicle, in seconds.
LOS = Level of service.
NA = Not Analyzed.
Build-out = Full development of entire Kapolei West development area.
Wilbur Smith Associates; November 30, 2004.

The increased traffic volumes along Kapolei Parkway would result in very long delays (LOS F) in both peak hours for vehicles turning left out of the Parcel B Access Road. The numbers of vehicles turning left would substantially exceed the estimated number of gaps available in the Kapolei Parkway traffic to make this movement. The traffic volumes on this approach include vehicles leaving the middle school as well as the Parcel B residential area traffic. Mitigative actions would be needed to improve these conditions.

The traffic turning left from both Road D and Road F at their shared intersection with the Kapolei Parkway would experience very long delays. The estimated number of vehicles turning left from Road D in the afternoon peak hour would exceed the estimated capacity for this movement. Mitigative actions would be needed to improve these conditions.

The traffic conditions at the intersection with Road H (Golf Course access) would be acceptable with STOP sign control.

Ko Olina Intersections – The analysis of the Olani Street and Koio Road intersections with the Aliinui Drive/Kapolei Parkway are based on the provision of STOP sign control on the side street approaches, even though the analyses without the Kapolei West Project indicates that a traffic signal would likely be appropriate at the intersection with Olani Street.

The addition of the Kapolei West Build-out traffic would increase the delays for the left turns from Olani Street, although the increases would not be sufficient to worsen the LOS designation for any of the movements. The increased through traffic would result in the volume of left turns from Olani Street exceeding the estimated capacity for this movement by 32% versus 24% without the Project. With a traffic signal and the existing lanes, the intersection would operate at very acceptable conditions in 2020 with the addition of the Project traffic, as summarized below:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.43	16.9	B
Afternoon	0.55	20.8	C

The Project traffic would worsen conditions for traffic turning left from Koio Drive at its intersection with the Kapolei Parkway/Aliinui Drive, with the average delay worsening from LOS C to LOS F in the afternoon peak hour. However, with the low volumes forecast for Koio Drive, the intersection would not satisfy the Category A or B of Warrant 3 for installation of traffic signal control. The peak hour delay is estimated at only 1.4 vehicle hours in the afternoon peak hour versus a minimum requirement of 5 hours, and the volume is estimated at 110 vehicles versus a minimum needed of 150 vehicles.

This assessment is based on the connection of Koio Road to Farrington Highway being limited to right-in/right-out movements, with no driveway connections planned to Koio Drive. If either of

these limitations on traffic use of Koio Road is changed, then the potential for a traffic signal should be reassessed in the future.

PEAK HOUR FREEWAY CONDITIONS

The development of the Kapolei West Urbanized Area is projected to add approximately 460 vehicles, for about a 9% increase, to the Honolulu-bound direction traffic on the H-1 Freeway in the morning peak hour, with the Waianae-bound traffic increased by about 310 vehicles. In the afternoon peak hour, the Project would increase the Waianae-bound volumes by about 480 vehicles (9% increase), while the Honolulu-bound volume would be increased by about 370 vehicles.

The analysis of the section of the H-1 Freeway east of the Makakilo Interchange indicates that the morning peak hour traffic conditions should be little affected by the Project traffic, as summarized in Table 6-4. The conditions are estimated to remain at LOS D in both travel directions with traffic at about 75% of capacity.

The addition of the Project traffic is estimated to result in the 2020 afternoon peak hour conditions for Waianae-direction worsening to LOS E from LOS D without the Project. The Waianae-bound traffic would just exceed the LOS D criteria by about 30 vehicles, i.e. a 30-vehicle reduction in the forecast volumes would have resulted in LOS D conditions estimated for the afternoon peak hour. The Project is forecast to decrease the average traffic speeds by more than 2 mph, from about 60.7 mph without the Project, to 58.4 mph with the Project. The Waianae-bound traffic would approximate 84% of the estimated freeway capacity.

Table 6-4
2020 H-1 FREEWAY CONDITIONS
WITH KAPOLEI WEST BUILDOUT

Peak Hour	Direction	Volumes	Lanes	Density (vphpl)	Speed (mph)	Level of Service
Location: East of Makakilo Interchange						
Morning	Eastbound	5,310	3	29.8	612	D
	Westbound	5,144	3	29.8	61.3	D
Afternoon	Eastbound	5,684	3	33.5	59.5	D
	Westbound	5,936	3	35.3	58.4	E

vphpl = vehicles per hour per lane
mph = miles per hour

Wilbur Smith Associates; November 23, 2004.

PROPOSED MITIGATIVE ACTIONS

The following paragraphs identify potential roadway improvements to mitigate the impacts at those intersections substantially affected by the Kapolei West traffic in 2020.

Kalaeloa Boulevard-Kapolei Parkway – The addition of right-turn lanes on makai-bound Kalaeloa Boulevard and Honolulu-bound Kapolei Parkway approaches, combined with the provision of double left-turn lanes on the Honolulu-bound Kapolei Parkway approach, were proposed to mitigate the Project impacts in 2014. Acceptable conditions could be provided in 2020 with the addition of the two right-turn lanes but without the double left-turn lane on the Honolulu-bound approach of the Kapolei Parkway. The additional right-turn lanes would offset the Project impacts in 2020 as summarized below.

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.92	52.0	D
Afternoon	0.93	52.6	D

The addition of the double left-turn lane would further reduce the average delay per vehicle at the intersection by about 1 to 2 seconds from the approximately 52 second delays indicated above in each peak hour, but would not improve the volume-to-capacity ratio.

Kapolei Parkway-Kamokila Boulevard – At this intersection, the Kapolei West Project would primarily add traffic to the through movements along the Kapolei Parkway. However, the most effective mitigative action would be the provision of a second (double) left turn lane to better accommodate the high volume of left turns from Honolulu-bound Kapolei Parkway onto Kamokila Boulevard. This modification would result in the following conditions:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.62	27.7	C
Afternoon	0.88	37.3	D

Kapolei Parkway-Hanua Street Extension – The Project traffic can be accommodated by the addition of a right-turn lane and a second (double) left-turn lane on the makai-bound approach of Hanua Street Extension, plus the addition of double left-turn lanes on the Honolulu-bound approach of the Kapolei Parkway. These lanes would result in the following intersection conditions with the forecast 2020 peak hour traffic:

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.79	44.2	D
Afternoon	0.93	44.5	D

The proposed number of lanes are depicted in Figure 6-3.

Parcels A/B Access Roads-Kapolei Parkway – The left turns from the makai-side access roads for Parcel B and the middle school would experience extremely long delays with STOP sign controls. The conditions were compared to the MUTCD Warrant #3 criteria

- **Warrant 3 Category A**
  All three conditions of this criteria must be satisfied by the same one-hour period: With the Parcel B approach striped to provide separate left/through- and right-turn lanes, the requirements and forecast values for the afternoon peak hour period are as follows:

Peak Hour Criteria	Minimum Requirement	Forecast Amount	Satisfy Requirement
Minor Street Delay	5 hours	13.8 hours	Yes
Minor Street Volume	150 vehicles	262 vehicles	Yes
Total Intersection Volume	800 vehicles	2,186 vehicles	Yes

  The forecast intersection conditions in 2020 would satisfy the requirements to permit installation of a traffic signal at this location.

- **Warrant 3 Category B**
  For the number of lanes at this intersection and the afternoon peak hour volumes along Kapolei Parkway, this warrant would require a minimum of 150 vehicles exiting one of the two driveways in the peak hour.

  The Parcel B/Middle School Access Road, with a forecast 262 vehicles in the morning peak hour, has more than the minimum volume requirement and satisfies this part of the warrant.

Based on the forecast volumes and conditions in the afternoon peak hour, a traffic signal may be appropriate at this intersection. With the installation of a traffic signal and the existing lanes, the traffic conditions with the forecast 2020 traffic would be as follows:.

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.52	22.9	C
Afternoon	0.66	19.4	B

Roads D/F-Kapolei Parkway – The left turns from the makai-side Road F would experience the longest delay in the afternoon peak hour with STOP sign controls. The conditions were compared to the MUTCD Warrant #3 for consideration of a traffic signal.

- **Warrant 3 Category A**
  All three conditions of this criteria must be satisfied by the same one-hour period: With the Parcel B approach striped to provide separate left/through- and right-turn lanes, the requirements and forecast values for the afternoon peak hour period are as follows:

Peak Hour Criteria	Minimum Requirement	Forecast Amount	Satisfy Requirement
Minor Street Delay	5 hours	20.4 hours	Yes
Minor Street Volume	150 vehicles	237 vehicles	Yes
Total Intersection Volume	800 vehicles	2,254 vehicles	Yes

  The forecast intersection conditions in 2020 would satisfy the requirements to permit installation of a traffic signal at this location.

- **Warrant 3 Category B**
  For the number of lanes at this intersection and the afternoon peak hour volumes along Kapolei Parkway, this warrant would require a minimum of 150 vehicles exiting one of the two driveways in the peak hour.

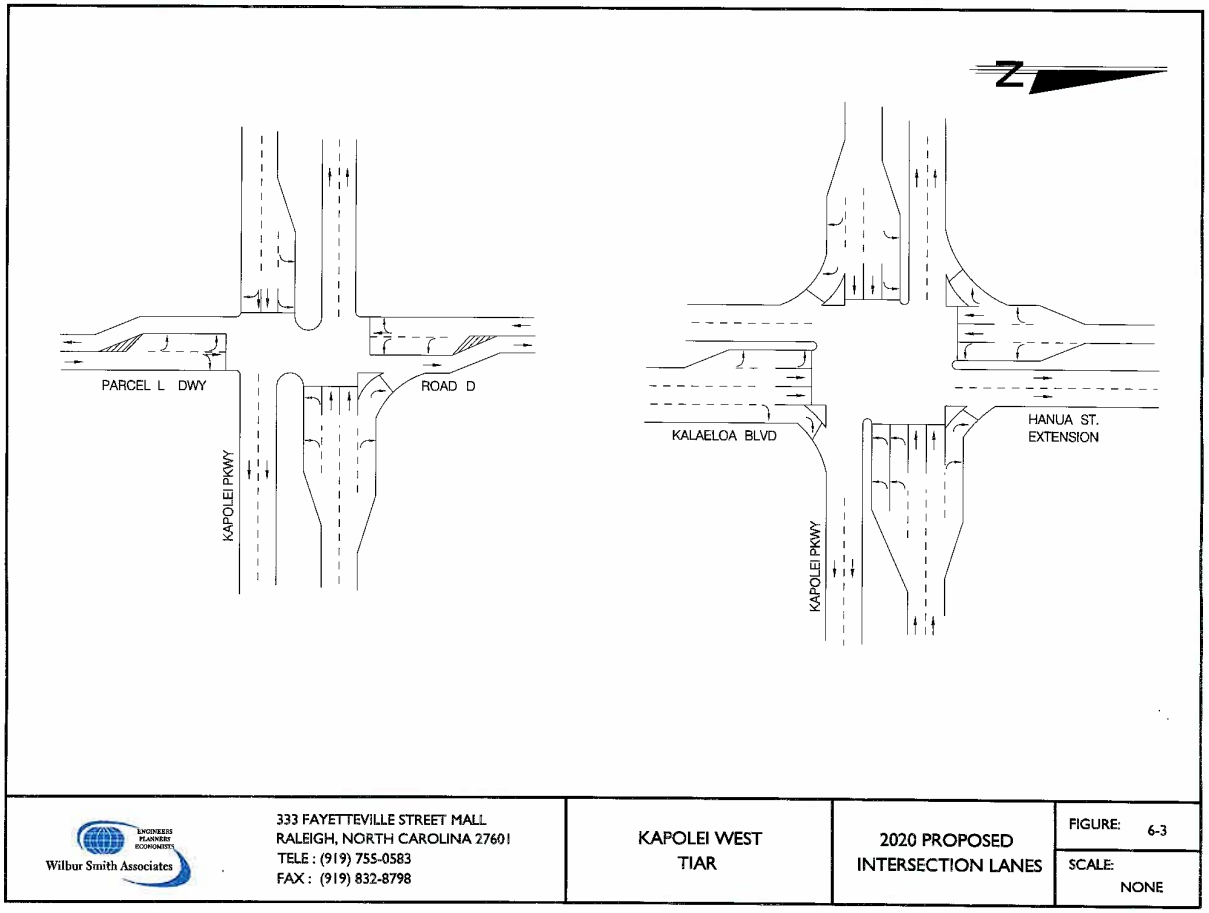
  The Road F approach, with a forecast 237 vehicles in the afternoon peak hour, has more than the minimum volume requirement and satisfies this part of the warrant.

Based on the forecast volumes and conditions in the afternoon peak hour, a traffic signal may be appropriate at this intersection. With the installation of a traffic signal and the existing lanes, the traffic conditions with the forecast 2020 traffic would be as follows:.

Peak Hour	Volume-to-Capacity Ratio	Ave. Delay Per Vehicle (sec.)	Level of Service
Morning	0.44	27.5	C
Afternoon	0.57	29.3	C

The proposed development along the mauka roadway (Road D) is estimated to result in a high volume of right turns from the Waianae-bound approach of the Kapolei Parkway. The provision of a right-turn lane would be desirable to minimize the impacts of the forecast volume of turns on through traffic.

The proposed number of lanes are depicted in Figure 6-3.



