Volume II (Part 1)
Appendices A – D1

VOLUME II OF III
(Appendices A to E-1)

Final Environmental Assessment

MAKALAPUA PROJECT DISTRICT

(TMK NOS. (3)7-4-008:002 (por.), (3)7-4-010:009 and 010, (3)7-4-025:001, 002, 003, 005, 015, and 021)

Prepared for:

Lili‘uokalani Trust

Approving Agency:

County of Hawai‘i
Planning Department

October 2024

MUNEKIYO HIRAGA

Planning. Project Management. Sustainable Solutions.

VOLUME II OF III
(Appendices A to E-1)

Final Environmental Assessment

MAKALAPUA PROJECT DISTRICT
(TMK NOS. (3)7-4-008:002 (por.), (3)7-4-010:009 and 010, (3)7-4-025:001, 002, 003, 005, 015, and 021)

Prepared for:

Lili‘uokalani Trust

Approving Agency:

County of Hawai‘i
Planning Department

October 2024

MUNEKIYO HIRAGA

LIST OF APPENDICES (VOLUME II OF III)

LIST OF APPENDICES (VOLUME III OF III)

DOCKET NO. A89-646 ORDER GRANTING MOTION FOR ORDER MODIFYING THE 1991 DECISION AND ORDER

APPENDIX

A

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAII

In the Matter of the Petition of QUEEN LILI'UOKALANI TRUST To Amend the Agricultural District Boundary into the Urban District for approximately 919.366 acres and to Amend the Conservation District Boundary into the Urban District for approximately 188.358 acres, at Keahuolū, Island, County and State of Hawai'i, Hawai'i Tax Map Key Nos. (3) 7-4-08: por. 2, por. 12	DOCKET NO. A89-646 ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991; CERTIFICATE OF SERVICE

2016 APR 21 P 12:22

LAND USE COMMISSION
STATE OF HAWAII

ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991

CERTIFICATE OF SERVICE

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, HAWAI'I.

By _____ 04/21/2016
DANIEL E. ORODENKER
Executive Officer Date

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAII

In the Matter of the Petition of QUEEN LILI'UOKALANI TRUST To Amend the Agricultural District Boundary into the Urban District for approximately 919.366 acres and to Amend the Conservation District Boundary into the Urban District for approximately 188.358 acres, at Keahuolū, Island, County and State of Hawai'i, Hawai'i Tax Map Key Nos. (3) 7-4-08: por. 2, por. 12	DOCKET NO. A89-646 ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991; CERTIFICATE OF SERVICE

2016 APR 21 P 12:23

LAND USE COMMISSION
STATE OF HAWAII

ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991

AND

CERTIFICATE OF SERVICE

A89-646 Lili'uokalani Trust
Motion to Modify

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAII

In the Matter of the Petition of QUEEN LILI'UOKALANI TRUST To Amend the Agricultural District Boundary into the Urban District for approximately 919.366 acres and to Amend the Conservation District Boundary into the Urban District for approximately 188.358 acres, at Keahuolū, Island, County and State of Hawai'i, Hawai'i Tax Map Key Nos. (3) 7-4-08: por. 2, por. 12	DOCKET NO. A89-646 ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991

ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991

On August 14, 2015, Petitioner QUEEN LILI'UOKALANI TRUST, a private operating foundation ("Petitioner") filed with the Land Use Commission of the State of Hawai'i ("Commission") a *Motion for Order Modifying the Findings of Fact, Conclusions of Law and Decision and Order filed August 28, 1991; Affidavit of LeeAnn Crabbe; Exhibits "1" "4"* in Docket No. A89-646 ("Motion to Modify"). The Motion to Modify requested the Commission issue an order modifying the Commission's *Findings of Fact, Conclusions of Law and Decision and Order filed August 28, 1991* ("1991 Decision and Order"), to remove 212.333 acres of

Agricultural Land makai of Queen Ka'ahumanu Highway ("Phase III") from the docket and the Petition Area that is subject to the 1991 Decision and Order. Phase III is further identified as Tax Map Key ("TMK") No. (3) 7-4-008:002 (por.) and is approximately shown on Exhibit "1" to the Motion to Modify.

The Commission, having duly considered the Motion to Modify, the arguments and representations by the parties, and the record in this docket finds and concludes the following:

FINDINGS OF FACT

1. Petitioner is a private operating foundation which provides benefits to orphans and destitute children of Hawaiian ancestry. On August 4, 1989, and by subsequent amendments on January 18, 31, and on February 5, 1991 (hereinafter collectively referred to as the "1991 Petition"), Petitioner petitioned the Commission to amend the land use district boundary to reclassify its land at Keahuolū, Island, County and State of Hawai'i, identified by Tax Map Key Nos. 7-4-08: por. 2 and 7-4-08: por. 12, to the State Urban District to permit the development of said lands.

2. The 1991 Petition identified three phases of development. Phase I and Phase II consisted of 545.391 acres of Agricultural and Conservation land mauka of Queen Ka'ahumanu Highway, previously identified as TMK No. 7-4-08: por. 12 in the 1991 Decision and Order, but now identified as TMK Nos. (3) 7-4-020:009, 010, 011, 012, 013, 014, 015, 022, and 028 (collectively "Phase I and II"). Phase III consisted of 212.333 acres of Agricultural land makai of Queen Ka'ahumanu Highway, identified as TMK No. 7-4-08: por. 2 ("Phase III").

3. Upon hearing and review of the testimony and evidence submitted in support of the 1991 Petition, the Commission entered its 1991 Decision and Order in which it reclassified Phase I and II to the Urban District. In the 1991 Decision and Order, the Commission also ordered that Phase III be "incrementally reclassified" pursuant to Hawaii Administrative Rules

("HAR") § 15-15-78 for redistricting from the Agricultural District to the Urban District pending a showing that Petitioner has made substantial completion of Phase I and II.

4. The 1991 Decision and Order specifically states:

> IT IS HEREBY FURTHER ORDERED that the portion of the Property designated "Phase III" (212 acres) in Petitioner's Phasing Plan (Exhibit 18), representing a portion of the Property, consisting of approximately 212.333 acres in the Agricultural District, situated at Keahuolu, Island, County and State of Hawai'i, Hawai'i Tax Map Key No.: 7-4-08: por. 2, as approximately shown on Exhibit "A" attached hereto and incorporated herein by reference shall be and the same is hereby incrementally reclassified pursuant to Commission Rule 15-15-78, and that redistricting from the Agricultural District to the Urban District will be granted upon receipt of an application by Petitioner for redistricting of this second increment (Phase III) upon a prima facie showing that Petitioner has made substantial completion of first increment (Phase I and II).

5. On August 14, 2015, Petitioner filed its Motion to Modify the 1991 Decision and Order seeking to remove Phase III from the docket and the incremental districting for the subject Petition Area.

6. On August 24, 2015, OP filed a request for an extension to filing responses on Petitioner's Motion until September 14, 2015.

7. On August 25, 2015, the Commission sent a letter granting an extension to OP and all other parties.

8. On September 28, 2015, OP filed a request for another extension to filing responses to Petitioner's Motion until October 22, 2015.

9. On September 30, 2015, the Commission sent a letter granting the extension request to OP and all other parties.

10. On October 16, 2015, Petitioner filed with the Commission its *Supplemental Memorandum in Support of its Motion for Order Modifying the Findings of Fact, Conclusions of Law, and Decision and Order filed August 28, 1991; Affidavit of LeeAnn Crabbe; Exhibit "5,"* which provided further background regarding the 1991 Petition and the Motion to Modify.

11. On October 22, 2015, OP filed a request for a further extension to filing responses to Petitioner's Motion until November 6, 2015.

12. On October 22, 2015, the Commission sent a letter granting the extension request to OP and all other parties.

13. On November 6, 2015, the State Office of Planning ("OP") filed its *Response to Petitioner's Motion for Order Modifying the Findings of Fact, Conclusions of Law, and Decision and Order filed August 28, 1001; Office of Planning Exhibit 1*, requesting additional information and reserving the right to offer further comments if additional information is submitted.

14. On November 6, 2015, the County of Hawai'i, Department of Planning ("County") sent an e-mail request for an extension on filing comments on Petitioner's Motion.

15. On November 20, 2015, the Commission sent a letter to Petitioner requesting additional information to support its motion and sent a letter granting the extension request for additional time to comment to the County and all other parties pending receipt of supplemental information from Petitioner.

16. On January 11, 2016, Petitioner filed its *Second Supplemental Memo in Support of its Motion for Order Modifying the Findings of Fact, Conclusions of Law, and Decision and Order filed Aug. 28, 1991; Affidavit of LeeAnn Crabbe; Exhibits "6" – "10,"* responding to the OP's Response and the Commission's letter.

17. On January 22, 2016, the Planning Department, County of Hawaii ("County") filed its *Response to Petitioner's First and Second Supplemental Memorandum in Support of its*

Motion for Order Modifying the Findings of Fact, Conclusions of Law, and Decision and Order filed August 28, 1991; County Exhibits "1" – "3," supporting the Motion to Modify.

18. On March 4, 2016, the OP filed its *Supplemental Response to Queen Liliuokalani Trust's Motion for Order Modifying The Findings of Fact, Conclusions of Law, and Decision and Order filed August 28, 1991; Exhibit 1*, supporting the Motion to Modify.

19. On March 10, 2016, the Commission mailed the meeting notice and agenda for its March 23-24, 2016, meeting in Kona, Hawai'i to all parties, and the Statewide and Hawai'i County mailing lists.

20. On March 11, 2016, Petitioner filed its *Third Supplemental Memo in Support of its Mtn. for Order Modifying the Findings of Fact, Conclusions of Law, and Decision and Order filed Aug. 28, 1991; Affidavit of LeeAnn Crabbe; Exhibits "11" "12,"* which made a technical correction to the acreage information provided in Petitioner's earlier filings.

21. On March 21, 2016, the Commission received correspondence from Greater Kona Community Council ("Intervener") representative, Mark Van Pernis, advising that he no longer represented the Intervener which was involved in the original district boundary amendment proceedings and would not be appearing. Additional background checking indicates that the Greater Kona Community Council disbanded in 1994.

22. On March 22, 2016, OP filed an update and revision to OP Exhibit 1 (State Department of Transportation letter) in Supplemental Response of March 4, 2016.

23. The Commission received no formal requests to intervene in the Motion to Modify proceedings.

24. On March 23 and 24, 2016, the Commission met in Kailua-Kona, Hawai'i and considered Petitioner's Motion to Modify. Benjamin A. Kudo, Esq., Clara Park, Esq., and

LeeAnn Crabbe appeared on behalf of Petitioner; Bryan Yee, Esq. and Rodney Funakoshi appeared on behalf of OP; and, Amy Self, Esq., Daryn Arai and Duane Kanuha appeared on behalf of the County.

25. At the meeting, the Commission provided an opportunity for public testimony. The Commission heard public testimony from Ken Melrose in support, and Kirsten Kahaloa representing the Kona Chamber of Commerce also in support.

26. At the meeting on March 23, 2016, the Petitioner introduced Petitioner's Exhibits 1 to 12 and filed two new Petitioner's Exhibits 13 and 14. OP introduced OP Exhibits 1, Supplemental Exhibit 1 Department of Transportation ("DOT") letter, and an updated supplement to the DOT letter. The County introduced County Exhibits 1 to 3. There were no objections by any of the parties. The Chair admitted all parties' exhibits into the record. On March 24, 2016, the Petitioner introduced Petitioner's Exhibit 15 Resume and Qualifications for Tim Cornwell (replacement testifier for Richard Gollis) and a copy of Findings of Fact, Conclusions of Law, and Decision and Order for A79-470 Trustees of the Lili'uokalani Trust (by request of Commissioner Scheuer for Commission review).

27. LeeAnn Crabbe, Vice President for Petitioner, and Tim Cornwell, of The Concord Group, testified on Petitioner's behalf and addressed questions by the Commissioners. Mr. Cornwell was qualified as an expert witness in market feasibility analysis. Ms. Crabbe testified that QLT would not develop the remainder of Phase III lands before getting Commission approval of a petition for district boundary amendment; would not develop "gentlemen farms" in Phase III; and would not sequentially redistrict additional portions of Phase III in less than 15 acre increments, with the exception of the parcel to be included in the Makalapua Project District ("MPD").

28. Petitioner has completed the backbone infrastructure improvements required under the 1991 Decision and Order, as well as some development of Phases I and II and the conditions applicable to Phases I and II. However, Petitioner has not been able to substantially complete Phases I and II as originally planned in the 1991 Petition.

29. The downward market trends and recessions that occurred between 1990 and 2015 were unanticipated and affected the development demand for the 1991 Petition's original planned uses.

30. In addition, Petitioner discovered that the severe slopes of the lands in the Phase I and II parcels were better suited for smaller footprint uses.