Wilbur Smith Associates ENGINEERS PLANNERS ECONOMISTS	333 FAYETTEVILLE STREET MALL RALEIGH, NORTH CAROLINA 27601 TELE : (919) 755-0583 FAX : (919) 832-8798	KAPOLEI WEST TIAR	2020 PROPOSED INTERSECTION LANES	FIGURE: 6-3 SCALE: NONE

APPENDICES

Appendix Table A-1

DISTRIBUTION OF VEHICLE TRIPS
2014 and 2020

Location	Gate	Kapolei Commercial AM	Kapolei Commercial PM	Adjacent Residential AM	Adjacent Residential PM	Recreation Facilities Employees	Recreation Facilities Visitors	Industrial/Harbor AM	Industrial/Harbor PM
H-1 Fwy East	2	29.5	23.5	39.8	39.8	29.5	79.4	51.0	55.0
H-1 Fwy West	1	11.5	10.5	8.5	8.5	11.5	7.9	20.0	21.0
Makakilo Dr	3	11.0	14.0	4.0	4.0	11.0	2.0	5.5	5.0
Roosevelt East		3.5	3.0	3.0	3.0	3.5	0.9	2.0	1.0
Farrington Hwy East	5	2.0	2.0	3.5	3.5	2.0	1.6	1.0	1.0
Kapolei Pkwy East	6	10.0	9.0	3.9	3.9	10.0	0.0	5.5	3.5
Kalaeloa Blvd South	7	4.0	4.0	2.8	2.8	4.0	0.0	2.0	2.0
Villages of Kapolei	10	13.0	12.0	5.0	5.0	13.0	3.7	7.0	4.5
Kapolei Knolls	10	1.0	1.5	0.0	0.0	1.0	0.0	0.5	0.5
Kalaeloa Redev.	15	1.0	3.5	2.0	2.0	1.0	0.0	0.5	1.0
Ko Olina, W. Kapolei	17	4.5	3.5	3.5	3.5	4.5	2.0	0.0	0.0
City of Kapolei		9.0	13.5	24.0	24.0	9.0	2.5	5.0	5.5
Totals		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

11/14/2003

Appendix Table B-1

VEHICLE TRIP GENERATION FOR 2014
NON-PROJECT LAND USES WITHIN CITY OF KAPOLEI

ZONE	Activity	Quantity	Units	ITE Use	Trip Generation Rates: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Vehicle Trips To/From Area: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Trips Less Passbys: PM Peak Hour %	PM Total	PM In	PM Out
4	Kapowai Place	17	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		27	23	3	25	4	21	0		0	0	0
10	Kalaeloa West Retail	157	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		111	68	44	407	174	232	0	0.65	264	113	151
11	Advertiser Printing	30	Emp Trips		0.5	0.4	0.11	1	0.25	0.75		15	12	3	30	8	23	0		0	0	0
12	Kapolei Power Ctr Central	130	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		92	56	36	337	144	192	0	0.65	219	94	125
15	Library																					
	Public Library	16	TSF	590	1	0.72	0.28	7.09	3.4	3.69		16	12	4	113	54	59	0		0	0	0
	Library Distribution	5	TSF	590	1	0.82	0.18	4.76	2.19	2.57		5	4	1	24	11	13	0		0	0	0
16	Civic Center	50	Emp	710	0.48	0.42	0.06	0.46	0.08	0.38		24	21	3	23	4	19	0		0	0	0
17	Ai / Chun Retail	25	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		18	11	7	65	28	37	0	0.35	23	10	13
18	Uluohia																					
	Retail	18	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		13	8	5	47	20	27	0	0.3	14	6	8
	Quality Resturant	5	TSF	831	0	0	0	7.49	5.02	2.47		0	0	0	37	25	12	0	0.56	21	14	7
30	Luana Koa Ph I/ Ph II	217	Veh. Trips		0.68	0.31	0.37	1	0.55	0.45		148	66	81	217	119	98	0		0	0	0
38	Generic A5 Office	36	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		56	49	7	54	9	45	0		0	0	0
41	Kamaaha N2 Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
42	Kamaaha N3																					
	Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
	Private School	68	TSF	521	3.54	2.23	1.31	0.77	0.29	0.48		241	152	89	52	20	33	0		0	0	0
43	Kamaaha N4 Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
44	Block 58 Road E Office	65	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		101	89	12	97	16	81	0		0	0	0
45	Block 59 Road E Ofice	65	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		101	89	12	97	16	81	0		0	0	0
48	Kapolei Power West																					
	Home Depot	146	TSF	862	1.48	0.8	0.68	2.87	1.35	1.52		216	117	99	419	197	222	0	0.52	218	102	115
	Ace Hardware	16	TSF	816	1.08	0.5	0.58	4.42	2.12	2.3		17	8	9	71	34	37	0	0.35	25	12	13
	Retail	25	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		18	11	7	65	28	37	0	0.35	23	10	13
	Theme Steak House	6	TSF	831	0	0	0	7.49	5.02	2.47		0	0	0	45	30	15	0	0.56	25	17	8
69	Kapolei Mauka Residential																					
	Low Density	350	DU	231	0.67	0.17	0.5	0.62	0.42	0.2		235	60	175	217	147	70	0		0	0	0
	Total											**1636**	**1014**	**622**	**2615**	**1118**	**1497**	**0**		**831**	**378**	**453**

10/27/2004

Appendix Table B-2

VEHICLE TRIP GENERATION FOR 2014
KAPOLEI REZONING PARCELS 1, 2 & 3

					Trip Generation Rates							Vehicle Trips To/From Area							Trips Less Passbys			
					AM Peak Hour			PM Peak Hour				AM Peak Hour			PM Peak Hour				PM Peak Hour			
ZONE	Activity	Quantity	Units	ITE Use	Total	In	Out	Total	In	Out	Daily	Total	In	Out	Total	In	Out	Daily	%	Total	In	Out
	Parcel 1																					
8	Civic Center																					
	Office	205	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		320	281	39	305	51	254	0		0	0	0
20	South Kalaeloa	113	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		80	49	32	293	125	167	0	0.61	179	77	102
34	Generic A1 Office	45	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		70	62	9	67	11	56	0		0	0	0
35	Generic A2 Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
36	Generic A3 Office	65	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		101	89	12	97	16	81	0		0	0	0
	Mid rise Apts	300	DU	223	0.3	0.09	0.21	0.39	0.23	0.16		90	27	63	117	69	48	0		0	0	0
37	Generic A4 Office	36	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		56	49	7	54	9	45	0		0	0	0
39	Generic A6 Office	36	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		56	49	7	54	9	45	0		0	0	0
40	Kamaaha N1 Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
49	Generic D3 Office	100	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		156	137	19	149	25	124	0		0	0	0
50	Generic B1 Retail	65	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		46	28	18	168	72	96	0	0.6	101	43	58
51	Generic B2 Retail	0	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		0	0	0	0	0	0	0	0.6	0	0	0
55	Generic B3 Retail	70	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		50	30	20	181	78	104	0	0.6	109	47	62
60	Generic D1 Office	140	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		218	192	27	209	35	174	0		0	0	0
	Total											**1366**	**1099**	**266.4**	**1810**	**521**	**1289**	**0**		**388**	**166**	**222**
	Parcel 2																					
21	North Kalaeloa Retail	120	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		85	52	34	311	133	178	0	0.62	193	83	110
	Total											**85**	**52**	**34**	**311**	**133**	**178**	**0**		**193**	**83**	**110**
	Parcel 3																					
31	Farrington Commercial	175	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		124	75	49	453	194	259	0	0.68	308	132	176
	Total											**124**	**75**	**49**	**453**	**194**	**259**	**0**		**308**	**132**	**176**
	Grand Total											**1575**	**1226**	**349**	**2574**	**848**	**1726**	**0**		**889**	**381**	**508**

6/28/2004

Appendix Table B-3

VEHICLE TRIP GENERATION FOR 2014
NON-PROJECT EAST AND SOUTH AREAS

					Trip Generation Rates							Vehicle Trips To/From Area							Trips Less Passbys			
					AM Peak Hour			PM Peak Hour				AM Peak Hour			PM Peak Hour				PM Peak Hour			
ZONE	Activity	Quantity	Units	ITE Use	Total	In	Out	Total	In	Out	Daily	Total	In	Out	Total	In	Out	Daily	%	Total	In	Out
	Villages of Kapolei																					
23	Village Center																					
	Church	67	TSF	560	0.72	0.39	0.33	0.66	0.36	0.3		48	26	22	44	24	20	0		0	0	0
	Shopping Center	67	TSF	320	0.71	0.43	0.28	2.59	1.11	1.48		48	29	19	174	74	99	0	0.6	104	45	59
	Medium Density Apts	290	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		128	20	107	157	104	52	0		0	0	0
27	Kapolei Village																					
	Single Family	314	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		236	60	176	317	204	113	0		0	0	0
32	NW Commercial																					
	Shopping Center	199.5	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		142	86	56	517	221	295	0	0.68	351	151	201
	Medium Density Apts	200	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		88	14	74	108	72	36	0		0	0	0
33	Kapolei Knolls																					
	Single Family	133	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		100	25	74	134	86	48	0		0	0	0
	Total											**788**	**260**	**528**	**1451**	**787**	**664**	**0**		**455**	**195**	**260**
	Kalaeloa Redevelopment Area																					
56	West Area Lt. Ind.	55	Acres	110	7.51	6.23	1.28	7.26	1.6	5.66		413	343	70	399	88	311	0		0	0	0
58	Regional Park	150	Acres	417	0.12	0.07	0.05	0.2	0.09	0.11		18	11	8	30	14	17	0		0	0	0
57	Vocational School	25	Emp	540	2.85	2.28	0.57	3.12	1.78	1.34		71	57	14	78	45	34	0		0	0	0
	Total											**502**	**410**	**92**	**507**	**146**	**361**	**0**		**0**	**0**	**0**
24	**Makakilo**																					
	Condominiums	236	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		104	17	87	127	85	42	0		0	0	0
	Single Family	674	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		506	128	377	681	438	243	0		0	0	0
	Total											**609**	**145**	**465**	**808**	**523**	**285**	**0**		**0**	**0**	**0**
	Grand Total											**1900**	**815**	**1085**	**2766**	**1456**	**1310**	**0**		**455**	**195**	**260**

6/28/2004

Appendix Table B-4

VEHICLE TRIP GENERATION FOR 2014
NON-PROJECT AREAS WEST OF KAPOLEI

ZONE	Activity	Quantity	Units	ITE Use	Trip Generation Rates: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Vehicle Trips To/From Area: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Trips Less Passbys: %	PM Peak Hour Total	PM In	PM Out
	Kapolei Business Park																					
25	Ind. Park	1268	TSF	110	0.82	0.7	0.12	0.86	0.18	0.68		1040	888	152	1090	228	862	0		0	0	0
	Barbers Pt. Harbor																					
28	**Lt. Ind.**	140	Veh Trips	110	1	0.81	0.19	0	0	0		140	113	27	0	0	0	0		0	0	0
		115	Veh Trips		0	0	0	1	0.32	0.68		0	0	0	115	37	78	0		0	0	0
	Ko Olina																					
61	Resort Beach Areas																					
	Hotel	990	Rooms	330	0.31	0.22	0.09	0.42	0.18	0.24		307	218	89	416	178	238	0		0	0	0
62	Olani St Hotel	300	Rooms	330	0.31	0.22	0.09	0.42	0.18	0.24		93	66	27	126	54	72	0		0	0	0
63	Coconut Plantation/Centex																					
	Single Family	60	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		45	11	34	61	39	22	0		0	0	0
	Medium Density	390	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		172	27	144	211	140	70	0		0	0	0
64	Medium Density	50	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		22	4	19	27	18	9	0		0	0	0
65	Marriott Timeshares	470	DU	330	0.31	0.22	0.09	0.42	0.18	0.24		146	103	42	197	85	113	0		0	0	0
	Aquarium	25	Veh Trips		1	0.87	0.13	0	0	0		25	22	3	0	0	0	0				
		180	Veh Trips		0	0	0	1	0.44	0.56		0	0	0	180	79	101	0				
67	Low Density	160	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		107	27	80	133	75	58	0		0	0	0
	Total											**916**	**478**	**438**	**1350**	**669**	**682**	**0 0**		**0**	**0**	**0**
	Makaiwa																					
68	Makaiwa Hills																					
	Single Family	750	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		563	143	420	758	488	270	0		0	0	0
	Low Density	375	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		251	64	188	311	176	135	0		0	0	0
	Medium Density	375	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		165	26	139	203	135	68	0		0	0	0
	Total											**979**	**233**	**746**	**1271**	**799**	**473**	**0 0**		**0**	**0**	**0**
	Grand Total											**3075**	**1712**	**1363**	**3827**	**1732**	**2095**	**0 0**		**0**	**0**	**0**

10/28/2004

Appendix Table B-5

VEHICLE TRIP GENERATION FOR 2014
KAPOLEI SOUTH RESIDENTIAL AND KAPOLEI WEST AREAS
Kapolei West Urbanized Area Only