31. Under the 1991 Decision and Order, Phase III remains subject to incremental districting from the Agricultural District to the Urban District because the 1991 Decision and Order requires the completion of Phases I and II before Phase III can be reclassified.

32. Petitioner has revised its development strategy for its Keahuolū lands, including Phase III, to better respond to community and market needs and to correspond with the Kona Community Development Plan ("Kona CDP"). Petitioner provided a conceptual overview of the two projects that it plans to develop: the MPD development, and the Keahuolū Land Plan development.

33. Petitioner filed the Motion to Modify to release the Phase III lands from incremental districting so that the Phase III lands can be incorporated into Petitioner's revised development strategy.

34. After Phase III is released from incremental districting, Petitioner will first seek reclassification of a less than 15-acre portion of Phase III through the County of Hawai'i, to be included in the MPD development. Petitioner will later seek reclassification of the remainder of

Phase III through a new petition for district boundary amendment to be filed with the Commission.

35. The release of Phase III lands for inclusion in the MPD development is critical because these lands are necessary to attract the types of tenants needed to support a regional commercial center as envisioned in the Kona CDP, and to generate the revenue needed to support the larger-scale Keahuolū Land Plan. The MPD development represents an immediate opportunity with significant retail and hotel interest, and Petitioner is already in active discussions regarding the MPD development.

36. The County stated its support of the Motion to Modify and addressed questions by the Commissioners. The County agreed that stagnation has occurred on commercial development within Petitioner's Phase I and II, with growth in recent years concentrated on lands situated makai of the Queen Ka'ahumanu Highway and immediately adjacent to the south of Phase III. The County believes that Petitioner's MPD development concept, which calls for the inclusion of a portion of the Phase III lands, will be a step towards establishing a Regional Center Transit Oriented Development as called for in the Kona CDP.

37. The OP stated its support of the Motion to Modify and addressed questions by the Commissioners. The OP requested that Petitioner provide OP with one hard copy and one electronic copy of its application for district boundary amendment with the County of Hawai'i within 24 hours of filing. The OP also recommended that Petitioner and the County consult with the State Department of Transportation, Department of Education, Department of Defense, Department of Land and Natural Resources, and Department of Health before the reclassification of the less than 15-acre area.

38. Following discussion by the Commissioners, a motion was made and seconded to grant the Motion to Modify. There being a vote tally of 7 ayes, 0 nays, and 1 absent, the motion carried.

CONCLUSIONS OF LAW

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

2. HAR § 15-15-94 states:

> (a) If a petitioner, pursuant to this subsection, desires to have a . . . modification of the commission's order, the petitioner shall file a motion in accordance with section 15-15-70 and serve a copy on all parties to the boundary amendment proceeding in which the condition was imposed or in which the order was issued, and to any person that may have a property interest in the subject property as recorded in the county's real property tax records at the time that the motion is filed.
>
> (b) For good cause shown, the commission may act to . . . modify the commission's order.
>
> (c) Any . . . modifications to the commission's order shall follow the procedures set forth in subchapter 11.

3. Under HAR §15-15-94(b), Petitioner has presented the Commission with good cause to modify the 1991 Decision and Order to remove Phase III from the docket and the incremental districting for the subject Petition Area.

ORDER

Having duly considered Petitioner's Motion to Modify, the oral and written arguments presented by the parties, the records and files herein, and a motion having been made at a hearing conducted on March 23 and 24, 2016, at Kailua-Kona, Hawai'i, and the motion having received

the affirmative votes required by HAR § 15-15-13, and there being good cause for the motion, the Commission ORDERS as follows:

1. The Motion to Modify filed by Petitioner is hereby GRANTED.

2. Within 24 hours of filing an application for district boundary amendment of a portion of Phase III with the County of Hawai'i, Petitioner shall provide OP with one hard copy and one electronic copy of its application.

3. Petitioner comply with State DOT recommendations:

   a. Road A, a proposed road connecting the development to Queen Ka'ahumanu Highway between Hale Maka'i Street and Makala Boulevard, shall be configured as a right-turn in and right-turn out (RIRO) for both highway approaches;

   b. The conversion of the Hale Maka'i Street intersection with Queen Ka'ahumanu Highway to right-turn in and right-turn out, and the relocation of the traffic signal from this intersection to the proposed Manawalea Boulevard intersection with Queen Ka'ahumanu Highway is under discussion and will be analyzed further; and,

   c. Prepare and submit a Traffic Impact Analysis Report ("TIAR") to DOT for review and acceptance prior to submittal of the application for district boundary amendment with the County of Hawai'i . The TIAR shall include a discussion and calculation of the new QLT development's fair-share contribution for regional roadway improvements and may propose specific improvements that would satisfy the project's fair-share contribution.

4. Petitioner and the County shall consult with the State Department of Transportation, Department of Education, Department of Defense, Department of Land and Natural Resources, and Department of Health before the reclassification of a portion of Phase III by the County.

I. ADOPTION OF ORDER

This ORDER shall take effect upon the date this ORDER is certified and filed by this Commission.

Done at Kahului, Maui, this 21st day of April, 2016, per motion on March 24, 2016.

APPROVED AS TO FORM

Deputy Attorney General

LAND USE COMMISSION
STATE OF HAWAI'I

By
EDMUND ACZON
Chairperson and Commissioner

Filed and effective on:

04/21/2016

Certified by:

DANIEL E. ORODENKER
Executive Officer

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI'I

In the Matter of the Petition of QUEEN LILI'UOKALANI TRUST To Amend the Agricultural District Boundary into the Urban District for approximately 919.366 acres and to Amend the Conservation District Boundary into the Urban District for approximately 188.358 acres, at Keahuolū, Island, County and State of Hawai'i, Hawai'i Tax Map Key Nos. (3) 7-4-08: por. 2, por. 12	DOCKET NO. A89-646 ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991; CERTIFICATE OF SERVICE

CERTIFICATE OF SERVICE

I hereby certify that a copy of the ORDER GRANTING PETITIONER QUEEN LILI'UOKALANI TRUST'S MOTION FOR ORDER MODIFYING THE FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER FILED AUGUST 28, 1991 was served upon the following by either hand delivery or deposit the same in the U.S. Postal Service by regular or certified mail as noted:

CERTIFIED MAIL: BENJAMIN A. KUDO, Esq.
CONNIE C. CHOW, Esq.
Ashford & Wriston LLP
999 Bishop Street, Suite 1400
Honolulu, Hawai'i 96813
Attorney for Movant, Queen Lili'uokalani Trust

DEL.: LEO R. ASUNCION, Director
State Office of Planning
P. O. Box 2359
Honolulu, Hawai'i 96804-2359

REGULAR MAIL: BRYAN C. YEE, Esq.
DEBORAH DAY EMERSON
Deputy Attorney General
425 Queen Street
Honolulu, Hawai'i 96813
Attorney for State Office of Planning

REGULAR MAIL: DUANE KANUHA, Planning Director
Hawai'i Planning Department
County of Hawai'i
101 Pauahi Street, Room 325
Hilo, Hawai'i 96720

REGULAR MAIL: AMY SELF, Esq.
Office of the Corporation Counsel
County of Hawai'i
101 Aupuni Street, Room 325
Hilo, Hawai'i 96720
Attorney for the County of Hawai'i Department of Planning

Dated: Honolulu, Hawai`i, 04/21/2016.

DANIEL E. ORODENKER
Executive Officer

APPENDIX B

INFRASTRUCTURE REPORT

Infrastructure Report

For the

Lili'uokalani Trust

Makalapua
Project District

Kailua-Kona, Hawaii

Lili'uokalani Trust
1100 Alakea Street, Suite 1100
Honolulu, Hawaii

Prepared by:
ParEn, Inc.
dba Park Engineering
711 Kapiolani Boulevard, Suite 1500
Honolulu, Hawaii 96813

August 2024

Infrastructure Report

For the

Lili'uokalani Trust

Makalapua
Project District

Kailua-Kona, Hawaii

Lili'uokalani Trust
1100 Alakea Street, Suite 1100
Honolulu, Hawaii

KEITH S. UEMURA
LICENSED PROFESSIONAL ENGINEER
No. 7472-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION

ParEn, Inc.
dba PARK ENGINEERING
LICENSE EXPIRATION 4-30-2026

Prepared by:
ParEn, Inc.
dba Park Engineering
711 Kapiolani Boulevard, Suite 1500
Honolulu, Hawaii 96813

August 2024

Table of Contents

FIGURES

TABLES

APPENDICES

1 DESCRIPTION OF PROJECT

The Lili'uokalani Trust (LT) proposes the development, enhancement, and refinement of approximately 70 acres in Kailua-Kona on the island of Hawai'i as the Makalapua Project District (MPD). LT is a nonprofit public benefit organization dedicated to improving the welfare of orphan and other destitute children in Hawai'i. LT manages its landholdings to provide a financial foundation for the perpetual benefit of its beneficiaries.

The Makalapua Project District may include residential, hotel, retail, commercial, office, and civic/community uses. The proposed project will be organized around an interconnected, pedestrian-oriented street network where homes, businesses, and entertainment are intermingled to provide a diverse experience for residents and visitors. The proposed mixed-use project will include approximately 600 residential units; 150 hotel rooms; 220,900 square feet of commercial use (retail, employment); and a variety of open space and archaeological features. The Makalapua Project District's street network may include the realignment of Makala Boulevard and the extension of Kuakini Highway, Pawai and Ma'a Way.

A summary of the proposed land uses is provided in Table 1-1.

TABLE 1-1
SUMMARY OF PROPOSED LAND USES

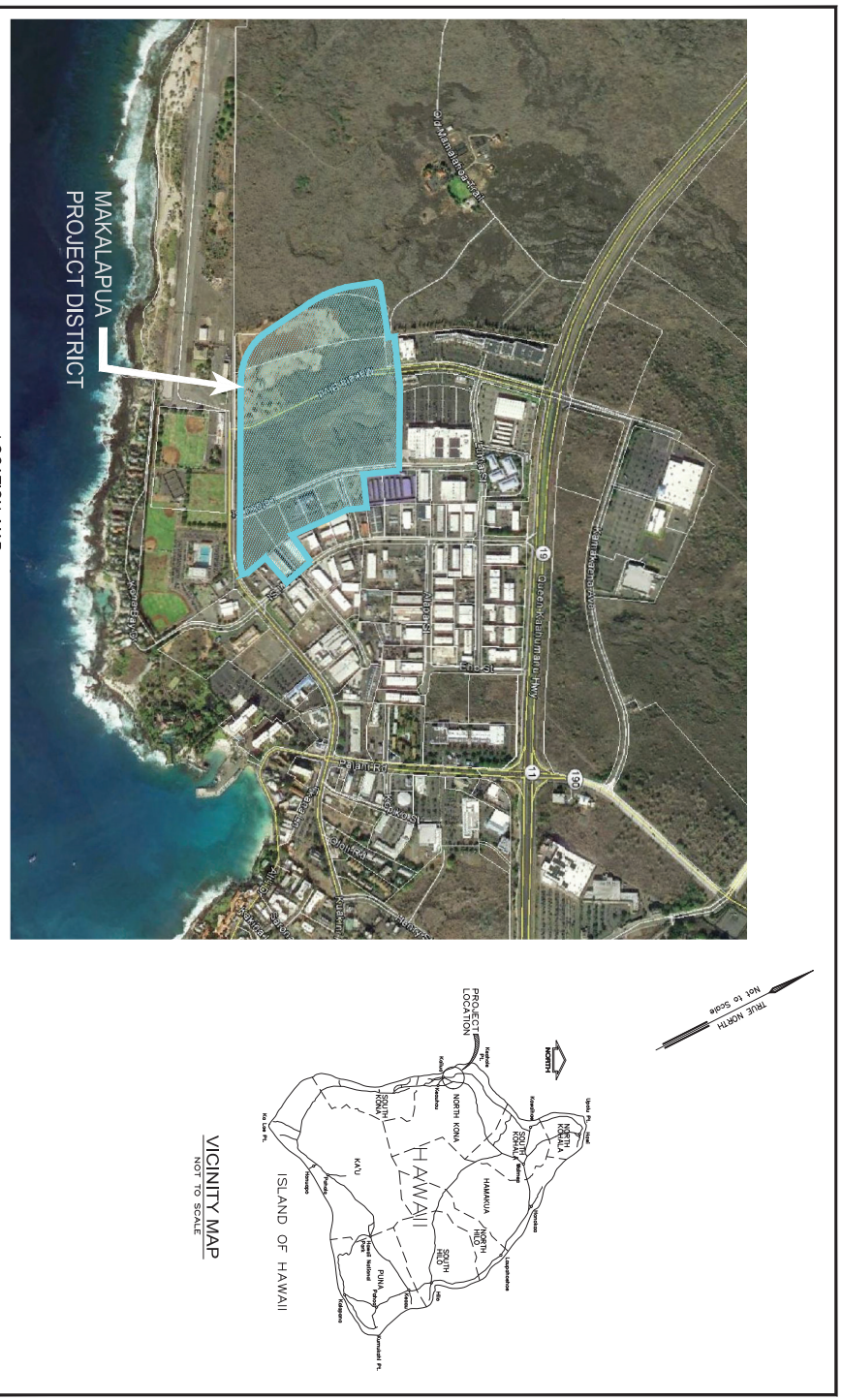
Land Use	Acres	Quantity	Units
Residential			
Single Family – Courtyard Homes/Cottages	13.83	100	Each
Multi Family (Mixed Use) – Flats/Lofts	13.73	500	Each
Non-Residential			
Retail/Commercial	17.09	179,500	Sq. Ft.
Retail (Mixed Use)	7.06	41,400	Sq. Ft.
Hotel	0.71	150	Rooms
Archaeological Sites and Buffers	3.57		Acres
Backbone Roads	12.00		Acres
Open Space	1.56		Acres
TOTAL	**69.55**		

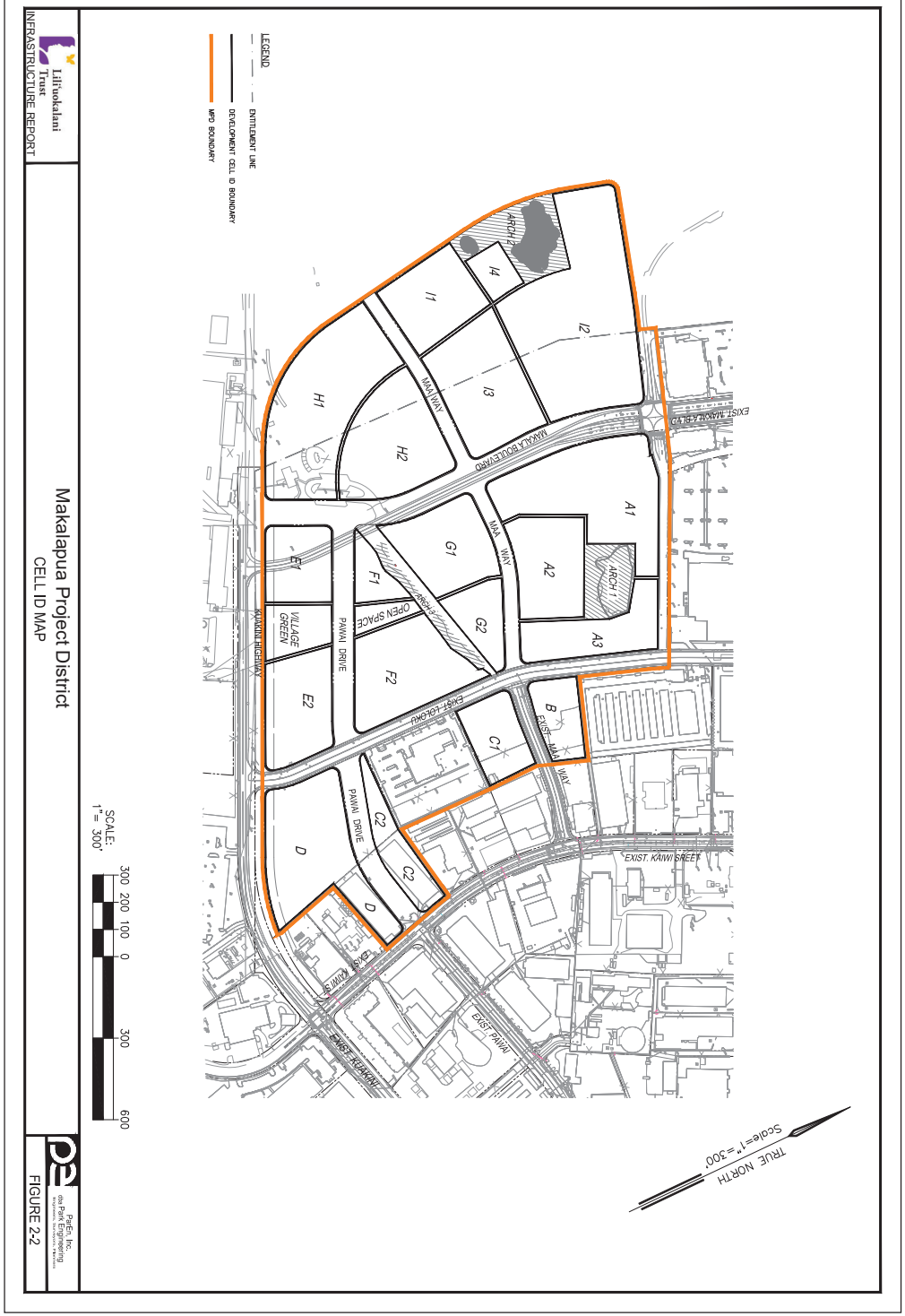
2 PROJECT LOCATION

The Makalapua Project District site is located in Kailua-Kona on the island of Hawaii. It is bordered to the northeast by the existing Kona Commons retail area which includes a Ross Dress for Less and Target store. Southwest of the project site is the Kailua Park (also known as Old Kona Airport Park) and Kona Community Aquatic Center adjacent to Kuakini Highway. The southeast quadrant is bounded by the existing Kona Industrial Subdivision and Kaiwi Street while the area to the northwest is undeveloped land. (See Figure 2-1 – Location Map). The Makalapua Project District is further divided into cells in order to identify the various areas of development within the project site (See Figure 2-2 – Cell ID Map).

3 TOPOGRAPHY

Existing topography at the MPD project site ranges from elevation 10 to 40 feet MSL. Average slope at the site is approximately 3%. The site generally slopes down in a southwest direction towards the Old Kona Airport Park.





4 SEWER SYSTEM

4.1. EXISTING SEWER SYSTEM

4.1.1. Kealakehe Wastewater Treatment Plant (WWTP)

The Kealakehe WWTP is a regional facility that treats wastewater from a service area extending from Keauhou to the south and Kealakehe to the north. It is located to the immediate north of the undeveloped lands makai of Queen Ka'ahumanu Highway owned by LT. Current treated flow for the WWTP is approximately 2.0 million gallons per day (mgd) with a maximum capacity of 5.3 mgd.

4.1.2. Kealakehe Sewage Pump Station (SPS)

Kealakehe SPS is also a regional facility that pumps sewage from the Kona Industrial Subdivision and areas to the south of Kailua-Kona via a 24" sewer force main to the Kealakehe WWTP. The SPS is located just south of the Kona Aquatic Center. The alignment of the force main follows the mauka border of the Old Airport Park then crosses through undeveloped lands owned by LT. There is an existing 15-inch and 42-inch gravity sewer main connected to the influent box of the SPS. The 15-inch gravity line serves the Makalapua Shopping Center, Kona Commons and portions of the Kona Industrial Subdivision (KIS). The 42-inch gravity line serves KIS and areas to the east. Sewage flows from Keauhou to Kailua town and is lifted by a series of pump stations before being discharged into the 42-inch sewer line.

4.1.3. Sewer Mains

The existing gravity sewer line within the Makalapua Project District site is a 15-inch vitrified clay (VC) sewer pipe that is located in existing Loloku Street and Kuakini Highway. The 15-inch sewer line terminates at the existing Kealakehe SPS. As per the approved Kona Industrial Subdivision, Sewer Master Plan update, Preliminary Engineering Report, dated September 2006, approximately 78 acres of land owned by LT located on the mauka side of Queen Ka'ahumanu Highway can flow into this existing gravity sewer line.

Also, the existing gravity sewer system within KIS consists of a network of vitrified clay (VC) sewer pipes ranging in size from 6 inches to 20 inches diameter located within the public roadways and easements in the private lots. The KIS sewer system connects to the existing 36 inch

and 42 inch diameter sewer main along Kuakini Highway and then gravity flows to the existing Kealakehe SPS.

See Figure 4-1 – Existing Sewer System

4.2. PROPOSED SEWER SYSTEM IMPROVEMENTS

The sewer system will be designed to satisfy the requirements of the Department of Environmental Management (DEM) and in accordance with the "Wastewater System Design Standards, City and County of Honolulu", dated July 2017. Sewer mains will be designed to carry the peak flows of this development.

In general, the proposed onsite wastewater collection system will follow the proposed public roadway system and will be conveyed by gravity (8-inch or 12-inch sewer). MPD development flows utilize the following sewer systems:

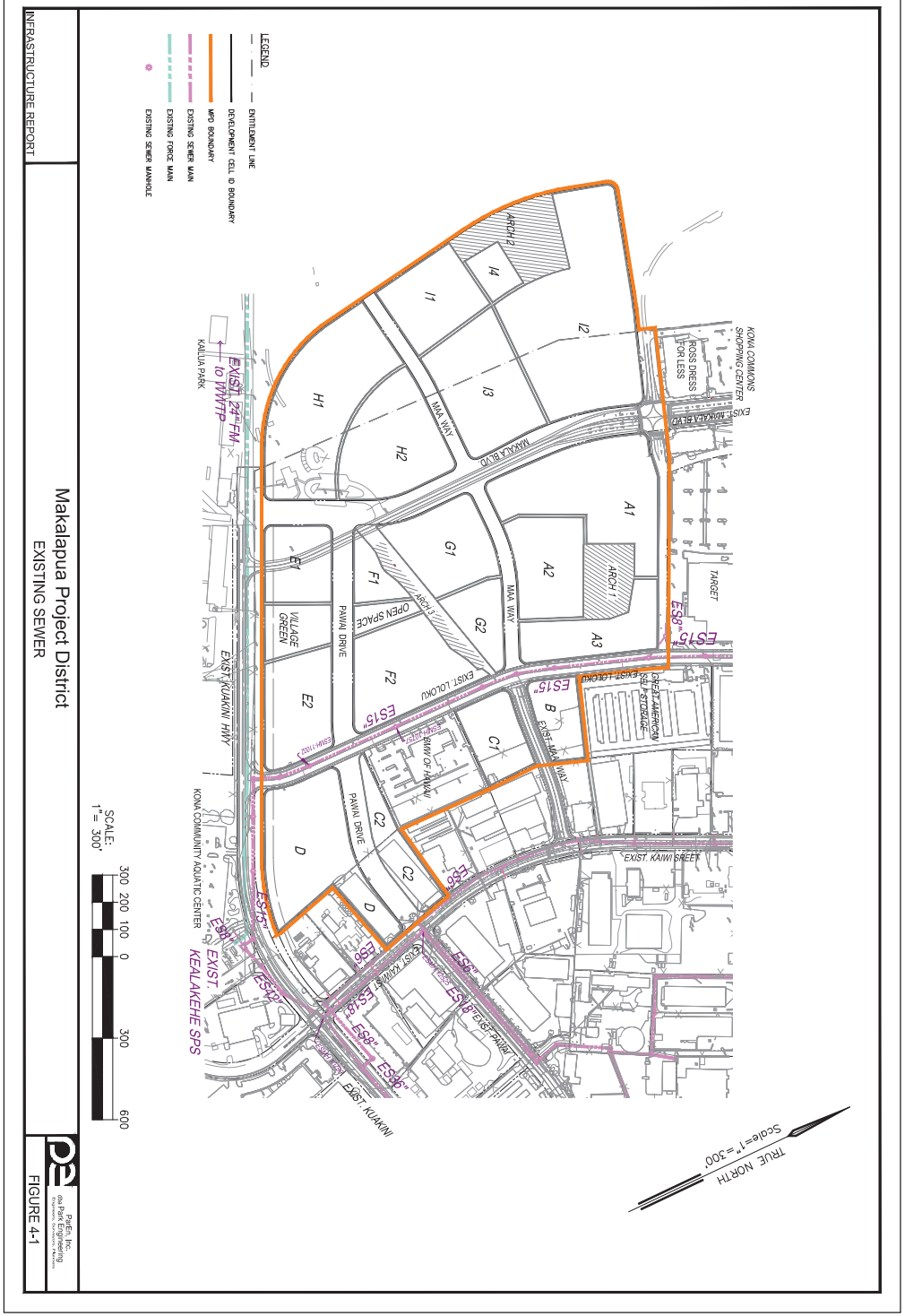
1. Majority of the parcels will flow through private property and/or a public roadway system and will be conveyed by gravity (8-inch sewer) to a private SPS at the intersection of Makala and Kuakini. The wastewater will be pumped from the private SPS at the corner of Makala and Kuakini through a 6-inch force main to a discharge manhole in Kuakini. The wastewater will then be conveyed by gravity through a 12-inch main in Kuakini to connect to the existing sewer system (ESMH-12464) in Loloku. Parcel D will utilize the existing sewer lateral in Loloku which is connected downstream of ESMH-11002. The sewer will then flow to Kealakehe SPS at the south-east corner.