ZONE	Activity	Quantity	Units	ITE Use	Trip Generation Rates: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Vehicle Trips To/From Area: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Trips Less Passbys: %	PM Peak Hour Total	PM In	PM Out
	South Residential (Schuler)																					
53	Schuler East																					
	Low Density	270	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		181	46	135	224	127	97	0		0	0	0
	Medium Density	230	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		101	16	85	124	83	41	0		0	0	0
52	Schuler West																			0	0	0
	Neighborhood Commercial	10	TSF		0.71	0.43	0.28	2.59	1.11	1.48		7	4	3	26	11	15	0	0.30	8	3	4
	Apartments	30	DU	220	0.3	0.09	0.21	0.39	0.23	0.16		9	3	6	12	7	5	0				
	Low Density	344	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		230	58	172	286	162	124	0		0	0	0
	Medium Density	282	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		124	20	104	152	102	51	0		0	0	0
54	Elementary School	650	Student	520	0.29	0.17	0.12	0.07	0.04	0.03		189	111	78	46	26	20	0		0	0	0
	Total											**841**	**258**	**584**	**869**	**517**	**352**	**0 0**		**7.77**	**3.33**	**4.44**
	Kapolei West																					
66	Regional Commercial	255	TSF	820	1.03	0.63	0.4	3.75	1.8	1.95		263	161	102	956	459	497	0	0.70	669	321	348
71	"L" Transit/Mixed Use																					
	Med Density Resident	150	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		66	11	56	81	54	27	0		0	0	0
	Commercial	100	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		71	43	28	259	111	148	0	0.60	155	67	89
72	"A" Residential																					
	Primary Resident SF Homes	162	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		122	31	91	164	105	58	0		0	0	0
	Non-Resident Homes	29	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		9	4	4	9	4	5	0		0	0	0
73	"C" Residential																					
	Primary Resident SF Homes	113	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		85	21	63	114	73	41	0		0	0	0
	Non-Resident Homes	38	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		11	6	6	12	5	6	0		0	0	0
74	"B" Residential																					
	Primary Resident MF Homes	208	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		92	15	77	112	75	37	0		0	0	0
	Non-Resident Homes	37	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		11	6	6	11	5	6	0		0	0	0
	Middle School	600	Student	522	0.53	0.29	0.24	0.15	0.08	0.07		318	174	144	90	48	42	0	0.75	68	36	32
75	Golf Course	18	Holes	430	3.01	1.41	1.6	3.56	1.53	2.03		54	25	29	64	28	37	0		0	0	0
76	"D,I,J" + Neighborhood Com.																					
	Primary Resident SF Homes	357	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		268	68	200	361	232	129	0		0	0	0
	Non-Resident Homes	160	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		48	24	24	50	22	27	0		0	0	0
	Neighborhood Commercial	22	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		7	4	3	26	11	15	0	0.30	8	3	4
	Total											**1424**	**592**	**832**	**2309**	**1233**	**1076**	**0 0**		**900**	**427**	**472**
	Grand Total											**2265**	**849**	**1415**	**3178**	**1750**	**1428**	**0 0**		**908**	**430**	**477**

11/16/2004

Appendix Table B-6

VEHICLE TRIP GENERATION FOR 2014
KAPOLEI SOUTH RESIDENTIAL AND KAPOLEI WEST AREAS
Combined Kapolei West Urbanized and Petition Areas

ZONE	Activity	Quantity	Units	ITE Use	Trip Generation Rates: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Vehicle Trips To/From Area: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Trips Less Passbys: PM Peak Hour %	PM Total	PM In	PM Out
	South Residential (Schuler)																					
53	Schuler East																					
	Low Density	270	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		181	46	135	224	127	97	0		0	0	0
	Medium Density	230	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		101	16	85	124	83	41	0		0	0	0
52	Schuler West																			0	0	0
	Neighborhood Commercial	10	TSF		0.71	0.43	0.28	2.59	1.11	1.48		7	4	3	26	11	15	0	0.30	8	3	4
	Apartments	30	DU	220	0.3	0.09	0.21	0.39	0.23	0.16		9	3	6	12	7	5	0				
	Low Density	344	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		230	58	172	286	162	124	0		0	0	0
	Medium Density	282	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		124	20	104	152	102	51	0		0	0	0
54	Elementary School	650	Student	520	0.29	0.17	0.12	0.07	0.04	0.03		189	111	78	46	26	20	0		0	0	0
	Total											**841**	**258**	**584**	**869**	**517**	**352**	**0**	**0**	**7.77**	**3.33**	**4.44**
	Kapolei West																					
66	Regional Commercial	255	TSF	820	1.03	0.63	0.4	3.75	1.8	1.95		263	161	102	956	459	497	0	0.70	669	321	348
72	"A" Residential																					
	Primary Resident SF Homes	162	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		122	31	91	164	105	58	0		0	0	0
	Non-Resident Homes	29	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		9	4	4	9	4	5	0		0	0	0
73	"C" Residential																					
	Primary Resident SF Homes	113	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		85	21	63	114	73	41	0		0	0	0
	Non-Resident Homes	38	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		11	6	6	12	5	6	0		0	0	0
74	"B" Residential																					
	Primary Resident MF Homes	208	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		92	15	77	112	75	37	0		0	0	0
	Non-Resident Homes	37	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		11	6	6	11	5	6	0		0	0	0
	Middle School	600	Student	522	0.53	0.29	0.24	0.15	0.08	0.07		318	174	144	90	48	42	0	0.75	68	36	32
75	Golf Course	18	Holes	430	3.01	1.41	1.6	3.56	1.53	2.03		54	25	29	64	28	37	0		0	0	0
76	"I,J" + Neighborhood Com.																					
	Primary Resident SF Homes	94	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		71	18	53	95	61	34	0		0	0	0
	Non-Resident Homes	114	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		34	17	17	35	16	19	0		0	0	0
	Neighborhood Commercial	22	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		7	4	3	26	11	15	0	0.30	8	3	4
77	"61%(E, F), K" Residential																					
	Med Density Primary Residen	93	DU	210	0.44	0.07	0.37	0.54	0.36	0.18		41	7	34	50	33	17	0		0	0	0
	Med Density Non-Resident H	218	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		65	33	33	68	31	37	0		0	0	0
	Low Dens Primary Resident H	147	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		98	25	74	122	69	53	0		0	0	0
	Low Dens Non-Resident Hom	32	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		10	5	5	10	4	5	0		0	0	0
	Total											**1290**	**550**	**740**	**1939**	**1028**	**910**	**0**	**0**	**745**	**360**	**384**
	Grand Total											**2131**	**808**	**1323**	**2808**	**1545**	**1263**	**0**	**0**	**753**	**364**	**388**

11/16/2004

Appendix Table C-1

VEHICLE TRIP GENERATION FOR 2020
NON-PROJECT LAND USES WITHIN CITY OF KAPOLEI

ZONE	Activity	Quantity	Units	ITE Use	Trip Generation Rates: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Vehicle Trips To/From Area: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Trips Less Passbys: PM Peak Hour %	PM Total	PM In	PM Out
4	Kapowai Place	17	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		27	23	3	25	4	21	0		0	0	0
10	Kalaeloa West Retail	157	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		111	68	44	407	174	232	0	0.65	264	113	151
11	Advertiser Printing	30	Emp Trips		0.5	0.4	0.11	1	0.25	0.75		15	12	3	30	8	23	0		0	0	0
12	Kapolei Power Ctr Central	130	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		92	56	36	337	144	192	0	0.65	219	94	125
	FHB Branch Bank	3	TSF	911	4.07	2.28	1.79	33.14	16.57	16.6		12	7	5	99	50	50	0	0.53	53	26	26
	FHB Office	7	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		11	10	1	10	2	9	0				
15	Library																					
	Public Library	16	TSF	590	1	0.72	0.28	7.09	3.4	3.69		16	12	4	113	54	59	0		0	0	0
	Library Distribution	5	TSF	590	1	0.82	0.18	4.76	2.19	2.57		5	4	1	24	11	13	0		0	0	0
16	Civic Center	50	Emp	710	0.48	0.42	0.06	0.46	0.08	0.38		24	21	3	23	4	19	0		0	0	0
17	Ai / Chun Retail	25	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		18	11	7	65	28	37	0	0.35	23	10	13
18	Uluohia																					
	Retail	6	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		4	3	2	16	7	9	0	0.3	5	2	3
	Quality Resturant	5	TSF	831	0	0	0	7.49	5.02	2.47		0	0	0	37	25	12	0	0.56	21	14	7
	Lot 56 Restaurant	6	TSF	831	0	0	0	7.49	5.02	2.47		0	0	0	45	30	15	0	0.56	25	17	8
30	Luana Koa Ph I/ Ph II	217	Veh. Trips		0.68	0.31	0.37	1	0.55	0.45		148	66	81	217	119	98	0		0	0	0
38	Generic A5 Office	36	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		56	49	7	54	9	45	0		0	0	0
41	Kamaaha N2 Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
42	Kamaaha N3																					
	Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
	Private School	760	Students	521	0.92	0.55	0.37	0.2	0.08	0.12		699	418	281	152	61	91	0		0	0	0
43	YMCA	40	TSF	495	1.32	0.87	0.45	1.75	0.6	1.15		53	35	18	70	24	46	0		0	0	0
44	Block 58 Road E Office	40	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		62	55	8	60	10	50	0		0	0	0
45	Block 59 Road E Ofice	48	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		75	66	9	72	12	60	0		0	0	0
46	Pad A Bank Drive-thru	3	TSF	912	12.63	7.07	5.56	54.78	27.39	27.4		38	21	17	164	82	82		0.53	87	44	44
48	Kapolei Power West																					
	Home Depot	146	TSF	862	1.48	0.8	0.68	2.87	1.35	1.52		216	117	99	419	197	222	0	0.52	218	102	115
	Ace Hardware	16	TSF	816	1.08	0.5	0.58	4.42	2.12	2.3		17	8	9	71	34	37	0	0.35	25	12	13
	Retail	15	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		11	6	4	39	17	22	0	0.35	14	6	8
	Theme Steak House	6	TSF	831	0	0	0	7.49	5.02	2.47		0	0	0	45	30	15	0	0.56	25	17	8
69	Kapolei Mauka Residential																					
	Low Density	350	DU	231	0.67	0.17	0.5	0.62	0.42	0.2		235	60	175	217	147	70	0		0	0	0
	Total											**2067**	**1233**	**834**	**2926**	**1302**	**1624**	**0**		**978**	**457**	**521**

10/27/2004

Appendix Table C-2

VEHICLE TRIP GENERATION FOR 2020
KAPOLEI REZONING PARCELS 1, 2 & 3

					Trip Generation Rates							Vehicle Trips To/From Area							Trips Less Passbys			
				ITE	AM Peak Hour			PM Peak Hour				AM Peak Hour			PM Peak Hour				PM Peak Hour			
ZONE	Activity	Quantity	Units	Use	Total	In	Out	Total	In	Out	Daily	Total	In	Out	Total	In	Out	Daily	%	Total	In	Out
	Parcel 1																					
8	Civic Center																					
	Office	205	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		320	281	39	305	51	254	0		0	0	0
20	South Kalaeloa	113	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		80	49	32	293	125	167	0	0.65	190	82	109
34	Generic A1 Office	45	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		70	62	9	67	11	56	0		0	0	0
35	Generic A2 Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
36	Generic A3 Office	130	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		203	178	25	194	33	161	0		0	0	0
	Mid rise Apts	300	DU	223	0.3	0.09	0.21	0.39	0.23	0.16		90	27	63	117	69	48	0		0	0	0
37	Generic A4 Office	36	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		56	49	7	54	9	45	0		0	0	0
39	Generic A6 Office	36	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		56	49	7	54	9	45	0		0	0	0
40	Kamaaha N1 Office	39	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		61	53	7	58	10	48	0		0	0	0
49	Generic D3 Office	100	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		156	137	19	149	25	124	0		0	0	0
50	Generic B1 Retail	65	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		46	28	18	168	72	96	0	0.6	101	43	58
51	Generic B2 Retail	65	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		46	28	18	168	72	96	0	0.6	101	43	58
55	Generic B3 Retail	70	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		50	30	20	181	78	104	0	0.6	109	47	62
60	Generic D1 Office	250	TSF	710	1.56	1.37	0.19	1.49	0.25	1.24		390	343	48	373	63	310	0		0	0	0
	Total											**1685**	**1367**	**317.8**	**2239**	**636**	**1602**	**0**		**501**	**215**	**286**
	Parcel 2																					
21	North Kalaeloa Retail	120	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		85	52	34	311	133	178	0	0.62	193	83	110
	Total											**85**	**52**	**34**	**311**	**133**	**178**	**0**		**193**	**83**	**110**
	Parcel 3																					
31	Farrington Commercial	217.8	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		155	94	61	564	242	322	0	0.68	384	164	219
	Total											**155**	**94**	**61**	**564**	**242**	**322**	**0**		**384**	**164**	**219**
	Grand Total											**1925**	**1512**	**412.4**	**3114**	**1011**	**2102**	**0**		**1077**	**462**	**616**

1/22/2004

Appendix Table C-3

VEHICLE TRIP GENERATION FOR 2020
NON-PROJECT EAST AND SOUTH AREAS

					Trip Generation Rates							Vehicle Trips To/From Area							Trips Less Passbys			
				ITE	AM Peak Hour			PM Peak Hour				AM Peak Hour			PM Peak Hour				PM Peak Hour			
ZONE	Activity	Quantity	Units	Use	Total	In	Out	Total	In	Out	Daily	Total	In	Out	Total	In	Out	Daily	%	Total	In	Out
	Villages of Kapolei																					
23	Village Center																					
	Church	67	TSF	560	0.72	0.39	0.33	0.66	0.36	0.3		48	26	22	44	24	20	0		0	0	0
	Shopping Center	67	TSF	320	0.71	0.43	0.28	2.59	1.11	1.48		48	29	19	174	74	99	0	0.65	113	48	64
	Medium Density Apts	290	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		128	20	107	157	104	52	0		0	0	0
27	Kapolei Village																					
	Single Family	314	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		236	60	176	317	204	113	0		0	0	0
32	NW Commercial																					
	Shopping Center	199.5	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		142	86	56	517	221	295	0	0.68	351	151	201
	Medium Density Apts	200	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		88	14	74	108	72	36	0		0	0	0
33	Kapolei Knolls																					
	Single Family	133	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		100	25	74	134	86	48	0		0	0	0
	Total											**788**	**260**	**528**	**1451**	**787**	**664**	**0**		**464**	**199**	**265**
	Kalaeloa Redevelopment Area																					
56	West Area Lt. Ind.	85	Acres	110	7.51	6.23	1.28	7.26	1.6	5.66		638	530	109	617	136	481	0		0	0	0
58	Regional Park	250	Acres	417	0.12	0.07	0.05	0.2	0.09	0.11		30	18	13	50	23	28	0		0	0	0
57	Office	250	Acres	710	1.56	1.37	0.19	1.49	0.25	1.24		390	343	48	373	63	310	0				
	Vocational School	25	Emp	540	2.85	2.28	0.57	3.12	1.78	1.34		71	57	14	78	45	34	0		0	0	0
	Total											**1130**	**947**	**183**	**1118**	**266**	**852**	**0**		**0**	**0**	**0**
24	**Makakilo**																					
	Condominiums	236	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		104	17	87	127	85	42	0		0	0	0
	Single Family	674	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		506	128	377	681	438	243	0		0	0	0
	Total											**609**	**145**	**465**	**808**	**523**	**285**	**0**		**0**	**0**	**0**
	Grand Total											**2527**	**1351**	**1176**	**3376**	**1575**	**1801**	**0**		**464**	**199**	**265**