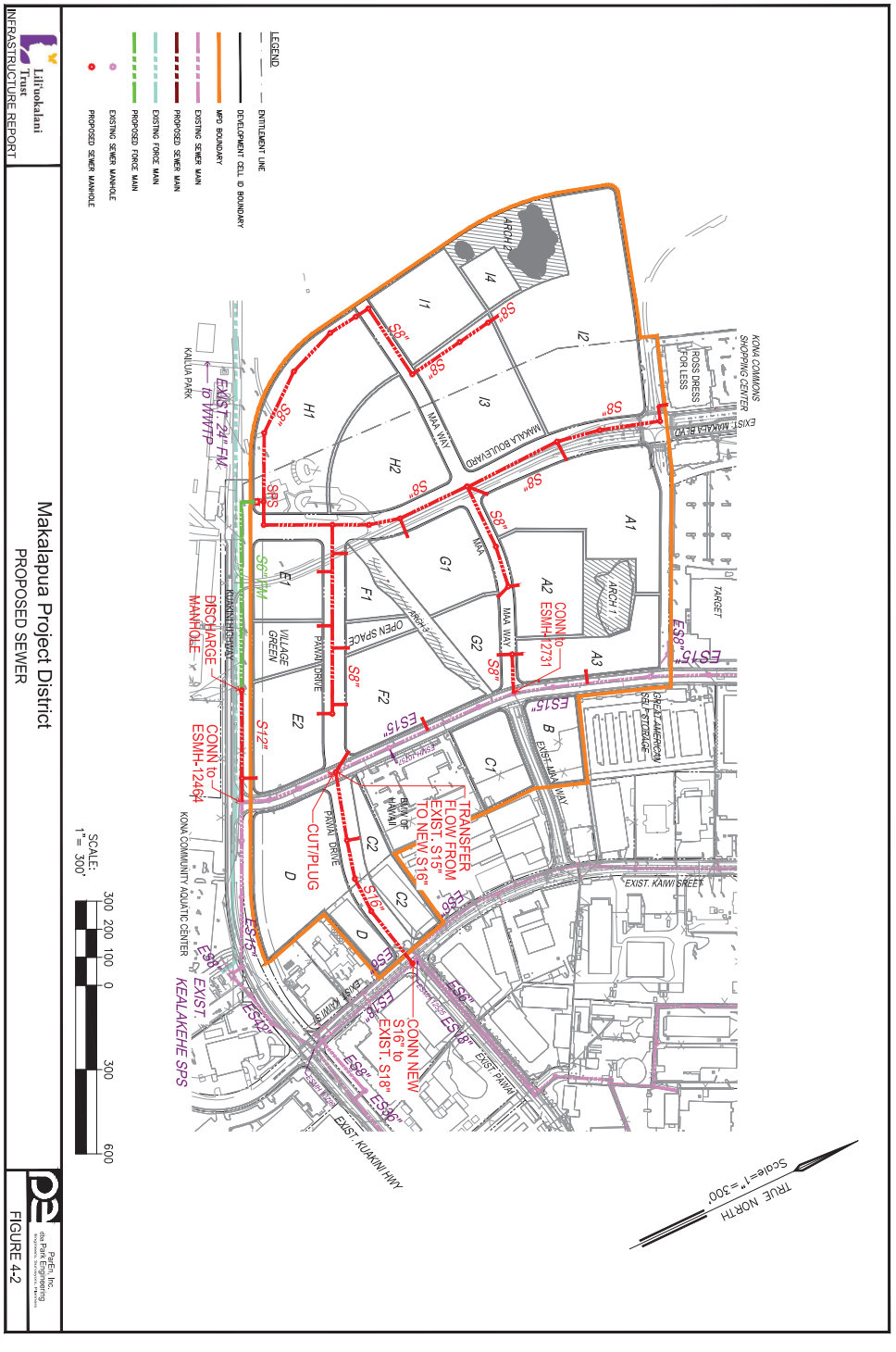
2. To eliminate the need to connect a new sewer line to the existing influent box at the Kealakehe SPS, the existing flows in the existing 15-inch sewer (above ESMH-11002) in the intersection of Loloku and Pawai, will be diverted and connected to the existing 18-inch sewer line in Kaiwi (KIS gravity line), which flows to the Kealakehe SPS via the existing 42-inch sewer line in Kauakini. The existing 15-inch sewer line will be cut and plugged right below the diversion sewer manhole.

3. There are portions of Parcel C2 and D that will continue to utilize the existing laterals which are connected to the existing 6-inch sewer in Kaiwi (KIS gravity line), which flows to the Kealakeha SPS via the existing 42-inch sewer line in Kuakini.

Flows will then be pumped from Kealakehe SPS to the existing Kealakehe WWTP via the existing 24-inch force main

See Figure 4-2 – Proposed Sewer Improvements.





DEM has reviewed sewer calculations and figures for MPD and agreed, in concept, that the proposed sewer plan is a viable option. DEM will require flow data to confirm the existing capacity of the sewer system to make a final determination on whether the system can accommodate the proposed MPD flows.

4.3. PROJECTED SEWER DEMAND

Hawaii County uses the "Wastewater System Design Standards, City and County of Honolulu", dated July 2017 as the basis for flow computations. For the above-mentioned sewer systems, it is estimated that the proposed project will generate the following peak wastewater flows: 1) 0.4546 MGD, 2) 0.1060 MGD and 3) same as existing.

The average daily per capita flow is 70 gallons per day (gpd). Commercial, office/employment, and civic/cultural land uses are the only exceptions with a per capita flow rate of 25 gpd. Average daily wastewater generation is based on the County standard population densities associated with the various land uses. The densities listed in Table 4-1 are used for the specified categories of land use.

TABLE 4-1
WASTEWATER GENERATION BY LAND USE TYPE

Land Use	Quantity	Units
MAKALAPUA PROJECT DISTRICT (MPD)		
RESIDENTIAL		
Residential Single Family	4	Capita per unit
Residential Multi-Family	2.8	Capita per unit
COMMERCIAL		
[1]Commercial	1*	Capita per 150 Sq. Ft.
[1]Office/Employment	1*	Capita per 150 Sq. Ft.
OPEN SPACE		
Village Green 1 Equivalent Dwelling Subd Unit (EDSU)	4	Capita per green area
KAILUA INDUSTRIAL (KIS)		
NEIGHBORHOOD BUSINESS		

* Per capita flow rate of 25 gallons per day.
[1] Commercial and Office/Employment land use were computed using 1 person per 150 square feet due to projected development type.

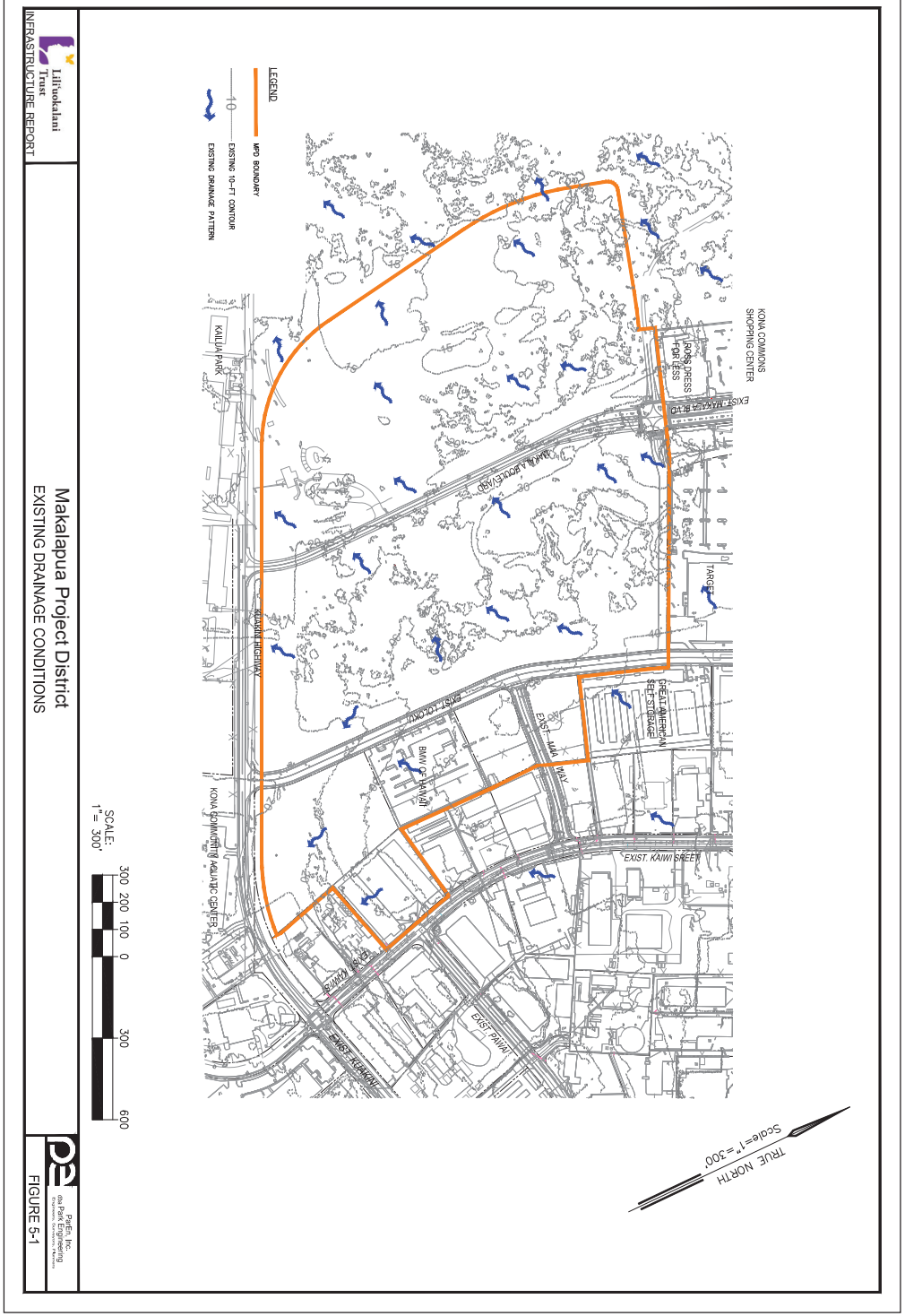
A summary of the wastewater computation is presented in Appendix A. Wastewater computations were done by dividing the project site into tributary areas based on land use. .

5 DRAINAGE SYSTEM

5.1. EXISTING DRAINAGE CONDITIONS

The existing ground conditions at the site can be characterized as old lava fields. Depending on the type of lava rock present, the stormwater runoff will flow and then infiltrate into the ground. Currently, there are existing catch basins, drain intakes, pipes and drywells in the developed areas that convey and dispose stormwater runoff onsite. See Figure 5-1, Existing Drainage Conditions, for existing drainage patterns in and around the project site. Preliminary hydrologic calculations indicate that the existing 10-year peak stormwater runoff rate for the 70 acre project site is approximately 38 cfs (See Appendix B).

The general topography of the site may be described as gently sloped from the northeast to the southwest end of the project site. Existing ground elevations



range from 10 feet above mean sea level (msl) near the Old Kona Airport Park to 40 feet above msl near Great American Self Storage. The existing ground slopes range from 0 percent to 12 percent with an average slope of 3 percent.

Erosion and sediment during construction will be addressed through the implementation of Best Management Practices (BMPs) in accordance with the "Erosion and Sedimentation Control Standards and Guidelines", Department of Public Works, County of Hawaii, dated December 12, 1975.

5.2. PROPOSED DRAINAGE IMPROVEMENTS

Stormwater runoff from the project site will be collected by swales, ditches, gutters, inlets and/or catch basins then conveyed to drywells and/or infiltration areas for onsite disposal. An underground injection control (UIC) permit will be required by the Hawaii State Department of Health (DOH) to construct and operate the drywells. Drainage improvements for the project will be designed in accordance with the "Storm Drainage Standards", Department of Public Works, County of Hawaii, dated October 1970, as amended.

Preliminary consultation with a geotechnical engineer indicates that a drywell may have the capacity to dispose of three (3) cubic feet per second (cfs) of stormwater runoff. Preliminary hydrologic calculations were performed based on the 3 cfs capacity for drywells within newly developed lots and including considerations for maximum inlet spacing of 500 feet for drywells along the roadways. The results of the preliminary hydrologic calculations indicate that the post-development 10-year peak stormwater runoff rate will be approximately 151 cfs (See Appendix B). Approximately 74 drywells may be required for onsite disposal of the stormwater runoff from the project. The drywells should be distributed throughout the project site and constructed in the proposed parking lots, along the proposed roadways and other locations where space is available. General proposed drainage patterns and locations of catch basin drywells within the roadways are shown in Figure 5-2, Proposed Drainage Conditions. Drywells within the lots are not shown in the figure but will be located strategically where space is available based on the site plan. With the construction of the 74 drywells, the net runoff will be equal to or less than the existing runoff. No drainage impacts to downstream properties and nearshore waters are anticipated. In general, the post-development drainage pattern will be similar to the existing drainage pattern. Stormwater runoff will generally flow in the northeast to southwest direction.

Permanent Best Management Practices (BMPs) and Low Impact Development (LID) will be considered during the design of the drainage systems. Appropriate BMPs and LIDs for the site will be determined by the anticipated land uses and their potential pollutants. The anticipated land uses for Makalapua Project District include residential, hotel, retail, commercial, office and civic/community. Table 5-1 lists the expected pollutant generating activities within each land use.

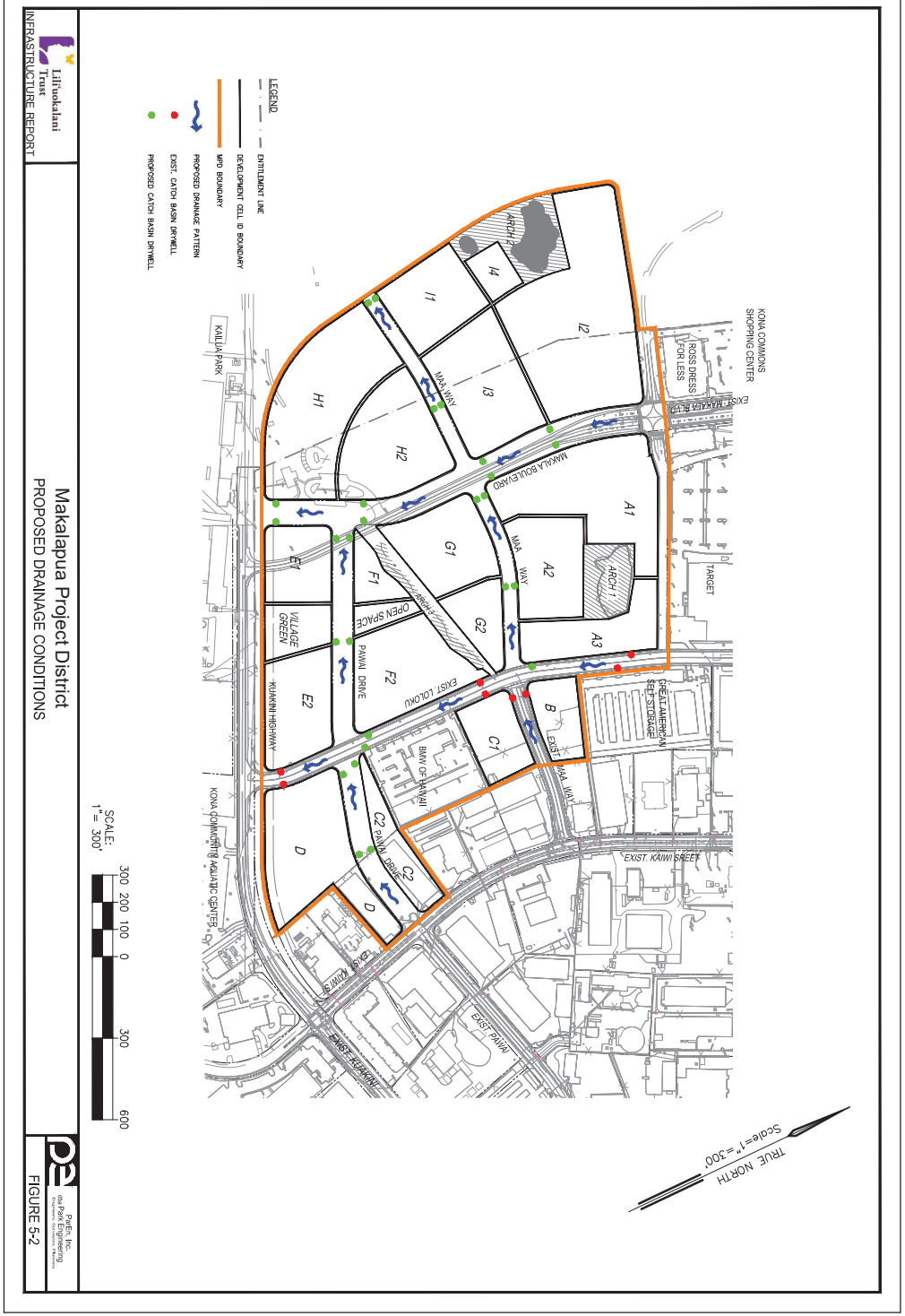


TABLE 5-1
Expected Activities Associated with Land Uses

Land Use	Activity	
Regional Commercial	• Retail • Uncovered parking lots	• Restaurants • Landscaping
Neighborhood Commercial	• Vehicle fueling (retail gas outlet)	
Mixed Use Commercial/Residential	• Hotel • Offices • Theater • Residential • Retail	• Uncovered parking lot and parking structure • Restuarants • Landscaping
Single Family Residential	• Single-family home occupation	• Landscaping
Medium Density Residential	• Multi-family low-rise occupation • Uncovered parking lots and parking structures	• Landscaping
Light Industrial	• Light manufacturing, processing, and packaging • Wholesaling and distribution	• Food manufacturing and processing • Warehousing
Roads, Streets	• Transportation activities (vehicle, bicycle, pedestrian, other)	

Based on the activities identified, potential pollutants for the project include nutrients, sediment, trash, pathogens, pesticides/herbicides, oil and grease, metals, and organic compounds. Source Control BMPs and Permanent Treatment Control BMPs will be utilized to address these pollutants. Possible Source Control BMPs that may be used include: limiting runoff from landscaped areas to impervious areas; designing irrigation systems to minimize runoff of excess irrigation runoff and promote surface filtration; providing stenciling or labeling of all storm drain inlets and catch basins with prohibitive language; including overhanging roof structure or canopy over fuel dispensing areas; paving fuel dispensing areas with Portland cement concrete; designating a car wash area for apartment buildings and directing/diverting wash water to vegetated areas or an engineered infiltration system; grading parking areas to direct runoff towards vegetated/landscaped areas or other Post-Construction Treatment Control BMPs.

Permanent Treatment Control BMPs, such as subsurface infiltration, dry well, permeable pavement, bioretention basin, vegetated swale, or vegetated bio-filter, may be considered to treat stormwater prior to discharge to drywells in order to protect groundwater and near shore waters.

6 WATER SYSTEM

6.1. EXISTING POTABLE WATER SYSTEM

The Makalapua Project District will fall within the Hawaii County Department of Water Supply's (DWS) 325 ft. water service zone. Currently there is a 12-inch potable water line in Loloku Street which connects the Kona Commons area to the Kona Industrial Subdivision and existing Kuakini Highway. Both Kaiwi Street and Makala Boulevard through Kona Commons have 8-inch water mains. The existing system belongs to DWS. The DWS 325 ft. system is served by the 0.3 million gallons (MG) Palani Station No. 1 reservoir located at 7-4-21:22 and the 2.0 MG Pua Puaa Reservoir near Pualani Estates Subdivision.

The source of water for the Makalapua Project District is the Keauhou Aquifer System which is comprised of basal, high-level, and deep-confined freshwater aquifers. Current sustainable yield for the aquifer set by the Commission on Water Resources Management is 38 million gallons per day (MGD). At present, pumpage from the aquifer is approximately 14.5 MGD. Planning studies by the County of Hawaii DWS indicate that the maximum pumping rate with projected demands based on full build out allowable by county zoning will be just over 28 MGD. This projected pumpage falls within 75 percent of the established sustainable yield.

See Figure 6-1 – Existing Potable Water System.

6.2. PROJECTED POTABLE WATER SYSTEM DEMANDS

It is estimated that the proposed Makalapua Project District will generate an average daily water demand of approximately 327,450 gallons per day (GPD). Refer to Table 6-1 for the projected potable water demand of the proposed Makalapua development.

LT will tap into available water credits with DWS in accordance with the Makalapua Business Center (MBC) Water Commitment and the Keahuolu Lands Water Resources Development Agreement (KLWRA) for the initial phases of MPD. Water credits are expressed in equivalent units based on a maximum day demand of 600 GPD. Maximum day demand is calculated by multiplying average day demand by a factor of 1.5. Therefore, 819 water credits are needed for MPD. However, the number of credits required will be reduced by the previously allocated water credits for parcels along Kaiwi Street and Loloku Street. These parcels are identified as Parcels B, C1, C2 and D and BMW of Hawaii. Therefore, the adjusted amount of water credits required for MPD is 717 units of credit. The current estimate of available credits for LT is 78 units from MBC and 649 units from KLWRA, which is sufficient to accommodate the MPD. However, LT has other planned projects in Kona that are in various

ParEn, Inc. dba park engineering

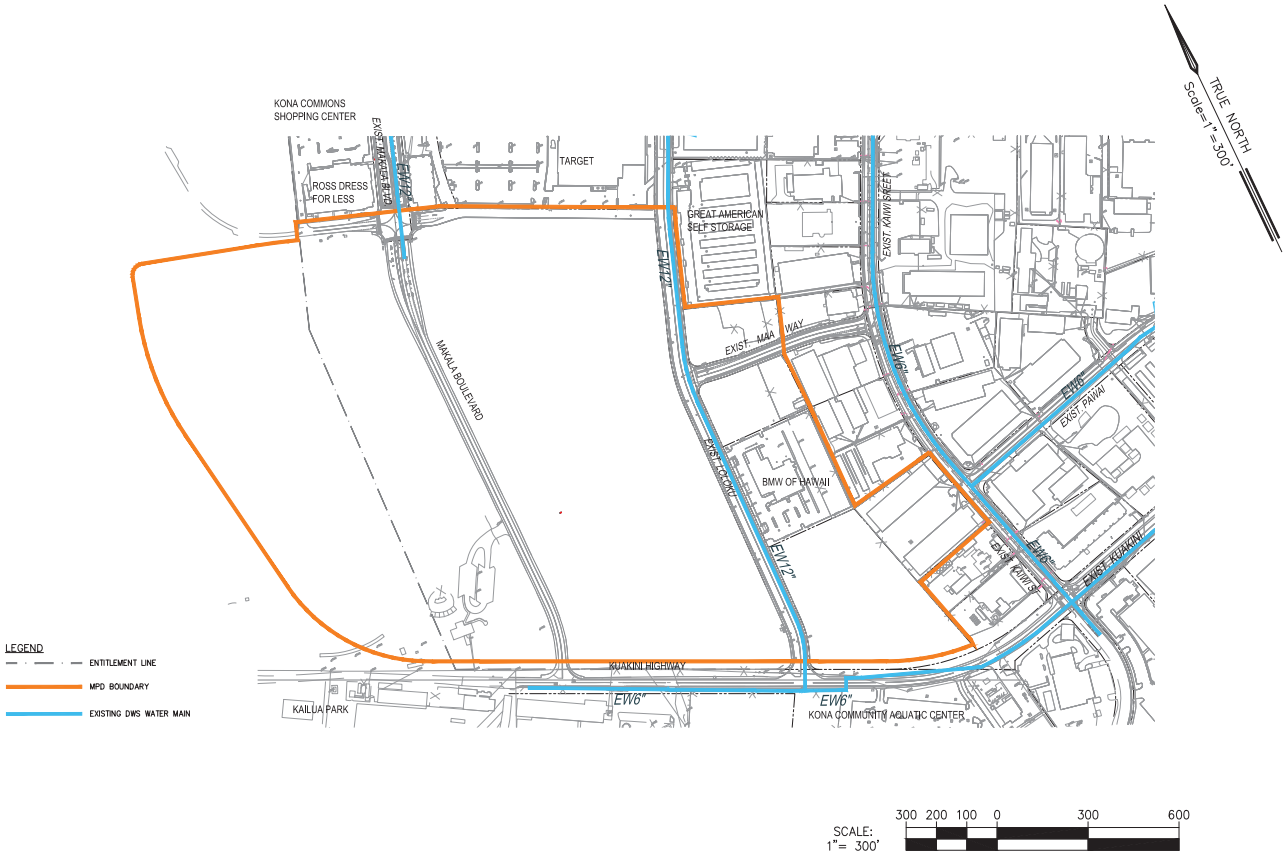
TABLE 6-1
MAKALAPUA PROJECT DISTRICT WATER DEMAND
325 FT. SERVICE ZONE

Land Use	Acres	Square Feet	No. of Units	Unit Demand		Average Daily Demand (GPD)	Maximum Daily Demand (GPD)	Peak Hour Demand (GPD)	Required Water Credits[1]
				GPD/Acre	GPD/Unit				
Residential									
Single Family	13.83		100	--	400	40,000	60,000	200,000	100
Multi-Family (Mixed Use)	13.73	--	500	--	400	200,000	300,000	1,000,000	437
Commercial									
Retail/Commercial	17.09	179,500	--	3,000	--	51,270	76,905	256,350	89
Retail (Mixed Use)	7.06	41,400	--	3,000	--	21,180	31,770	105,900	53
Hotel[3]	0.71	--	150		100	15,000	22,500	75,000	37.5
Public Backbone Street ROW[5]	12.00	--	--	--	--	--	--	--	--
Public Open Space[2]	1.56	--	--	--	--	--	--	--	--
Archeological Sites	3.57	--	--	--	--	--	--	--	--
Total	69.55	--	750	--	--	327,450	491,175	1,637,250	717

[1]Required water credits have been adjusted to account for previously allocated water credits for Parcels B, C1, BMW, C2 & D.