6/29/2004

Appendix Table C-4

VEHICLE TRIP GENERATION FOR 2020
NON-PROJECT AREAS WEST OF KAPOLEI

ZONE	Activity	Quantity	Units	ITE Use	Trip Generation Rates: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Vehicle Trips To/From Area: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Trips Less Passbys: %	PM Peak Hour Total	PM In	PM Out
	Kapolei Business Park																					
25	Ind. Park	1952	TSF	130	0.82	0.7	0.12	0.86	0.18	0.68		1601	1366	234	1679	351	1327	0		0	0	0
	Barbers Pt. Harbor																		0.65			
28	**Lt. Ind.**	235	Veh Trips	110	1	0.81	0.19	0	0	0		235	190	45	0	0	0	0		0	0	0
		190	Veh Trips		0	0	0	1	0.32	0.68		0	0	0	190	61	129	0		0	0	0
70	**Theme Park**	83	Veh Trips		1	0.87	0.13	0	0	0		83	72	11	0	0	0	0				
		675	Veh Trips		0	0	0	1	0.44	0.56		0	0	0	675	297	378	0				
29	**Amphitheater**	30	Emp	110	0.44	0.37	0.07	0.42	0.09	0.33		13	11	2	13	3	10	0				
	Ko Olina																					
61	Resort Beach Areas																					
	Hotel	1790	Rooms	330	0.31	0.22	0.09	0.42	0.18	0.24		555	394	161	752	322	430	0		0	0	0
62	Olani St Hotel	300	Rooms	330	0.31	0.22	0.09	0.42	0.18	0.24		93	66	27	126	54	72	0		0	0	0
63	Coconut Plantation/Centex																					
	Single Family	60	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		45	11	34	61	39	22	0		0	0	0
	Medium Density	390	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		172	27	144	211	140	70	0		0	0	0
64	Medium Density	410	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		180	29	152	221	148	74	0		0	0	0
65	Marina Area																					
	Marriott Timeshares	650	DU	330	0.31	0.22	0.09	0.42	0.18	0.24		202	143	59	273	117	156	0				
	Aquarium	25	Veh Trips		1	0.87	0.13	0	0	0		25	22	3	0	0	0	0				
		180	Veh Trips		0	0	0	1	0.44	0.56		0	0	0	180	79	101	0				
67	Low Density	160	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		107	27	80	133	75	58	0		0	0	0
	Total											**1379**	**719**	**659**	**1956**	**975**	**982**	**0 0**		**0**	**0**	**0**
	Makaiwa																					
68	Makaiwa Hills																					
	Single Family	1500	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		1125	285	840	1515	975	540	0		0	0	0
	Low Density	750	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		503	128	375	623	353	270	0		0	0	0
	Medium Density	750	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		330	53	278	405	270	135	0		0	0	0
	Total											**1958**	**465**	**1493**	**2543**	**1598**	**945**	**0 0**		**0**	**0**	**0**
	Grand Total											**5268**	**2824**	**2444**	**7055**	**3284**	**3771**	**0 0**		**0**	**0**	**0**

11/16/2004

Appendix Table C-5

VEHICLE TRIP GENERATION FOR 2020
KAPOLEI SOUTH RESIDENTIAL AND WEST KAPOLEI AREAS

ZONE	Activity	Quantity	Units	ITE Use	Trip Generation Rates: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Vehicle Trips To/From Area: AM Peak Hour Total	AM In	AM Out	PM Peak Hour Total	PM In	PM Out	Daily	Trips Less Passbys: %	PM Peak Hour Total	PM In	PM Out
	South Residential (Schuler)																					
52	Schuler West																					
	Low Density	344	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		230	58	172	286	162	124	0		0	0	0
	Medium Density	282	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		124	20	104	152	102	51	0	0.65	99	66	33
	Neighborhood Commercial	10	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		7	4	3	26	11	15	0	0.30	8	3	4
	Apartments	30	DU	220	0.3	0.09	0.21	0.39	0.23	0.16		9	3	6	12	7	5	0				
53	Schuler East																					
	Low Density	270	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		181	46	135	224	127	97	0		0	0	0
	Medium Density	230	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		101	16	85	124	83	41	0		0	0	0
54	Elementary School	650	Student	520	0.29	0.17	0.12	0.07	0.04	0.03		189	111	78	46	26	20	0		0	0	0
	Total											**841**	**258**	**583**	**870**	**517**	**353**	**0**		**107**	**69**	**37**
	Kapolei West Buildout																					
66	Regional Commercial	255	TSF	820	1.03	0.63	0.4	3.75	1.8	1.95		263	161	102	956	459	497	0	0.70	669	321	348
71	"L" Transit/Mixed Use																					
	Med Density Resident	150	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		66	11	56	81	54	27	0		0	0	0
	Commercial	100	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		71	43	28	259	111	148	0	0.60	155	67	89
72	"A" Residential																					
	Primary Resident SF Homes	162	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		122	31	91	164	105	58	0		0	0	0
	Non-Resident Homes	29	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		9	4	4	9	4	5	0		0	0	0
73	"C" Residential																					
	Primary Resident SF Homes	113	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		85	21	63	114	73	41	0		0	0	0
	Non-Resident Homes	38	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		11	6	6	12	5	6	0		0	0	0
74	"B" Residential																					
	Primary Resident Med Density	208	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		92	15	77	112	75	37	0		0	0	0
	Non-Resident Homes	37	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		11	6	6	11	5	6	0		0	0	0
	Middle School	600	Student	522	0.53	0.29	0.24	0.15	0.08	0.07		318	174	144	90	48	42	0	0.75	68	36	32
75	Golf Course	18	Holes	430	3.01	1.41	1.6	3.56	1.53	2.03		54	25	29	64	28	37	0		0	0	0
76	"I,J,D" + Neighborhood Com.																					
	Primary Resident SF Homes	357	DU	210	0.75	0.19	0.56	1.01	0.65	0.36		268	68	200	361	232	129	0		0	0	0
	Non-Resident Homes	160	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		48	24	24	50	22	27	0		0	0	0
	Neighborhood Commercial	22	TSF	814	0.71	0.43	0.28	2.59	1.11	1.48		7	4	3	26	11	15	0	0.30	8	3	4
77	"E, F, G, H, K" Residential																					
	Med Density Primary Resident Hom	243	DU	230	0.44	0.07	0.37	0.54	0.36	0.18		107	17	90	131	87	44	0		0	0	0
	Med Density Non-Resident Homes	592	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		178	89	89	184	83	101	0		0	0	0
	Low Dens Primary Resident Homes	237	DU	231	0.67	0.17	0.5	0.83	0.47	0.36		159	40	119	197	111	85	0		0	0	0
	Low Dens Non-Resident Homes	48	DU	260	0.3	0.15	0.15	0.31	0.14	0.17		14	7	7	15	7	8	0		0	0	0
	Total											**1881**	**745**	**1136**	**2835**	**1522**	**1313**	**0 0**		**2 901**	**427**	**473**
	Grand Total											**2722**	**1003**	**1720**	**3705**	**2039**	**1666**	**0 0**		**2 1008**	**496**	**510**

11/16/2004

Appendix D
Methodology for Analyzing Traffic Conditions

The Transportation Research Board (TRB), a division of the National Science Foundation, has developed standardized methods for use in evaluating the effectiveness and quality of service for roadways and streets. Different methodologies are available for analyzing traffic signal-controlled intersections and other types of roadways.

The TRB evaluation methods use concepts referred to as volume-to-capacity ratio and level-of-service (LOS). The volume-to-capacity ratio (V/C) compares the existing or projected traffic volumes on a facility to the facility's theoretical capacity and, as such, indicates the relative adequacy of the facility to accommodate the traffic volumes. Capacity is estimated primarily from the facility's physical characteristics (e.g. number and widths of lanes), and to a lesser extent by the traffic characteristics (e.g. types of vehicles) and type of traffic controls. The level of service concept describes facility traffic conditions in terms of travel delays or travel speeds, with the service quality expressed on a letter basis from A to F, which signify excellent to unacceptable conditions, respectively.

Signal-Controlled Intersections--Traffic conditions at traffic signal-controlled intersections were evaluated using the Operations Analysis methodology described in the *2000 Highway Capacity Manual (HCM).*[1] The methodology calculates a ratio of actual or estimated peak hour traffic volumes to the theoretical capacity of the intersection. This volume-to-capacity ratio (V/C) reflects the physical characteristics of the intersection and the traffic characteristics, and is somewhat independent of the efficiency of the traffic signal phasing/timing. This ratio indicates the proportion of available capacity being used by traffic volumes and where there is unused capacity available for future traffic increases.

With the 2000 HCM method, the level-of-service is based on the average delay per vehicle for the various movements within the intersection as a result of the traffic signal control. This total delay is the difference between the travel time experienced with the traffic signal and the reference travel time that would result under ideal conditions, in the absence of the traffic control and geometric delay. This delay, referred to as control delay, includes initial deceleration delay, stop delay, queue move-up delay, and final acceleration delay. Average delay time and level-of-service is estimated for the entire intersection, for each roadway approach, and for each traffic movement or lane group.

The level of service for a traffic signal-controlled intersection are defined to reflect the duration of control delay at the intersection. A description of the criteria associated with LOS A through LOS F at is provided in Table D-1.

[1] *2000 Highway Capacity Manual,* Transportation Research Board, October 2000.

LOS A represents operations with low control delay due to the traffic signal. This occurs when progression is extremely favorable and many vehicles do not stop at all. Short cycle lengths tend to contribute to low delay values.

LOS B also occurs with good progression and short cycle lengths, but typically reflects a higher number of vehicles being required to stop at the signal.

The increased delays at LOS C may result from only fair progression, longer cycle lengths, or both. Cycle failures may begin at this level, when all vehicles do not clear for an individual movement during its green phase. The number of vehicles stopping is significant, although many still pass through the intersection without stopping.

At LOS D, the influence of congestion and individual cycle failures becomes more noticeable. Longer delays may result from some combination of long cycle lengths, unfavorable progression, and high volumes of vehicles relative to the intersection capacity. The proportion of vehicles not stopping declines. This condition may be considered acceptable during peak traffic hours in urban areas.

LOS E describes unstable traffic operations when individual cycle failures are frequent. The high delay values generally result from a high volume of traffic relative to the intersection capacity, long cycle lengths, and poor progression.

LOS F often occurs with over-saturation of the intersection with traffic when the arrival flow rate of vehicles exceeds the capacity of one or more of the traffic movements. Poor progression and long cycle lengths may also contribute to high delay levels. This level of delay is considered unacceptable to most drivers.

Delays in the range of LOS F can occur with traffic volumes less than the intersection capacity where there are long cycle lengths, poor signal progression, or a major traffic movement is disadvantaged by the allocation of green time. Conversely, an intersection can experience delays at LOS E or better when traffic exceeds the intersection capacity if there are short cycle lengths or major flows that receive very short delays.

In the assessment of traffic signal-controlled intersections, it is usually most appropriate to relate the adequacy of the geometric design features (such as numbers and use of lanes, lane widths, etc.) to the V/C. Delay and LOS are most relevant to assessing modifications to the traffic signal controls, since these are most directly related to the signal design features, such as cycle length, number and arrangement of phases, allocation of green time, and the degree of coordination with adjacent traffic signals.

Unsignalized Intersections—At intersections with STOP sign controls, the level of service was calculated using the 2000 HCM procedures for intersections with STOP or YIELD signs. In this methodology, the six levels of service, A through F, are used to describe traffic conditions for those movements that must yield to other movements:

- Left-turn out of the side street or driveway;

- Through movement from the side street,
- Right-turn out of the side street or driveway; and
- Left-turn into the side street.

Through vehicles on the major streets are not required to yield to other movements at two-way STOP controlled intersections.

The general indicator of intersection delay is determined by calculating the one-hour capacity for each key movement, based on the conflicting traffic volumes, and then comparing the number of vehicles making that maneuver to the calculated capacity. The unused or "reserve" capacity for the movement is then used to identify a delay time and a level-of-service for that movement. Unlike analysis at signalized intersections, an overall intersection level-of-service is not calculated, but a level-of-service is calculated for each lane group subject to the STOP or YIELD condition.

The level-of-service criteria for unsignalized intersections with STOP or YIELD controls are defined in Table D-2.

Table D-1

LEVEL-OF-SERVICE CRITERIA FOR INTERSECTIONS WITH TRAFFIC SIGNAL CONTROL

LOS	Average Stopped Delay (seconds/vehicle)
A	<10.0
B	10.1 - 20.0
C	20.1 - 35.0
D	35.1 - 55.0
E	55.1 - 80.0
F	>80

Source: 2000 Highway Capacity Manual, Transportation Research Board, Chapter 16, 2000.

Table D-2

LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

LOS	Average Stopped Delay (seconds/vehicle)
A	<10.0
B	10.1 - 15.0
C	15.1 - 25.0
D	20.1 - 35.0
E	35.1 - 50.0
F	>50

Source: 2000 Highway Capacity Manual, Transportation Research Board, Chapter 17, 2000.

Freeway Sections – Speed and the freedom to maneuver are primary indicators of operating conditions on freeway sections. Both of these are related to the density of vehicles in the traffic stream, which the 2000 HCM uses to define conditions on freeway sections. Table D-3 presents the maximum vehicle density, minimum speed, and maximum volume-to-capacity ratio for Level of Service A through F for freeways designed for free flow speeds of 65 mph. The criteria for the 65 mph free flow speed are used in this study since this represents the posted speed limit, even though the design speed is likely higher. The maximum capacity is considered to be 2,400 vehicles per lane per hour under average conditions for six- and eight-lane freeways.

With these guidelines and assumptions, the H-1 Freeway is assumed to provide capacities of 2,350 vehicles per hour for normal use lanes.

Table D-3
LEVEL OF SERVICE CRITERIA FOR BASIC FREEWAY SEGMENTS

Level of Service	Maximum Density (PC/Mi/Ln)	Minimum Speed (mph)	Maximum Service Flow Rate (PC/Hr/Ln)	Maximum Volume/Capacity Ratio
A	11.0	65.0	710	0.30
B	18.0	65.0	1,170	0.50
C	26.0	64.6	1,680	0.71
D	35.0	59.7	2,090	0.89
E	45.0	52.2	2,350	1.00
F	*	*	*	*

Criteria based on free flow speed of 65 miles per hour (mph)
PC/Mi/Ln = Passenger cars per mile per lane
PC/Hr/Ln = Passenger cars per hour per lane
• = Unstable operations, demand exceeds capacity of the junction.

Source: Highway Capacity Manual 2000, Transportation Research Board, Chapter 23, 2000.

Appendix E
Traffic Conditions at Key Freeway Access Ramps

Traffic conditions were analyzed for weaving sections for several ramps that would be used by traffic accessing the H-1 Freeway from the Kapolei West development (the Project) to assess the impact of the Project on these facilities.

Weaving Section Between Eastbound Off-Ramp to Farrington Highway and On-Ramp from Kalaeloa Boulevard

This weaving section, located mauka of the existing Kmart store, is separated from the H-1 Freeway mainline lanes by an open grass area. The 1,200-foot long weaving section has a single-lane entry from the Freeway at the west end with this single-lane continuing through the weaving section to exit onto the Freeway at the east end. The entry ramp from Kalaeloa Boulevard has two lanes with these lanes continuing through the weaving section and both lanes continue through the weaving section to exit to Farrington Highway.

As summarized in Table E-1, the existing (2003) traffic volumes are estimated to have operated at a very acceptable Level of Service (LOS) B in this weaving section during both weekday peak hours. The forecast 2014 traffic volumes without the Kapolei West Project are estimated to result in a decrease of about 3.5 miles per hour (mph) in both peak hours, with the afternoon conditions worsening to LOS C.

The 2014 traffic volumes with the addition of the Project, either the Urbanized area or Petition area scenarios, would reduce the average speed through the weaving section by about 1.5 mph in each weekday peak hour. The increased traffic density/decreased speeds would worsen conditions from LOS B to LOS C in the morning peak hour and from LOS C to LOS D in the afternoon peak hour.

The 2020 traffic volumes reflect the construction of the Hanua Street Extension with an on-ramp connection to eastbound H-1 Freeway. This Hanua Street on-ramp would attract use by a portion of the Campbell Industrial Park, Harbor area, and Kapolei Business Park traffic that would other wise use the Farrington Highway-Kalaeloa Boulevard weaving section to access eastbound H-1 Freeway, as well as some of the Kapolei West Project traffic. This results in projected conditions for the No Project scenario that are only slightly worse than in 2014.

The Kapolei West Project would have less effect on the weaving section in 2020 than in 2014 since much of the commercial area and residential area traffic would use the Hanua Street on-ramp. In the morning peak hour the Project would decrease the average speed by 0.2 mph, with conditions at LOS B. The afternoon Project traffic would decrease speeds by an estimated 0.4 mph, with this small change resulting in LOS D conditions versus LOS C without the Project.

Table E-1
TRAFFIC CONDITIONS AT
KEY FREEWAY RAMP WEAVING SECTIONS

Year and Development Scenarios	Weekday Morning Peak Hour			Weekday Afternoon Peak Hour		
	Density	Speed	LOS	Density	Speed	LOS
Existing Eastbound Weaving Section for Off-ramp to Farrington Hwy. and On-Ramp from Kalaeloa Blvd.						
2003	10.7	31.1	B	15.8	29.3	B
2014 No Kapolei West Project	18.1	27.4	B	26.0	25.8	C
2014 with Urbanized Area	23.4	25.8	C	33.7	24.2	D
2014 with Petition Area	22.6	26.0	C	32.6	24.4	D
2020 No Kapolei West Project	19.1	27.1	B	27.0	25.5	C
2020 with Project Build-out	19.7	26.9	B	29.1	25.1	D
Proposed Eastbound Weaving Section for On-ramp from Hanua St. Extension and Off-Ramp to Farrington Hwy.						
2020 No Kapolei West Project	26.5	41.4	C	32.7	34.6	D
2020 with Project Build-out	31.9	36.6	D	39.5	33.2	E

Density = Passenger car equivalents per mile per lane in analyses section.
Speed = Average speed in miles per hour through weaving area.
LOS = Level of service in weaving area.

Wilbur Smith Associates; June 1, 2005.

Weaving Section Between Eastbound On-Ramp from Hanua Street and Off-Ramp to Farrington Highway

The proposed construction of an on-ramp from Hanua Street to the eastbound H-1 Freeway would likely require the removal of the existing off-ramp to Kalaeloa Boulevard. A new off-ramp would be provided from eastbound H-1 Freeway to Hanua Street to accommodate the traffic that would otherwise use the existing off-ramp. This would provide a single-lane weaving section between the proposed Hanua Street on-ramp and the existing off-ramp to Farrington Highway of about 1,200 feet for traffic to merge onto/diverge from the Freeway mainline lanes. The results of the weaving analysis for the projected traffic volumes using this lane in 2020 are summarized in Table E-1.

The 2020 traffic conditions in this weaving section without the Kapolei West Project are projected at LOS C in the weekday morning peak hour and LOS D in the afternoon peak hour. A substantial portion of the Project traffic from both the commercial area and the residential areas would use the proposed Hanua Street on-ramp to access the eastbound H-1 Freeway. The Project traffic would reduce the estimated speeds in the lane by about 4.8 mph in the morning peak hour, with conditions worsening from LOS C without the Project to LOS D with the Project. In the afternoon peak hour, the Project would reduce speeds by about 1.4 mph in the weaving area. However, the increased traffic density/reduce speed would result in LOS E conditions versus LOS D without the Project.

Traffic conditions on this weaving section could be improved to LOS D or better by either lengthening the weaving section to 2,100 feet, or adding a lane to the H-1 Freeway mainline through this section to 3 eastbound lanes, or by providing an auxiliary lane for the ramp weaving area. These options should be evaluated during the future planning of the Hanua Street extension to identify the most cost-effective action.

Appendix F
Public Transit Trip Generation

Additional assessment of Kapolei West Project impacts on public transit was made in response to agency comments regarding the draft TIAR.

Estimated Public Transit Trips

The numbers of person trips to/from the Project made via TheBus were estimated using trip rates developed by Wilbur Smith Associates during the traffic impact study for the Koa Ridge development in Central Oahu. The trip rates were developed from data presented in the 1993 Comprehensive Operations Analysis Study.[1] The average trip-making rates for the Mililani area were used to develop a low estimate of the number of bus boardings or alightings each weekday by persons traveling to or from the Project land uses, while the average trip rate for the Waipahu area was used to provide a high estimate of trips using TheBus.

Based on these trip rates, the Kapolei West Project is estimated to generate between approximately 500 and 800 transit trip ends each weekday in 2014, with about half this number boarding TheBus in the Project area and half alighting from TheBus in the area. At full build-out in 2020, the Project is estimated to generate between 900 and 1500 transit trip ends each weekday.

Scenario	Low Estimate of Daily Transit Trips	High Estimate of Daily Transit Trips
2014 Urbanized Area	500	800
2014 Petition Area	500	800
2010 Project Build-out	900	1,500

Potential Need for TheBus Service

The estimated numbers of potential TheBus trips would merit the extension of one or more TheBus routes into the Project area. Initial TheBus service would likely be provided by the extension of a new or existing local community shuttle route from the Kapolei Transit Center into the Project area to serve the Regional Commercial Center and residential areas.

When the Kapolei Parkway is completed through the Kapolei West area to connect to Aliinui Drive, a suburban trunk or local route could be routed along Kapolei Parkway-Aliinui Drive to provide service connecting the residential communities in the Waianae Coast, Ko Olina, and Kapolei West areas to the employment, shopping, and recreational activities in the corridor. If sufficient demand exists, this through route could be augmented with a local community shuttle route.

[1] *Comprehensive Operations Analysis of TheBus System*, prepared for the City and County of Honolulu by Barton-Aschman Associates, August 1993.



APPENDIX L
Civil Engineering
(Engineering Concepts, Inc.)

ENGINEERING CONCEPTS, INC.
Consulting Engineers

May 27, 2005

Helbert, Hastert and Fee
733 Bishop Street, Suite 2590
Honolulu, Hawaii 96813

Attention: Ms. Corlyn Orr

Subject: Kapolei West

Based on the various comments to the draft EA, the table identifying the wastewater flows in our Preliminary Engineering Report has been modified as indicated below.

Wastewater Flows for Project Area

		Ave. Wastewater Flow Rate (gpd)
Low Density Residential (869 units)		*278,100*
Medium Density Residential (1,351 units)		302,600
Mixed Use/Residential (150 units)		33,600
Neighborhood Commercial (2 acres)		6,400
Regional Commercial (23 acres)		257,600
Golf Course Clubhouse (2 acres)		22,400
School/Public Facility (1,000 students)		25,000
Dry Weather Infiltration		49,100
		974,800
	SAY	*0.98* MGD

Wastewater Flows for Petition Area

		Ave. Wastewater Flow Rate (gpd)
Low Density Residential (11 units)		*3,500*
Medium Density Residential (1,143 units)		256,100
Dry Weather Infiltration		16,300
		275,900
	SAY	0.28 MGD

Please call me if you have any questions or require additional information.

Very truly yours,

Craig Arakaki

Craig Arakaki, P.E.
Principal

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PRELIMINARY ENGINEERING REPORT

FOR THE

PROPOSED KAPOLEI WEST DEVELOPMENT

KAPOLEI, OAHU, HAWAII

Prepared for:
AINA NUI CORPORATION
Kapolei, Hawaii

Prepared by:
Engineering Concepts, Inc.
1150 South King Street, Suite 700
Honolulu, Hawaii 96814

February 2005

PRELIMINARY ENGINEERING REPORT
FOR THE
PROPOSED KAPOLEI WEST DEVELOPMENT

INTRODUCTION

Aina Nui Corporation is proposing a golf and residential development in Kapolei, Oahu. The development, known as Kapolei West, will occupy approximately 547 acres of former sugarcane lands west of the City of Kapolei. The project site is bordered to the south by the OR&L right-of-way, to the west by the City of Kapolei, to the north by the H-1 freeway/Farrington Highway, and by the Ko Olina resort development to the east (see Figure 1).

The objectives of this preliminary engineering investigation are to present information on infrastructure requirements for the proposed Kapolei West development. Specifically, this report will address:

1. background information on the proposed project;
2. existing conditions;
3. modifications after development; and
4. potential impacts due to development and proposed mitigative measures.

PROJECT BACKGROUND

The proposed Kapolei West development will include land uses in the approximate quantities listed in Table 1.

TABLE 1 - PROPOSED LAND USES

Land Use	Area (ac.)	Units
Golf Course	212.7	
Residential (2,220 units, 225.3 ac)		
Low Density Residential	117.2	869
Medium Density Residential	98.1	1,351
Mixed Use/Residential	10.0	150
Neighborhood Commercial	2.0	
Regional Commercial	23.2	
Elementary School	6.0	
Transit (Public Facility)	5.8	
Parks	24.8	
Circulation and Other Open Space	47.0	
TOTAL	546.8	2,370

LAND USE AND ZONING

The majority of the project site (approximately 373 acres) is currently designated as an Urban District by the State. The remaining 174+ acres are designated Agricultural. A petition to the State Land Use Commission will be made requesting a change from the Agricultural designation to an Urban designation

The project site is currently zoned as Agriculture by the City and County of Honolulu. A zone change application to the City will be made requesting designation to the appropriate uses.

EXISTING USES

The project site is presently undeveloped. The existing residential developments of Honokai Hale and Nanakai Gardens are adjacent to the project site's northwest corner. To the west of the site is the Ko Olina development and golf course. The City of Kapolei lies to the east of the site while the vacant property currently proposed as the site of the future Makaiwa Hills development lies to the north. South of the site is the Barbers Point Harbor and other vacant properties owned by the Estate of James Campbell or its affiliates.

CLIMATE

The climate in the Ewa Plain region is relatively warm and dry. Tradewinds from the northeast occur much of the time, with occasional Kona winds. The normal temperature range for the region varies from the high 60's (degrees Fahrenheit) to the low 90's. Rainfall is light, with mean annual rainfall of about 20 inches.

TOPOGRAPHIC FEATURES

The project site ranges in elevation from about 60 feet mean sea level (MSL) at the southern boundary near the railroad right-of-way, to an elevation of about 155 feet at the interstate highway along the northern boundary.

Slopes range from one-half percent in the southeastern corner of the site to about 5 percent in the norther portion of the site as you approach the freeway. An existing drainage/irrigation ditch runs through the site, from the freeway to the railroad right-of-way. Mounds and depressions dot the site, typical of former sugar cane lands.