[2]Public Backbone Street ROW includes Makala Boulevard, Ma'a Way & Pawai Street

[3]Hotel unit demand is based on the median daily water use per hotel room from the "Energy Star Data Trends: Water Use Tracking Factsheet" (https://www.energystar.gov/buildings/tools-and-resources/datatrends-water-use-tracking)



Lili'uokalani Trust
INFRASTRUCTURE REPORT

Makalapua Project District
EXISTING POTABLE WATER SYSTEM

ParEn, Inc. dba Park Engineering

FIGURE 6-1

stages of planning that will also require water credits from these two commitments. As such, it is noted that LT is in the process of developing a new regional water source which would be dedicated to the County. This new water source would provide water for the County's future water needs in the region and would provide an allocation to LT to support its planned projects in Kona.

6.3. PROPOSED POTABLE WATER IMPROVEMENTS

The existing 325 ft. water service zone will serve the entire MPD development area. Proposed distribution mains will be either 8-inches or 12-inches in diameter and will be installed in all proposed backbone roads, including County dedicable roads and private roads. Analysis of the Peak Hour and Maximum Daily + Fire Flow scenarios show there are high levels of pressure available (See Appendix C). Therefore, pressure reducing units shall be installed at each water connection. All proposed water system improvements will be developed in accordance to the Water System Standards, Department of Water Supply, County of Hawaii, dated 2002. LT is working to confirm source and storage requirements with DWS, including the development of a new regional water source as previously mentioned.

See Figure 6-2 – Proposed Potable Water Improvements

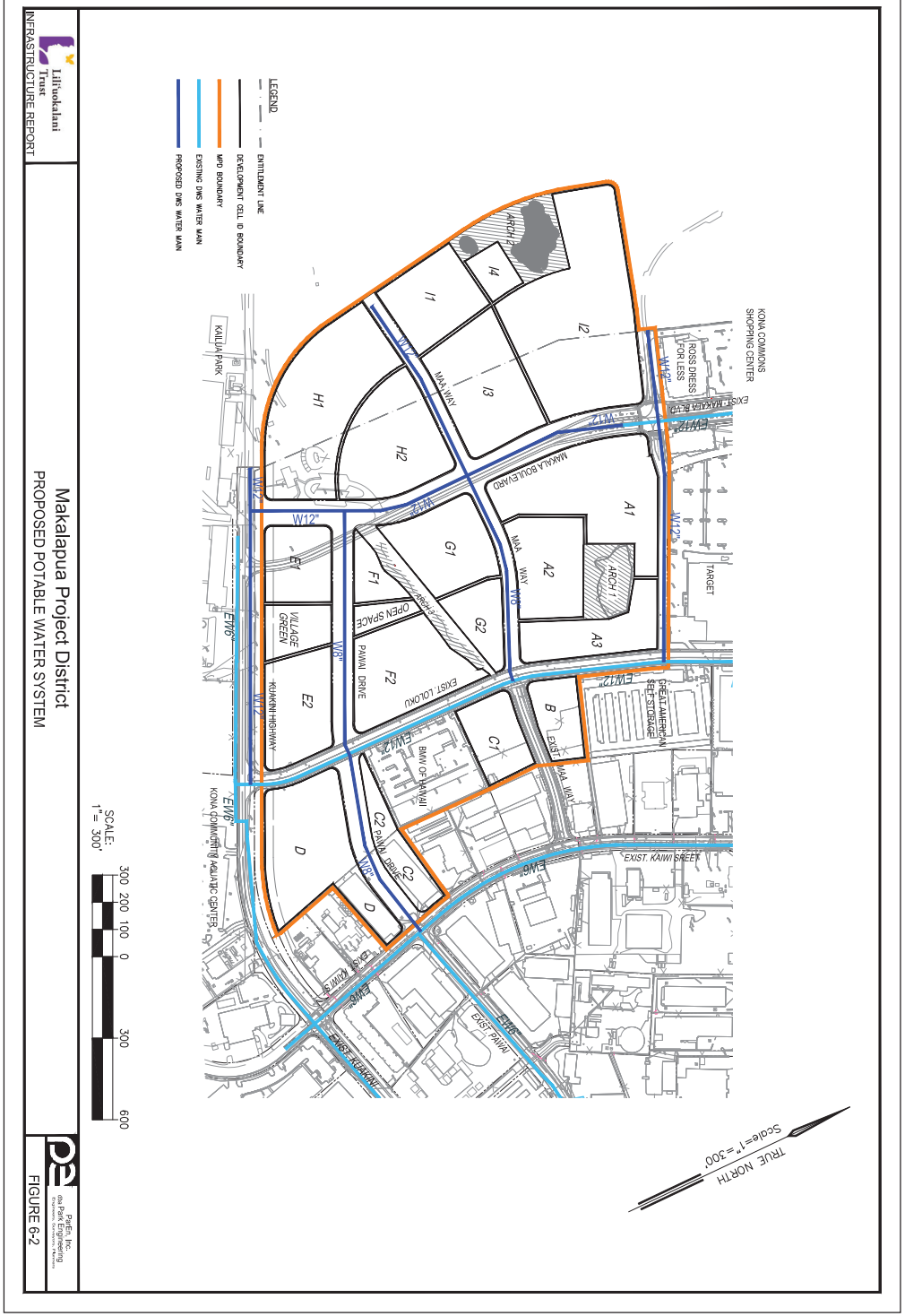
6.4. PROPOSED NON-POTABLE WATER IMPROVEMENTS

The DEM is currently in the design stage of upgrading the Kealakehe WWTP to produce R-1 quality water for reuse. Although this reuse source is not yet available, it is anticipated that DEM will install a reuse water transmission main to the Kona Park, immediately adjacent to MPD. Irrigation of open space areas in MPD using reuse water could be considered if a source of reuse water is installed in close proximity to these open space areas.

7 ELECTRICAL AND TELECOMMUNICATIONS

7.1. EXISTING CONDITIONS

As a preface to this section, it should be noted that prior to a few years ago, the name of the electric utility company providing service to the island of Hawai'i was referred to as Hawaii Electric Light Company (HELCO) and prior to that, as Hilo Electric Light Company. Subsequently, a recent corporate re-organization has occurred and the HELCO reference is no longer utilized in favor of Hawaiian Electric (HE).



HE is the main supplier of electricity on Hawai'i Island and is a State Public Utilities Commission (PUC) regulated Utility Company. Most of Hawai'i's power, approximately 178 Mega-Volt Amperes (MVA), is generated by three fossil fuel burning plants located on the east, Kanoelehua, west, Keahole and north, Waimea, sides of the island and delivered through a number of 69 kilo-Volt (kV) transmission corridors. The 69 kV transmission lines connect HE's generators, other third-party generators and grid-scale alternate energy producers with transmission switching stations to step the transmission voltage down to sub-transmission voltage levels (34.5 kV) that provide power to distribution substations. These distribution substations, in turn, provide 12 kV, 11.5 kV and a limited amount of 4.16 kV distribution power that serve HE's utility customers. The source for the 12-kV distribution power to the Kailua-Kona area are HE's existing Kailua, Palani and Kealakehe Substations. Kailua Substation is located adjacent to HE's Kona Office in the Kona Industrial Subdivision and HE's Palani Substation is located at the corner of Palani Road and Henry Street. The Kealakehe Substation, in addition to providing power to the State DHHL's Villages of La'i'opua Development provides power to the County's Kailua-Kona wastewater treatment facility makai of Queen Kaahumanu Highway.

HE's transmission (69 kV) and sub-transmission lines, within the Kailua-Kona area are overhead and supported by metal or wood utility poles. HE distribution and secondary lines are routed both overhead and underground throughout the Kailua-Kona area depending upon when they were constructed. Hawaiian Telcom (HT) and Spectrum Oceanic (Spectrum), high bandwidth, trunking cables are mostly overhead and in many cases are jointly supported by the same utility transmission and sub-transmission poles as HE. The older, existing HT and Spectrum facilities consist mainly of twisted, copper pair and coaxial cables and, similar to HE distribution and secondary cables may be either overhead or underground depending upon when they were constructed. It should be noted that in recent years both HT and Spectrum have committed to a "fiber-to-the Prem" approach to their facility development strategy and are using fiber optic cables for area and local distribution and as service drops to customers.

Additional existing off-site facilities that would serve the property are HT's Kailua-Kona central office located near the intersection of Queen Kaahumanu Highway and Palani Road and Spectrum's facility located to the north in the Kaloko Industrial Park.

7.2. PROPOSED IMPROVEMENTS

Standard Development Scenario

For new developments, HT and Spectrum typically requires developers to provide underground telecommunications duct systems infrastructure ("support

structures") at their own cost but will provide the cabling at the utility companies' cost. While HE, like HT and Spectrum, typically requires developers to provide underground electrical duct systems infrastructure at their own cost, the cabling, which HE will provide, will not be solely at HE's cost. In the most common scenario for new electric services, new HE facilities that are triggered by specific development projects, will be constructed underground. Under "Rule No. 13 - Line Extensions" of HE's tariffs, the funds for the underground HE cabling cost, paid to HE by the developer for electric service, consist of a refundable portion covering the cost of an equivalent overhead system, called the "Advance," and a non-refundable portion reflecting the cost difference between an underground system and an equivalent overhead system. Following permanent connections to HE's systems within the subdivision, HE will reimburse the project developer, for a period of up to 5 years after the date of the Advance, a total up to the amount of the Advance. The reimbursements will be paid on a year-by-year basis and will be a sum equivalent to the electricity usage charges paid by the energized development during that year. It should be noted that HE's tariffs are subject to change and LT will need to continue to coordinate with HE to confirm HE's tariffs regarding costs and reimbursements for underground systems.

The funding mechanisms and responsibilities for local electrical improvements initiated by the County, State, or HEC vary, depending on what the project entails and what type of electrical facility is being improved. In general, new developments and re-developments are required to fund and construct the underground infrastructure associated with their respective developments.

Utility Relocation

For utility relocation work, project developers are typically assessed 100% of the cost for the relocation work by all utility companies with the exception of County and State projects where relocation cost sharing is mandated by State Statute, County Ordinance and/or Legislation. Examples of such cost sharing are HRS 264-33 and Improvement District legislation. In the latter, cost for the relocation is prorated between the developers/property owners, the governmental agency and the utility companies through a negotiated formula. It is understood that another process, Community Funded Development, is being contemplated, but the cost sharing formula and funding mechanisms are still being developed.

Utility Coordination and Planning

Any larger scale master planned community that would significantly increase the electrical demand loading in any part of the island of Hawai'i would need both the County of Hawai'i and utility company review and inputs as part of the entitlement process before any actual development or construction would occur. As part of on-going customer service improvements, HE has, as of 2023, instituted a pre-service request process in place of their master plan reviews.

Under the pre-service request process and in exchange for a non-refundable deposit, HE will review conceptual development plans and preliminary load calculations and respond with their available system capacity, although this capacity would not be "reserved" for a particular development, and probable off-site improvements that would be needed to support the project.

HE has submitted a State PUC application (Docket 2022-0237) for what is being called the Customer Reservation of Capacity Pilot Program. Although not yet approved by the PUC, this program would essentially follow the same process as the Pre-Service Request but would also, in exchange for, an as yet undetermined payment, reserve HE system capacity for a particular applicant over a certain period of time. As indicated, all of these items will need to be negotiated and finalized before the PUC renders its final Decision and Order for this application.