DRAINAGE

Existing Conditions

The project site falls within two watersheds (Figure 2). Both watersheds run from the ocean to the crest of the Waianae Mountain range. The western watershed discharges through the Ko Olina resort development accepting runoff through the existing golf course. The eastern watershed will discharges through the West Kalaeloa area adjacent to the existing Barbers Point Harbor. Runoff from the upper watershed areas above the project site are conveyed under the H-1 freeway/Farrington Highway through a series of pipe culverts onto the project site.

A majority of the petition area, the area above the railroad right-of-way, sits within the western watershed discharging runoff into the adjacent Ko Olina golf course. The portion of the petition area below the railroad right-of-way will drain into the eastern watershed.

An existing drainage ditch currently traverses the project site, conveying runoff from the major culvert crossing of the freeway/highway to a rectangular culvert crossing at the railroad right-of-way near the southern end of the site. This existing ditch runs in a west to east direction after crossing the highway for approximately 2,800 feet before turning south to the railroad right-of-way. Previously used as an irrigation flume, the existing ditch is actually built up above the surrounding area. Smaller culvert crossings of the highway daylight directly onto the project site with no drainage improvements to collect mauka runoff.

An existing grass-lined channel is found on the western end of the project site parallel to Koio Drive. This channel also conveys runoff from the mauka areas through the project site and the Ko Olina development.

There are no drainage improvements within the petition area.

South (downstream) of the project site and petition area are the Barbers Point Harbor and West Kalaeloa area. Land uses for the West Kalaeloa development is currenlty being reviewed and could include commercial and light industrial uses.

Flood Hazard

The project site and petition area is designated Zone D in the Flood Insurance Rate Map, indicating areas in which flood hazards are undetermined.

Runoff

Runoff from the Mauka areas discharging through the Farrington Highway culverts (Figure 3) have been estimated and are listed in Table 2. Peak runoff rates (in cubic feet per second) were calculated for the 10- and 50-year storms using the Soil

Conservation Service TR 20 program. Calculations were based on a rainfall duration of one hour, and rainfall intensity of 1.9 inches for the 10-year storm and 2.3 inches for the 50-year storm.

TABLE 2 - EXISTING MAUKA RUNOFF (1-HR DURATION)

Subarea	Acres	10-YR Q (cfs)	50-YR Q (cfs)
A	705	697	844
B	23	41	53
C	62	103	125
D	5	10	12
E,F	162	208	252
G	508	522	631
H,I	286	288	349
J	95	137	166
K	31	51	62
L	1615	1350	1634
M	84	141	171
N	53	89	108
O	33	56	67
Watershed*	3,662	3,693	4,474

*mauka of Farrington Hwy.

Runoff from the project site and petition area under existing conditions using the same criteria above were estimated with results found in Table 2.

TABLE 3 - EXISTING SITE RUNOFF (1-HR DURATION)

Area	Acres	10-YR Q (cfs)	50-YR Q (cfs)
Project	547	562	680
Petition	174	223	271

Currently, much of the railroad tracks are higher than the adjacent mauka areas creating a berming effect along its alignment. Also, because the existing drainage ditch is built-up above ground, runoff cannot easily enter it. Consequently, much of the runoff from the project site and some of the mauka areas are retained in the low lying areas creating large areas of ponding.

Modifications after Development

The proposed Kapolei West development will alter the character of the 547 acre site. The vegetative cover currently established throughout the site will be replaced with pavement, buildings, and landscaped yards typical of a residential/commercial development.

As a result of the proposed improvements, the rate of peak runoff from the onsite areas is expected to increase. Estimated peak runoff rate for 10- and 50-year storms for the project site and petition area is given in Table 4. The runoff for the 100-year storm is based on the peak curve of the City and County's Storm Drainage Standards. The peak runoff rate generated by the project site and petition area is expected to increase by about 18 percent for the 10- and 50-year storms after development of the project.

TABLE 4 - FUTURE RUNOFF

Area	Acres	10-YR Q (cfs)	50-YR Q (cfs)	100-YR Q (cfs)
Project	547	665	805	1,700
Petition	174	240	291	800

Drainage patterns in the onsite areas proposed for development may be altered slightly from the existing conditions due to the alignment of the proposed roads, culverts and other drainage facilities.

Impacts and Mitigation

In general, consideration has been given to Kapolei West site in planning of downstream drainage facilities. Impacts on developments downstream of the Kapolei West site are not expected to be adverse. A detailed drainage master plan will be prepared and submitted to the City and County of Honolulu Department of Planning and Permitting for review and approval.

Offsite Drainage

Development of the portion of Kapolei West and the petition area within the western Ko Olina watershed can be accommodated by the existing Ko Olina drainage systems. Kapolei West was originally planned as Phase 2 of the Ko Olina development. Community Planning, Inc. prepared a hydrologic study for the Ko Olina development to include the increase in runoff for both phases of their development. Figure 4 is a copy of the hydrologic study and storm drainage system previously planned for the project site and petition area mauka of the railroad right-of-way.

Kapolei Property Development, an affliate of the Estate of James Campbell, is currently planning a major drainage channel as part of the West Kalaeloa development makai of the project and petition areas. Design of this channel will accommodate peak storm runoff contributions the mauka developments, including Kapolei West and Makaiwa Hills, in accordance with the storm drainage standards of the City and County of Honolulu. Should the development of Kapolei West precede construction of the drainage channel through West Kalaeloa, interim detention basins will need to be incorporated in the phasing of the Kapolei West development. These temporary detention basins would dampen flows discharged into West Kalaeloa to what the existing drainage system can accommodate. Temporary detention basins will likely be located within the limits of the proposed golf course.

Onsite Drainage

The Kapolei West golf course will also be a the major drainageway through the site. Runoff discharging from the mauka areas through culverts at Farrington Highway will be collected and directed to the golf course/drainageway. Onsite developments will collect runoff through an underground drainage system within the sites and roadways and convey the runoff to the golf course. Several major box or pipe culverts will be required at roadway crossings and at the crossing of the railroad right-of-way. Connections to mauka and makai developments will be coordinated as to locations and inverts. The golf course/drainageway and underground drainage systems will be designed to accommodate peak runoff flows for the onsite as well as offsite developments in accordance with the City's storm drainage standards.

Water Quality

The impact of the development is lessened by the inclusion of a golf course, parks and open areas. These uses help to lessen the increase in runoff associated with developments and provides some environmental benefits in improving the quality of storm runoff. It is anticipated that some areas of the golf course will be used as detention areas for water quality purposes. The quality of the storm water runoff will also be addressed with the individual development units within the project site. Flow through or structural means of water quality treatment will be reviewed for each development in accordance with the requirements of the storm drainage standards. Potential use of the golf course for treatment of runoff using detention methods will also be investigated during further planning and design of the project.

Short term impacts associated with construction can be mitigated by limiting construction to off-peak traffic hours, implementing an approved traffic control plan, and coordinating construction with any other construction projects along Farrington Highway. Generation of dust and noise due to construction operations will be mitigated by required compliance with the applicable Administrative Rules of the State Department of Health, Title 11: Chapter 42 (Vehicular Noise Control for Oahu), Chapter 43 (Community Noise Control for Oahu), and Chapter 60 (Air Pollution Control).

GRADING AND SOIL EROSION

Grading

Grading within the project site will include both excavation and embankment. Similar to other developments with the Ewa Plains, the development will likely generate fill material through the excavation of the golf course/drainageway. The development units within the project site will be graded higher than the golf course to provide positive drainage and freeboard.

An effort to balance the earthwork quantities of cut and fill is expected to minimize the cost of purchasing offsite borrow material and disposing excess excavated material at an off site location. Grading operations will be in conformance with the applicable ordinances of the City and County of Honolulu.

More detailed soils analyses will be performed as planning of the project proceeds. Mitigative measures, if required, will be recommended by the project's soils engineers as building types and locations are further defined. Mitigative measures may include removal of unsuitable soils under foundations and/or special foundation designs.

Calculation of Soil Erosion Potential

The U.S. Department of Agriculture, Soil Conservation Service utilizes the Universal Soil Loss Equation (USLE) to estimate long term average annual soil losses from sheet and rill erosion. The equation is used to estimate erosion on forest land, farm fields,

construction/development sites, and other areas. Soil losses can be estimated for present conditions or for a future condition. The soil loss equation considers rainfall, soil erodibility, ground cover and management, ground slope and length of overland flow. The existing soil erosion potential for the project site and petition area is estimated to be 500 tons per year and 150 tons per year, respectively using the USLE. After development, the soil erosion potential from the area is estimated to be 150 tons per year and 50 tons per year for the project site and petition area, respectively.

Impacts and Mitigation

Long Term Impacts

Based on the USLE, soil erosion potential at the project site should decrease after the development of the proposed Kapolei West project. This decrease in soil erosion is attributed to the reduction of erodible surfaces (increase in buildings and pavement); reduction of length and slope of overland flow due to site grading and construction of a storm drain system; and increase in landscaped area (reduction of bare ground).

Short Term Impacts and Mitigation

The construction of the proposed project will involve land disturbing activities that result in soil erosion. These land disturbing activities include removal of existing vegetation (clearing and grubbing) and leveling, removing, and replacing soil.

Implementing erosion control measures will lesson the short-term erosion impacts during construction. These measures may include: use of temporary sprinklers in non-active construction areas; stationing water trucks onsite during construction to provide immediate sprinkling in active construction zones; use of temporary berms and cut-off ditches; use of temporary silt fencing and screens; thorough watering of graded areas after construction activity has ceased for the day and on weekends, and; sodding or planting slopes immediately after grading work has been completed.

Additional erosion control measures would lessen construction impacts even further. These are:

$ Minimize time of construction.

$ Retain existing ground cover until the latest date before construction.

$ Early construction of drainage control features.

$ Use of temporary area sprinklers in nonactive construction areas when ground cover is removed.

$ Station water truck on site during construction period to provide for immediate sprinkling, as needed, in active construction zones (weekends and holidays included).

$ Use temporary berms and cut-off ditches, where needed, for control of erosion.

$ Thorough watering of graded areas after construction activity has ceased for the day and on weekends.

$ Sod or plant all cut and fill slopes immediately after grading work has been completed.

Grading and Erosion Control Plans will be prepared in compliance with Chapter 23, Revised Ordinances of Honolulu. Further, the contractor will be required to perform all grading and stockpiling operation in conformance with the applicable provisions of Chapter 54 (Water Quality Standards) and Chapter 55 (Water Pollution Control) of Title 11 Administrative Rules of the State Department of Health.

WATER

Existing Conditions

Potable Water

The Board of Water Supply (BWS) system provides potable water service to the Ewa/Kapolei region. Wells located in Waipahu, in the vicinity of the Kunia Interchange, are the water source for the system. These wells include the Hoaeae Wells, Kunia Wells I, and Waipahu Wells. EP 15 and 16 are also being improved by the Board as an additional source of water. Transmission of water from the wells to Ewa/Kapolei is via 30-inch and 36-inch transmission main along Farrington Highway. Storage for the area is handled by the Kapolei 215 reservoir located mauka of the freeway below the Makakilo City development and the 3.0 MG, 4.0 MG and 5.0 MG Barbers Point 215 Reservoirs, located above the project site in the southeastern corner of the proposed Makaiwa Hills development. Transmission of potable water continues west along Farrington Highway to Nanakuli via 24-inch transmission main and booster pumps located at the Barbers Point Reservoirs site. 24-inch and 20-inch mains are located in Kalaeloa Boulevard east of the site. A 16-inch main extends from Kalaeloa Boulevard westward towards the project site. In addition, a 12-inch water line is located in Alii Nui Drive west of the project site. The regional potable water system in the vicinity of the project site is illustrated in Figure 5. The BWS water system does not currently serve the project site or petition area.

Nonpotable Water

The existing Ko Olina golf course is currently served by a nonpotable water system for irrigation purposes. Wells within the golf course pump brackish water up to a nonpotable reservoir located above Farrington Highway.

The Board of Water Supply is currently in the process of providing nonpotable water for the Kapolei area through the use of recycled effluent from the Honouliuli Wastewater Treatment Plant. A 16-inch R1 water line runs along the railroad right-of-way from the treatment plant to the City of Kapolei. The nonpotable water system within the City of Kapolei has been coverted from a caprock brackish water source to the reclaimed effluent. Plans have been prepared for the installation of a nonpotable water line connecting the 16-inch transmission main to the Ko Olina nonpotable reservoir. This will bring a source of nonpotable water to the eastern boundary of the project site.

Projected Water Demand

Water demand estimates for the project are based on BWS Water System Design Criteria for the various land uses.

Potable Water

The potable water demand for the project is summarized below:

Potable Water Use for Project Area

Land Use	No. of Units	gpd/unit	Average Daily Demand (gpd)
Low Density Residential	869 units	400	347,600
Med. Density Residential	1,351 units	400	540,400
Mixed Use/Residential	150 units	400	60,000
Neighborhood Commercial	2 acres	3,000	6,000
Regional Commercial	23 acres	3,000	69,000
Golf Course	213 acres	720	153,360
School/Transit	12 acres	4,000	48,000
Park	25 acres	720	18,000
			1,242,360
		Say	1.24 MGD

Based on an average daily demand of 1.24 MGD, a maximum daily demand of 1.86 MGD is expected for the project area. The corresponding peak hour demand will be 3.72 MGD.

Potable Water Use for Petition Area

Land Use	No. of Units	gpd/unit	Average Daily Demand (gpd)
Low Density Residential	11 units	400	440
Med. Density Residential	1,143 units	400	457,200
Park	17 acres	720	12,240
			469,880
		Say	0.47 MGD

Based on an average daily demand of 0.47 MGD, a maximum daily demand of 0.705 MGD is expected for the petition area with a peak hour demand will be 1.41 MGD.

Nonpotable Water

The nonpotable water demand for the project area and petition area are estimated below. Nonpotable water will be used for irrigation purposes only.

Nonpotable Water Use for Project Area

Land Use	No. of Units	gpd/unit	Average Daily Demand (gpd)
Golf Course	213 acres	4,080	869,000
Park	25 acres	4,080	102,000
			971,000
		Say	1.00 MGD

Maximum Daily Demand is estimated to be 1.5 MGD for the project area.

Nonpotable Water Use for Petition Area

Land Use	No. of Units	gpd/unit	Average Daily Demand (gpd)
Golf Course	60 acres	4,080	244,800
Park	17 acres	4,080	69,360
		Say	0.314 MGD

Maximum daily demand is estimated to be 0.471 MGD for the petition area.

Proposed Water System

Potable Water System

The proposed Kapolei West development will create additional water demands on the BWS system. Potable water demands will include service to the proposed residential, commercial and public facility developments, and nonirrigation water service to the proposed parks and the golf course.

The existing potable water system serving the adjacent areas will be used and will be extended to serve the project and petition area. The distribution line in Alii Nui Drive will be connected to the 16-inch line in Kapolei Parkway near Kalaeloa Boulevard. This will provide a "looped" water system and will result in a stronger, more reliable system overall. In addition to the connection of the main distribution lines, additional storage may need to be provided. Additional storage requirements will be coordinated with the Board of Water Supply and will take into account regional water demands when sizing additional reservoirs. It is expected that an additional reservoir will be place next to the existing Barbers Point 215 tanks.

Nonpotable Water System

Nonpotable water will be used for irrigation purposes and will reduce the overall potable water demands for the project. Nonpotable water from the Board of Water Supply is expected to be available when the project proceeds. Plans for construction of the nonpotable water line connecting the City of Kapolei system to the existing nonpotable tanks above Farrington Highway is currently undergoing the review and approval process. Completion of the line is expected within the next two years.

Additional storage will be required as well as extension of the proposed BWS nonpotable water mains. As with the potable water storage tanks, sizing of the nonpotable tanks will likely be a regional effort, however, at a minimum, a 1.0 MGD tank will probably be required for the project. Storage requirements could also be met within the golf course itself in the form of lakes and water features. Storage requirements will be coordinated with the Board of Water Supply during design of the golf course.

Impacts and Mitigation

Kapolei West is one of the proposed developments in the Ewa/Kapolei area which will impact the existing regional water system by increasing the demand for potable water. In an effort to reduce the potable water requirements of the project, a dual water system is proposed. Nonpotable water is planned to irrigate the proposed golf course and park.

The Estate of James Campbell and its affiliates have been working with the Board of Water Supply to help provide for the needs of the proposed developments in the area. The Estate recently completed construction of the 4 million gallon Kapolei 215 tank. In addition, the Estate has provided the Board with wells EP 15 and 16 as an additional source of water for the developments. These wells were previously used for sugarcane cultivation.

The proposed offsite and onsite potable water system (including reservoirs and distribution mains) will be designed in accordance with the BWS Water System Standards and is anticipated to be dedicated to the BWS for operation and maintenance. A water master plan will be prepared and submitted to BWS for their review and approval.

Short term impacts due to the proposed water system will be construction related and may include dust, noise and traffic disturbances along Farrington Highway. Mitigation of these potential short term impacts can be achieved by limiting construction to off-peak traffic hours, use of wind breaks or watering to reduce dust, implementation of approved traffic control plans, and compliance with applicable Administrative Rules of the State Department of Health, Title 11: Chapter 42 (Vehicular Noise Control for Oahu), Chapter 43 (Community Noise Control for Oahu), and Chapter 60 (Air Pollution Control).

WASTEWATER

Existing Conditions

The Honouliuli wastewater treatment plant is located approximately four miles east of the project site. The treatment plant currently has a capacity of 38 MGD with a site that could be expanded to 51 MGD.

The closest municipal sewer is the Ko Olina interceptor which parallels the railroad right-of-way through the petition area. The Ko Olina interceptor is a force main/gravity sewer extending from the Ko Olina Resort along the railroad right-of-way to Fort Barrette Road. At Fort Barrette Road, the Ko Olina interceptor connects to the Makakilo interceptor, a 30-inch sewer which extends from Makakilo along Fort Barrette Road and Renton Road to the Honouliuli WWTP on Geiger Road (Figure 6).

The Ko Olina interceptor sewer was sized to accommodate the project site as Phase 2 of the resort development. There will probably be some additional capacity in the Ko Olina interceptor as the original Phase 1 and 2 densities were higher than currently proposed.

Currently under construction is the Kapolei Interceptor Sewer. A relief sewer line to the Makakilo interceptor, the Kapolei interceptor provides sewer conveyance capacity for the developments in the Kapolei area including Ko Olina, Kapolei West, The City of Kapolei, Kapolei Business Park, West Kalaeloa, The Villages of Kapolei, and portions of East Kapolei.

Projected Wastewater Flows

Wastewater will be generated from the various facilities within the proposed Makaiwa Hills development. The estimated average wastewater design flow is based on estimated water use calculations and the City and County Sewer Standards. Contributions expected from the proposed facilities within the project area are listed below:

Wastewater Flows for Project Area

	Ave. Wastewater Flow Rate (gpd)
Low Density Residential (869 units)	194,700
Medium Density Residential (1,351 units)	302,600
Mixed Use/Residential (150 units)	33,600
Neighborhood Commercial (2 acres)	6,400
Regional Commercial (23 acres)	257,600
Golf Course Clubhouse (2 acres)	22,400
School/Public Facility (1,000 students)	25,000
Dry Weather Infiltration	43,900
	886,200
	SAY 0.89 MGD

For planning purposes, the total average wastewater flow rate for the project area is 0.89 MGD. Peak flow factors will vary depending on the total tributary area that is being served.

Wastewater Flows for Petition Area

	Ave. Wastewater Flow Rate (gpd)
Low Density Residential (11 units)	2,500
Medium Density Residential (1,143 units)	256,100
Dry Weather Infiltration	16,200
	274,800
	SAY 0.28 MGD

For planning purposes, the total average wastewater flow rate for the project area is 0.28 MGD. As with the project area, peak flow factors will vary depending on the total tributary area that is being served.

Modifications after Development

Wastewater generated from the parcels is expected to be of typical domestic composition. Sewer lines will be extended to serve the project site from the existing Ko Olina interceptor sewer line running along the railroad right-of-way. The proposed onsite wastewater collection system will consist of gravity sewer lines and manholes within the projects roadways. All improvements will be done in accordance with the City's wastewater design standards.

Implementation of the proposed improvements is subject to approval from the City and County of Honolulu Department of Planning and Permitting (DPP). A sewer master plan and an Application for Sewer Connection will be submitted, at which time the DPP will

evaluate the capacity of the municipal sewerage system and treatment facility to handle the expected wastewater flow from the project site.

Impacts and Mitigation

Having been originally included in the overall Ko Olina wastewater masterplan, impacts on the existing wastewater systems by Kapolei West are minimized. With construction of the Kapolei Interceptor Sewer, adequate conveyance capacity is available from the project site to the Honouliuli Wastewater Treatment Plant.

Wastewater impacts related to the proposed development are expected to be short-term in nature. Short-term impacts are related to the construction of the proposed sewer improvements. Construction impacts such as noise and dust generation can be minimized by complying with applicable Administrative Rules of the State Department of Health, Title 11: Chapter 43 (Community Noise Control for Oahu) and Chapter 60 (Air Pollution Control).

SOLID WASTE

Existing Conditions

A refuse collection service does not presently serve the project site. Currently, the site is undeveloped and does not generate solid wastes.

Projected Solid Waste Generation and Characteristics

The proposed project will generate solid waste during construction and after development. Construction wastes will primarily be made up of vegetation, rocks, and debris resulting from clearing the site prior to construction. Most of these wastes will be combustible.
The typical range of per capita solid waste generation from a municipal source (residential and commercial) is 2.0 to 5.0 pounds per capita per day (lb/capita/day). Municipal solid waste generation from the proposed development is estimated to be 22 tons/day based on an average per capita generation rate of 4.0 lb/capita/day. The solid waste composition is expected to be typical for a municipal source.

Modifications after Development

It is anticipated that refuse generated by the proposed Kapolei West residential development will be collected by the City and County refuse collection service. Refuse from the proposed commercial area will be serviced by a private refuse collection company.

Impacts and Mitigation

The proposed development will be a new generator of solid waste. Generation of construction wastes due to clearing of the site will be a short term impact. The contractor will be required to remove all debris from the project site to mitigate the environmental impact.

The City and County is currently operating a landfill site in Waimanalo Gulch and the H-POWER waste energy recovery facility on the leeward side of Oahu. The City is currently exploring alternative means of handling solid waste as an ongoing city-wide concern. Other programs being implemented are recycling and reuse of green waste.

POWER AND COMMUNICATIONS

Existing Conditions

Hawaiian Electric Company (HECO) maintains two parallel 60-foot wide easements crossing the eastern portion of the project site in a northeast direction. The easements serve 138 kv overhead transmission lines originating from a HECO substation southeast of the project site and east of the petition area.

The Estate of James Campbell and/or its affiliates are currently coordinating alignments for additional HECO power lines through the West Kalaeloa area from the H-Power plant to the substation at the railroad right-of-way. These lines are necessary to provide additional power source to the regional power grid, supporting the continued growth of the area.

HECO is also in the processing of planning and design of a new substation in the Ko Olina development immediately west of the project site and petition area. This will serve the Ko Olina development and may also possibly serve portions of Kapolei West.

Modifications after Development

It is anticipated that HECO and Hawaiian Telephone Company (HTCO) will provide the necessary electrical and telephone service to the project site. It is estimated that power requirements will be in the 1 to 4 kv range with an assumed average of 48 kwh per unit per day. Power is planned to be supplied to the site via the existing substation at Kapolei and the new Ko Olina substation. Current coordination with HECO will continue as the project progresses to determine the actual needs of the development within the overall regional requirements.

Annual power consumption for the project area is estimated at 45 Mwh with the petition area having an annual power consumption of 21 Mwh.

The possibility of relocating the HECO overhead transmission lines underground, within the right-of-way of the proposed development roads, is under consideration.

Impacts and Mitigation

The proposed Makaiwa Hills development will place additional demands on the utility systems. Discussions between the Estate of James Campbell and its affiliates and HECO are ongoing. Mitigation of potential impacts to the HECO system due to Kapolei West and other projects in the Ewa/Kapolei area are under consideration in the planning of new facilities. Hawaiian Electric has indicated that it has plans for future expansion of its power generation capabilities. It is also anticipated that the development will consider implementation of energy efficiency design guidelines in an effort to minimize energy consumption.