The proposed electric and communications systems will be developed in accordance with the specifications and standards of HE, HT and Spectrum. Although the electrical network that serves the area of MPD consists of the Palani, Kailua, and Kealakeha Substations, the closest power source is Kailua Substation. As a result of the pre-service request submission to HE, HE conducted a Power Feasibility Study and provided two response letters. The response letter dated 21 August 2023 indicated that the Kailua Substation has sufficient capacity to support 5.661 MVA, which was the estimated total demand for the full build-out of the MPD Development based on the July 2023 conceptual plan. In October 2023, there was a slight increase to residential unit counts and a corresponding change in the way power demands were calculated for the hotels. For purposes of the Power Feasibility Study, hotels were reclassified from commercial use to residential use which increased the estimated total demand to 7.104 MVA. It should be noted that this update to the power analysis did not affect the land uses in the programming published in the draft Environmental Assessment (EA). Based on the updated power analysis, HE sent a response letter dated 8 July 2024, superseding the previous response, which stated that the Kailua Substation and the existing off-site distribution system do not have sufficient capacity to support the 7.104 MVA estimated total demand for the full build-out of the MPD Development. Based on the comparison between the two HE response letters, it appears there is sufficient capacity for the near-term development of the MPD. However, the Kailua Substation is a regional facility supporting the Kailua-Kona area and other new developments may affect the substation's capacity to serve the MPD Development. LT will need to continue to coordinate with HE to confirm HE's capacity for the initial build out and the off-site improvements necessary for the full-build out of the MPD Development.

As State PUC regulated public utilities, HE and HT are responsible for the development of off-site facilities that meet island-wide needs, such as power generating plants and power and signal transmission lines, and facilities that

serve regional needs of the Kailua-Kona area. Although not regulated by the PUC, Spectrum franchise agreement with the State Department of Commerce and Consumer Affairs requires it to be responsible for the off-site facilities that meet island-wide needs. Furthermore, it is Spectrum's off-site facility construction policy to provide such facilities where the anticipated revenue from the prospective service connections warrants the expenditure.

7.2.1. Off-Site Utility Infrastructure

Electric

Preliminarily, HE has indicated that the electric service to the property will likely be extended from HE's Makala Boulevard and Loloku Street duct system. HE's initial response letter indicates the off-site electrical facilities can support the early phases of the MPD Development. However, the latest response letter dated 8 July 2024 indicates additional off-site electrical improvements, including the addition of a substation transformer and a minimum of two new distribution circuits from the proposed substation transformer to the project location, will be required. The current off-site distribution system consists of underground conduit and cabling on Makala Boulevard, Luhia Street, and Loloku Street and overhead conductors on utility poles along Kaiwi Street, Luhia Street, and Kuakini Highway. Due to uncertainty of the provisions necessary for new distribution circuits from the new Kailua Substation to the property, provisions for new HE ductline along the existing off-site distribution system and Pawai Place are anticipated to be borne by the development. HE as preliminarily indicated that, based on 2023, the cost to add a 10 MVA substation transformer is approximately $4.5 million. LT may be asked to advance a portion of the cost of the transformer, which is determined based on the ultimate demand load of the full-build out of the MPD Development in relation to the load rating of the transformer and would not subject to reimbursement by HE. It should be noted that HE currently has a pending PUC Docket 2022-0237, the Customer Reservation of Capacity Pilot Program, that would provide a framework for HE's requests for payment. However, since the PUC has not provided its Decision and Order for this Docket, more discussions with HE would be required to determine the need for an advance payment of the substation upgrade system cost. The cost of the proposed HE duct system will solely be the responsibility of LT. However, per HE's tariffs, LT will only be responsible for the difference between the cost of the new underground cable line extensions installed in the proposed HE duct system and an equivalent overhead system. The cost of an equivalent overhead system, called the "Advance," would be subject to reimbursement by HE over a period of up to 5 years after the date of the Advance. It should be noted that HE's tariffs are subject to

change and LT will need to continue to coordinate with HE to confirm HE's tariffs regarding costs and reimbursements for underground systems.

Telecommunications

Preliminarily, HT has indicated that the existing HT duct system along Loloku Street and the existing overhead system along Kaiwi Street can be extended to the property. Primarily, Spectrum has indicated that the existing Spectrum handhole on Makala Boulevard can be used to extend their service to the property. Separate conduit laterals will be provided for HT and Spectrum.

TABLE 7-1 ELECTRICAL DEMAND REQUIREMENTS	
Electric and Comm. Master Plan	**Estimated Electric Demand (kiloVolt-Amperes-kVA)**
Residential Load	6000
Retail Load	456
Light Industrial Load	648
Total	7104

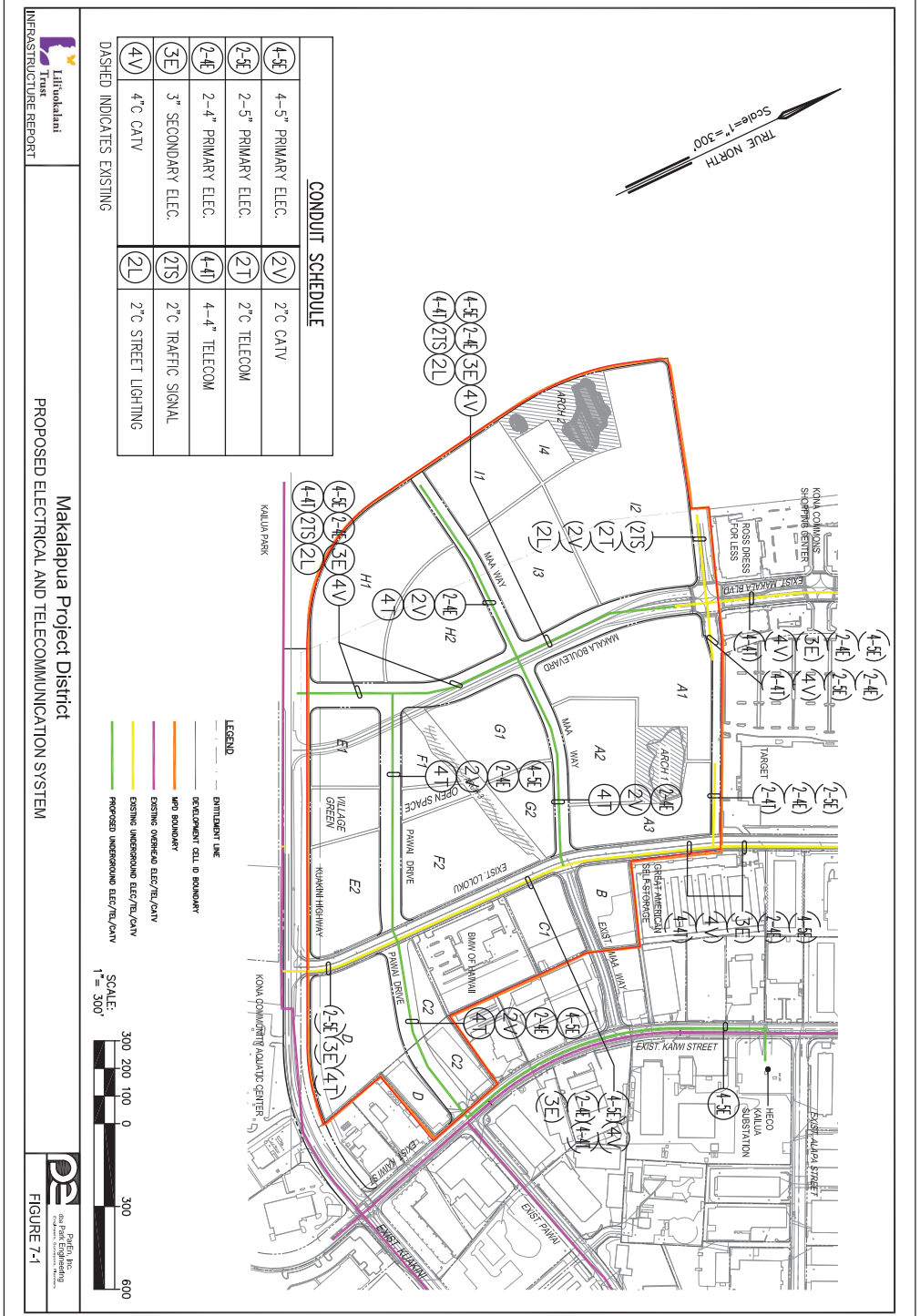
7.2.2. **On-Site Utility Infrastructure**

Electric

The on-site electric and communications systems would consist of concrete encased, PVC conduits, typically installed within a common trench and located, where feasible, under the roadway sidewalk between the curb and the edge of the road shoulder. Manholes and handholes would be placed periodically to serve as pulling points for the utilities and as parcel/building service points. The anticipated duct complement for the main infrastructure would consist of 4-5" and 2-4" conduits for HE, 4-4" conduits for HT and 2-4" conduits for Spectrum. The number and size of conduits would vary based on the adjacent land usage, with the typical minimum conduit complement for building service connections being 2-4" conduits for HE, 1-4" conduit for HT and 1-4" conduit for Spectrum. A summary of the MPD power projection computation is presented in Appendix D

See Figure 7-1 – Proposed Electrical and Telecommunication Systems

In addition to transformer pads for each of the commercial buildings and transformer pads that might serve multiple single family and multi-family buildings, HE will require several switchgear pads throughout the property. The HE switchgear acts as a protective device and



sectionalizer that is used by HE to minimize outages to the affected building as well as protect their main circuits. HT will likely require several fiber distribution hubs and one or more cross-connect locations within the Development. An 8' x 8' easement will be required for the fiber distribution hubs, while the cross-connect locations may be situated within the road right-of-ways. Preliminarily, Spectrum has indicated that a 3' x 5' handhole will be sufficient for a cable node. It is probable that HT, Spectrum, and other potential providers will propose to install fiber optic and/or hybrid infrastructure to feed the proposed development.

7.2.3. Roadway Lighting

Illumination for at-grade, dedicable roadways will be designed to meet County of Hawaii, Department of Public Works (DPW) standards and parking spaces will be designed to meet Illuminating Engineering Society (IES) RP-8 criteria. Luminaires selected will be specified with light emitting diode sources that meet the County of Hawaii's Outdoor Lighting ordinance. In addition, luminaires and poles for County-dedicable roadways will conform to DPW requirements.

8 CONCLUSION

Overall, the proposed improvements to the sewer, water, drainage, and electrical and telecommunication systems in the area of the Makalapua Project District should provide adequate service for the development. We do not anticipate any negative impacts to the existing utilities.

Sewer Calculations

APPENDIX A

Makalapua Project District
Infrastructure Report

SEWER: MPD
DISTRICT: KONA

Normal Infilt: 5 (gpcd) [USE 5 OR 35]
Wet Infilt: 1250 (gpad) [USE 1250 OR 2750]