KAPOLEI WEST
EWA, OAHU, HAWAII

LOCATION MAP

MARCH 10, 2005

FIGURE 1

Mar 10, 2005–11:46am
I:\CAD\Hilton\Dwg\Kapolei\9702\KAP WEST FIG\FIG-1.dwg

KAPOLEI WEST
EWA, OAHU, HAWAII

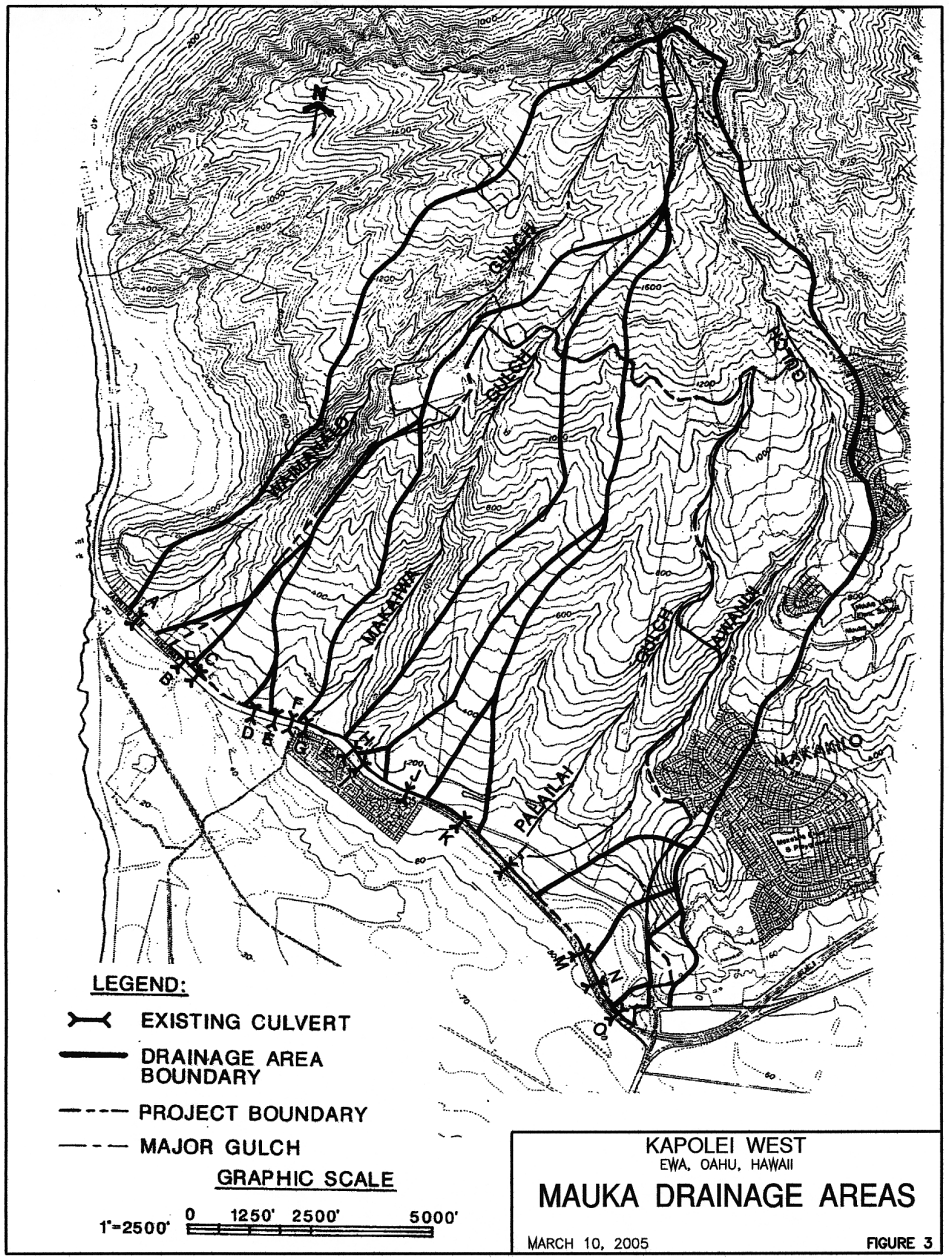
DRAINAGE AREAS

MARCH 10, 2005

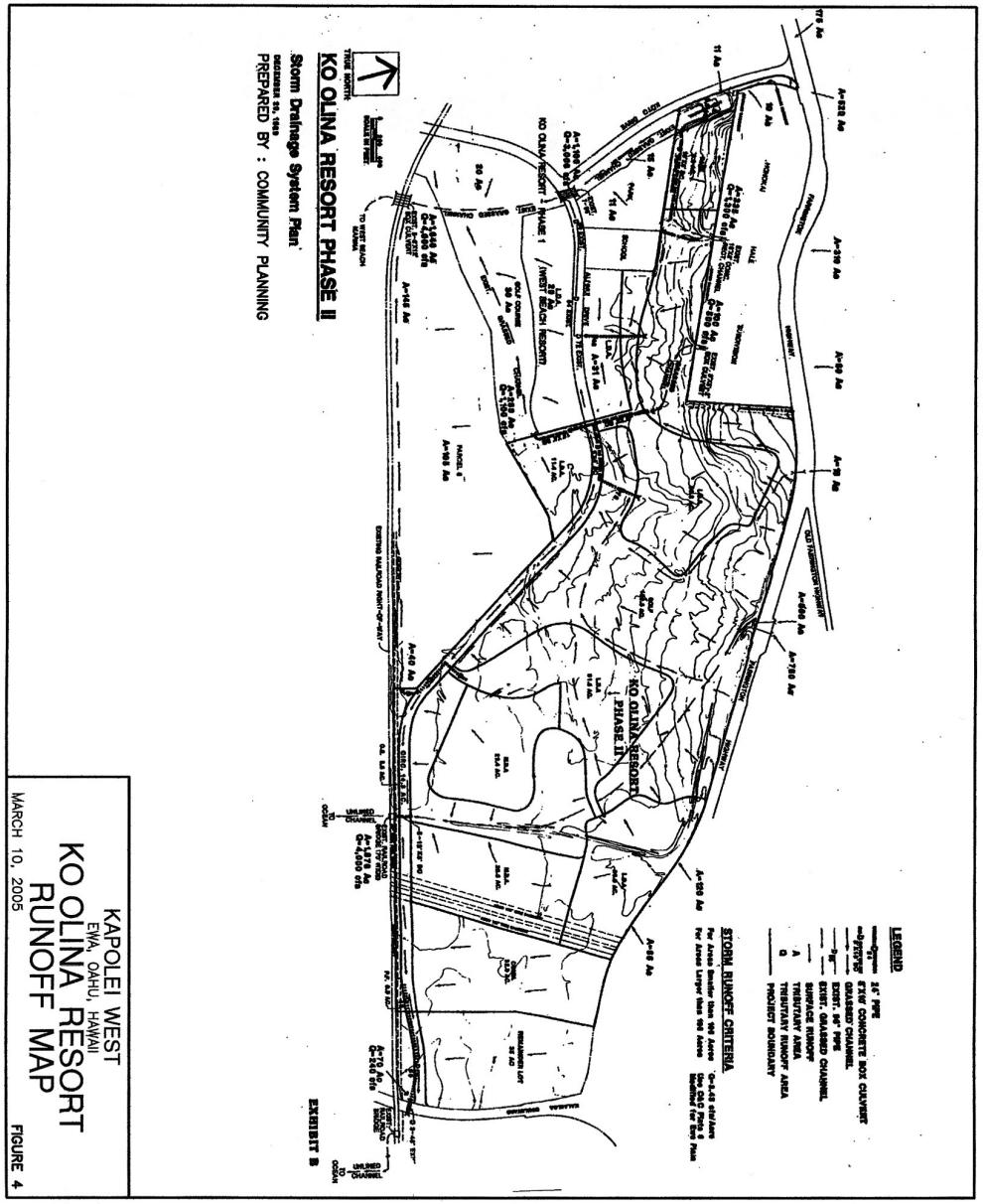
FIGURE 2

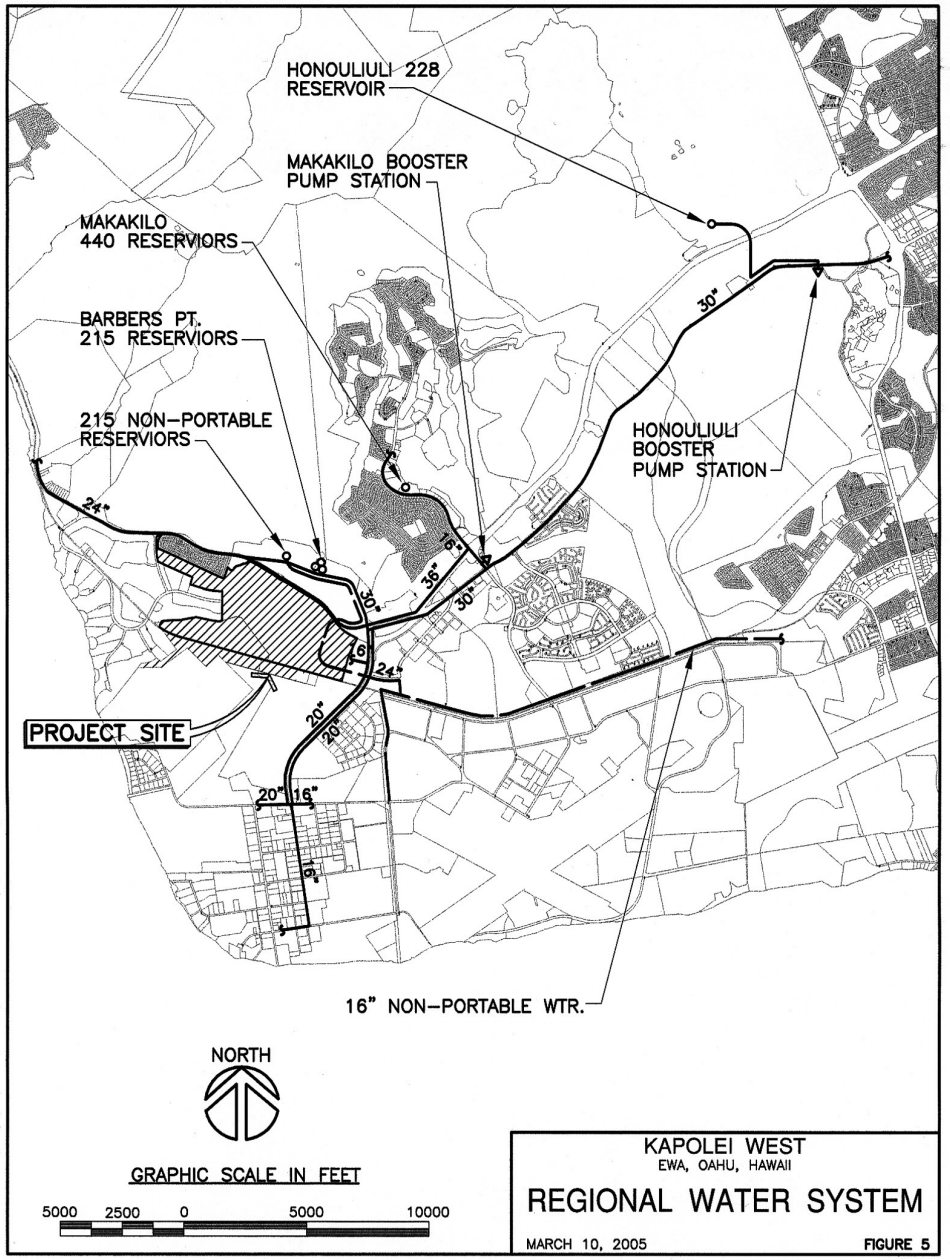
Mar 10, 2005–11:54am
I:\CAD\Hilton\Dwg\Kapolei\9702\KAP WEST FIG\FIG-2.dwg

Mar 10, 2005-12:30pm
I:\CAD\Hilton\Dwg\Kapolei\9702\KAP WEST FIG\FIG-4.dwg



Mar 10, 2005-12:31pm
I:\CAD\Hilton\Dwg\Kapolei\9702\KAP WEST FIG\FIG-3.dwg



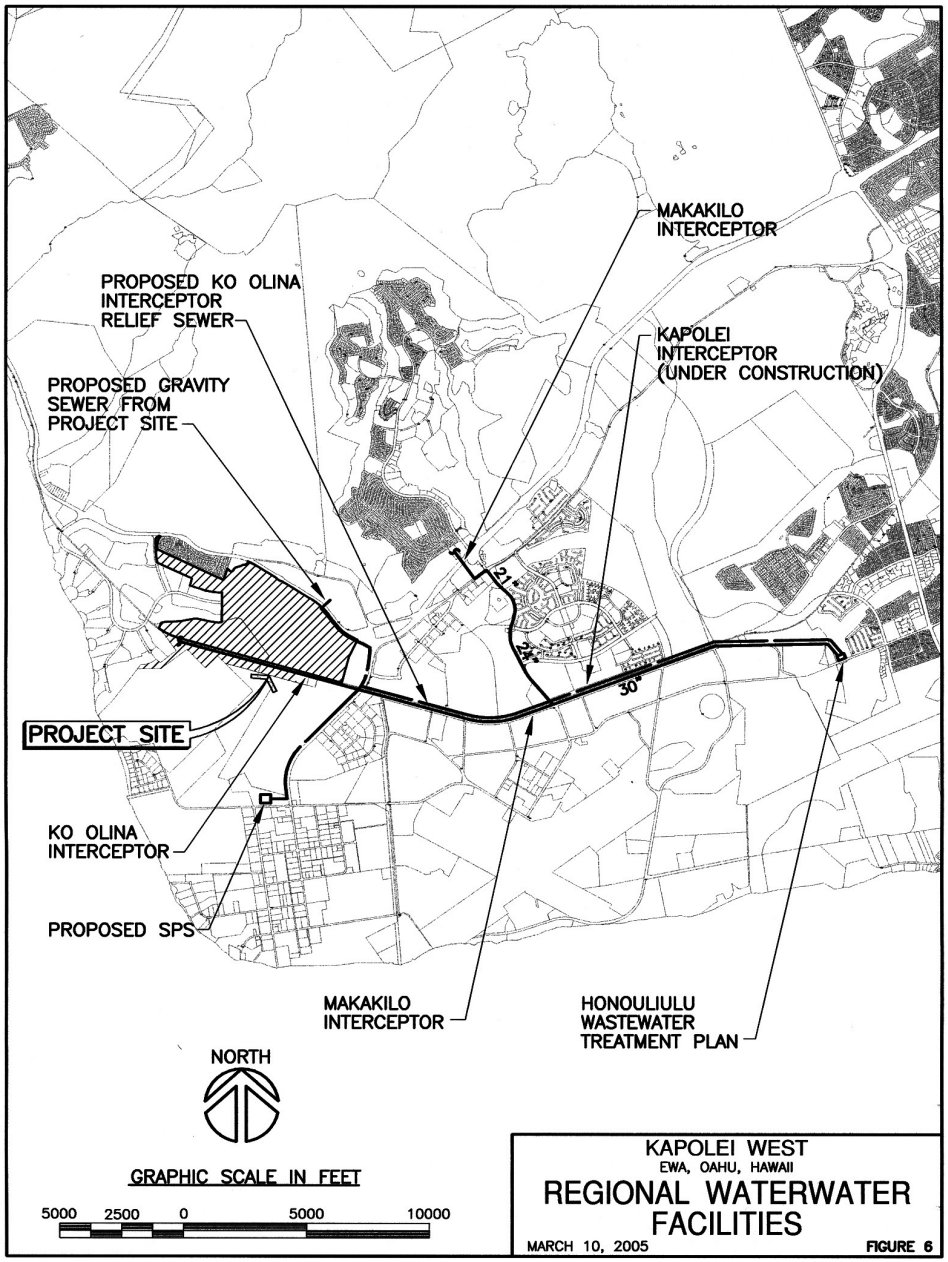


KAPOLEI WEST
EWA, OAHU, HAWAII

REGIONAL WATER SYSTEM

MARCH 10, 2005 FIGURE 5

Mar 10, 2005-12:23pm
I:\CAD\Hilton\Dwg\Kapolei\9702\KAP WEST FIG\FIG-5.dwg



KAPOLEI WEST
EWA, OAHU, HAWAII

REGIONAL WATERWATER FACILITIES

MARCH 10, 2005 FIGURE 6

Mar 10, 2005-11:59am
I:\CAD\Hilton\Dwg\Kapolei\9702\KAP WEST FIG\FIG-6.dwg