PacEn,Inc. dba park engineering

BY: TSW
DATE: ########

TABLE 4-2
Makalapua Project District
SEWER CALCULATIONS

LAND USE		LOT	NODE/ SEGMENT	TRIB. AREA Increment	TRIB. AREA Total			TRIB. POPULATION Units	TRIB. POPULATION Increment	TRIB. POPULATION Total	AVE FLOW gpcd	BASE SANITARY FLOW (BSF) (mgd)	PEAK FLOW FACT.	PEAK BASE SANITARY FLOW (PBSF) (mgd)	DRY WEATHER FLOW AVE (mgd)	DRY WEATHER FLOW PEAK (mgd)	DESIGN HRLY FLOW (mgd)	WET I/I (mgd)	DESIGN FLOW (QDES) (mgd)	Pipe Size (IN)	Slope (%)	Capacity (mgd)	Vel. (fps)	Qreq /Qall (%)
Proposed Makalapua Project District																								
MAUKA																								
INTERPRETIVE CENTER				0.50	0.50	10.0	PERSONS		3.13	3.13	70	0.0002	2.50	0.0005	0.0000	0.0002	0.0006	0.0006	0.0012	8	1.024	0.69	3.04	0.2%
*MAKALAPUA CENTER				25.40	25.90	29.4	CPA		746.76	749.89	70	0.0525	2.50	0.1312	0.0037	0.0562	0.1350	0.0324	0.1674	10	0.65	0.99	2.81	16.9%
JUDICIARY (RETAIL/BUSINESS)				10.00	35.90	40.0	CPA		400.00	1,149.89	70	0.0805	2.50	0.2012	0.0057	0.0862	0.2070	0.0449	0.2519	10	0.65	0.99	2.81	25.4%
MAKALA BLUFFS																								
Hotel	300			10.49	10.49	2.0	PERSONS/KEY		600.00	600.00														
Restaurant	3,148								8.00	608.00	70	0.0426	2.50	0.1064	0.0030	0.0456	0.1094	0.0000	0.1094	8	0.52	0.49	2.17	22.4%
					46.39					1,757.89	70	0.1231	2.50	0.3076	0.0088	0.1318	0.3164	0.0580	0.3744	10	0.65	0.99	2.81	37.8%
MAKAI																								
			SMH 2-3		46.39					1,757.89	70	0.1231	2.50	0.3076	0.0088	0.1318	0.3164	0.0580	0.3744	15	1.71	4.74	5.98	7.9%
			SMH 3-4		46.39					1,757.89	70	0.1231	2.50	0.3076	0.0088	0.1318	0.3164	0.0580	0.3744	15	3.66	6.94	8.75	5.4%
*Kona Commons Phase 1 going to target access road (take SPS offline)			SMH 4-5		46.39					1,757.89	70	0.1231	2.50	0.3076	0.0088	0.1318	0.3164	0.0580	0.3744	15	0.39	2.26	2.85	16.5%
*Kona Commons Phase 2b			SMH 5-6	1.95	48.34	40.0	CPA		78.00	1,835.89	70	0.1285	2.50	0.3213	0.0092	0.1377	0.3305	0.0604	0.3909	15	0.34	2.11	2.67	18.5%
*7-4-008:068 (HPM)			SMH 6-7	5.70	54.04	40.0	CPA		227.00	2,062.89	70	0.1444	2.50	0.3610	0.0103	0.1547	0.3713	0.0676	0.4389	15	0.31	2.02	2.55	21.7%
			SMH 7-8		54.04					2,062.89	70	0.1444	2.50	0.3610	0.0103	0.1547	0.3713	0.0676	0.4389	15	0.23	1.74	2.19	25.2%
*7-4-008:069				4.50	58.54	40.0	CPA		180.00	2,242.89														
*7-4-015:009, 010, 011, 016			SMH 8-9	6.50	65.04	40.0	CPA		259.00	2,501.89	70	0.1751	2.50	0.4378	0.0125	0.1876	0.4503	0.0813	0.5316	15	0.20	1.62	2.04	32.8%
*7-4-025:011(United Laundry)			SMH 9-10	3.10	68.14	100.0	CPA		310.00	2,811.89	70	0.1968	2.50	0.4921	0.0141	0.2109	0.5061	0.0852	0.5913	15	0.25	1.81	2.29	32.6%
*7-4-025:010 (GP Roadway Solutions)			SMH 10-11	1.00	69.14	40.0	CPA		40.00	2,851.89	70	0.1996	2.50	0.4991	0.0143	0.2139	0.5133	0.0864	0.5998	15	0.19	1.58	1.99	37.9%
*Kona Commons Phase 2a				11.02	80.16	40.0	CPA		440.80	3,292.69														
7-4-025:007 (Great American Self Storage)				3.41	83.57	40.0	CPA		136.40	3,429.09	70	0.2400	2.50	0.6001	0.0171	0.2572	0.6172	0.1045	0.7217	15	0.17	1.50	1.88	48.3%
					83.57					3,429.09														
MPD-COMMERCIAL (OFFICE)	14,850	A3		1.39	84.96				36	3,465.09														
			SMH 12-13		84.96					3,465.09	70	0.2426	2.50	0.6064	0.0173	0.2599	0.6237	0.1062	0.7299	15	0.17	1.50	1.88	48.8%
			SMH 13-14		84.96					3,465.09	70	0.2426	2.50	0.6064	0.0173	0.2599	0.6237	0.1062	0.7299	15	0.17	1.50	1.88	48.8%
MPD-COMMERCIAL	14,400	B		1.19	86.15				35	3,500.09														
MPD-RETAIL	7,560	A3		0.69	86.84				18	3,518.09														
MPD-3-STORY FLAT (PORTION)		G2		0.30	87.14	2.8	PERSONS/UNIT	10	28.00	3,546.09														
			SMH 14-15		87.14					3,546.09	70	0.2482	2.50	0.6206	0.0177	0.2660	0.6383	0.1089	0.7472	15	0.17	1.50	1.88	50.0%
MPD-INDUSTRIAL/FLEX	18,700	C1		1.45	88.59	100.0	CPA		145	3,691.09														
MPD-FLATS (PORTION)		F2		0.92	89.51	2.8	PERSONS/UNIT	25	70.00	3,761.09														
					89.51					3,761.09														
			SMH 15-16		89.51					3,761.09	70	0.2633	2.50	0.6582	0.0188	0.2821	0.6770	0.1119	0.7889	15	0.17	1.50	1.88	52.8%
EXIST. BMW (COMM)		7		2.59	92.10	40.0	CPA		103.60	3,864.69														
			SMH 16-16A		92.10					3,864.69	70	0.2705	2.50	0.6763	0.0193	0.2899	0.6956	0.1151	0.8108	15	2.38	5.59	7.05	14.5%
PAWAI TO KAIWI																								
MPD-RETAIL (PORTION)	6,000	F2		0.87	92.97				15.00	3,879.69														
LOFT (PORTION)		F2			92.97	2.8	PERSONS/UNIT	24	67.20	3946.89														
MPD-RETAIL (PORTION)	2,100	C2		0.53	93.50				5.00	3,951.89	70	0.2766	2.50	0.6916	0.0198	0.2964	0.7113	0.1169	0.8282	16	0.21	1.97	2.19	42.0%
* Per APPROVED Preliminary Engineering Report, "Kona Industrial Subdivision, Sewer Master Plan Update", dated September 2006																								
Kailua Park being pumped directly into 8" line connected to the SPS Influent Box																								
DESIGN CRITERIA POPULATION (GENERATING 25 GPCD) CONVERTED TO AN EQUIVALIENT POPULATION (GENERATING 80 GPCD) BY MULTIPLYING UNIT/POP BY 0.3571																								
COMMERCIAL: 1 PERSONS/150 SF @ 25 GPCD; HOTEL: 2 KEYS/ROOM																								

SEWER: MPD
DISTRICT: KONA

Normal Infilt: 5 (gpcd) [USE 5 OR 35]
Wet Infilt: 1250 (gpad) [USE 1250 OR 2750]

PacEn,Inc. dba park engineering

BY: TSW
DATE: ########

TABLE 4-2
Makalapua Project District
SEWER CALCULATIONS

LAND USE		LOT	NODE/ SEGMENT	TRIB. AREA Increment	TRIB. AREA Total			TRIB. POPULATION Units	TRIB. POPULATION Increment	TRIB. POPULATION Total	AVE FLOW gpcd	BASE SANITARY FLOW (BSF) (mgd)	PEAK FLOW FACT.	PEAK BASE SANITARY FLOW (PBSF) (mgd)	DRY WEATHER FLOW AVE (mgd)	DRY WEATHER FLOW PEAK (mgd)	DESIGN HRLY FLOW (mgd)	WET I/I (mgd)	DESIGN FLOW (QDES) (mgd)	Pipe Size (IN)	Slope (%)	Capacity (mgd)	Vel. (fps)	Qreq /Qall (%)
Existing																								
MAUKA																								
*MAKALAPUA CENTER				25.40	25.40	29.4	CPA		746.76	746.76	70	0.0523	2.50	0.1307	0.0037	0.0560	0.1344	0.0318	0.1662					
INTERPRETIVE CENTER				0.50	25.90	10.0	PERSONS		3.13	749.89	70	0.0525	2.50	0.1312	0.0037	0.0562	0.1350	0.0324	0.1674	10	0.65	0.99	2.81	16.9%
MAKAI																								
			SMH 2-3		25.90					749.89	70	0.0525	2.50	0.1312	0.0037	0.0562	0.1350	0.0324	0.1674	15	1.71	4.74	5.98	3.5%
			SMH 3-4		25.90					749.89	70	0.0525	2.50	0.1312	0.0037	0.0562	0.1350	0.0324	0.1674	15	3.66	6.94	8.75	2.4%
*Kona Commons Phase 1			SMH 4-5	10.60	36.50	40.0	CPA		424.00	1,173.89	70	0.0822	2.50	0.2054	0.0059	0.0880	0.2113	0.0456	0.2569	15	0.39	2.26	2.85	11.3%
*Kona Commons Phase 2b			SMH 5-6	1.95	38.45	40.0	CPA		78.00	1,251.89	70	0.0876	2.50	0.2191	0.0063	0.0939	0.2253	0.0481	0.2734	15	0.34	2.11	2.67	12.9%
*7-4-008:068 (HPM)			SMH 6-7	5.70	44.15	40.0	CPA		227.00	1,478.89	70	0.1035	2.50	0.2588	0.0074	0.1109	0.2662	0.0552	0.3214	15	0.31	2.02	2.55	15.9%
			SMH 7-8		44.15					1,478.89	70	0.1035	2.50	0.2588	0.0074	0.1109	0.2662	0.0552	0.3214	15	0.23	1.74	2.19	18.5%
*7-4-008:069				4.50	48.65	40.0	CPA		180.00	1,658.89														
*7-4-015:009, 010, 011, 016			SMH 8-9	6.50	55.15	40.0	CPA		259.00	1,917.89	70	0.1343	2.50	0.3356	0.0096	0.1438	0.3452	0.0689	0.4142	15	0.20	1.62	2.04	25.5%
*7-4-025:011(United Laundry)			SMH 9-10	3.10	58.25	100.0	CPA		310.00	2,227.89	70	0.1560	2.50	0.3899	0.0111	0.1671	0.4010	0.0728	0.4738	15	0.25	1.81	2.29	26.1%
*7-4-025:010 (GP Roadway Solutions)			SMH 10-11	1.00	59.25	40.0	CPA		40.00	2,267.89	70	0.1588	2.50	0.3969	0.0113	0.1701	0.4082	0.0741	0.4823	15	0.19	1.58	1.99	30.5%
			SMH 11-12	11.02	70.27					2,267.89	70	0.1588	2.50	0.3969	0.0113	0.1701	0.4082	0.0878	0.4961	15	0.46	2.46	3.10	20.2%
*Kona Commons Phase 2a					70.27	40.0	CPA		440.80	2,708.69														
7-4-025:007 (Great American Self Storage)			SMH 12-13	3.41	73.68	40.0	CPA		136.40	2,845.09	70	0.1992	2.50	0.4979	0.0142	0.2134	0.5121	0.0921	0.6042	15	0.17	1.50	1.88	40.4%
			SMH 13-14		73.68					2,845.09	70	0.1992	2.50	0.4979	0.0142	0.2134	0.5121	0.0921	0.6042	15	0.52	2.62	3.30	23.1%
			SMH 14-15		73.68					2,845.09	70	0.1992	2.50	0.4979	0.0142	0.2134	0.5121	0.0921	0.6042	15	0.54	2.66	3.36	22.7%
			SMH 15-16		73.68					2,845.09	70	0.1992	2.50	0.4979	0.0142	0.2134	0.5121	0.0921	0.6042	15	0.29	1.95	2.46	30.9%
7-4-025:003 (BMW)			SMH 16-17	2.59	76.27	40.0	CPA		103.60	2,948.69	70	0.2064	2.50	0.5160	0.0147	0.2212	0.5308	0.0953	0.6261	15	2.38	5.59	7.05	11.2%
			SMH 17-18		76.27					2,948.69	70	0.2064	2.50	0.5160	0.0147	0.2212	0.5308	0.0953	0.6261	15	0.17	1.50	1.88	41.9%
			SMH 18-19		76.27					2,948.69	70	0.2064	2.50	0.5160	0.0147	0.2212	0.5308	0.0953	0.6261	15	0.30	1.99	2.50	31.5%
			SMH 19-20		76.27					2,948.69	70	0.2182	2.50	0.5455	0.0147	0.2330	0.5603	0.0953	0.6556	15	0.26	1.85	2.33	35.5%
			SMH 20-21		76.27					2,948.69	70	0.2182	2.50	0.5455	0.0147	0.2330	0.5603	0.0953	0.6556	15	0.30	1.99	2.50	33.0%
			SMH 21-22		76.27					2,948.69	70	0.2182	2.50	0.5455	0.0147	0.2330	0.5603	0.0953	0.6556	15	0.86	3.36	4.24	19.5%
Terminate at Kealakehe SPS			SMH 22-23		76.27					2,948.69	70	0.2182	2.50	0.5455	0.0147	0.2330	0.5603	0.0953	0.6556	15	0.50	2.56	3.23	25.6%
* Per APPROVED Preliminary Engineering Report, "Kona Industrial Subdivision, Sewer Master Plan Update", dated September 2006																								
Kailua Park being pumped directly into 8" line connected to the SPS Influent Box																								

SEWER: MPD
DISTRICT: KONA

Park Engineering, Inc. dba park engineering

BY: TSW
DATE: ########

Normal Infilt: 5 (gpcd) [USE 5 OR 35]
Wet Infilt: 1250 (gpad) [USE 1250 OR 2750]

TABLE 4-2
Makalapua Project District
SEWER CALCULATIONS

LAND USE		LOT	NODE/ SEGMENT	TRIB. AREA Increment	TRIB. AREA Total			TRIB. POPULATION Units	TRIB. POPULATION Increment	TRIB. POPULATION Total	AVE FLOW gpcd	BASE SANITARY FLOW (BSF) (mgd)	PEAK FLOW FACT.	PEAK BASE SANITARY FLOW (PBSF) (mgd)	DRY WEATHER FLOW AVE (mgd)	DRY WEATHER FLOW PEAK (mgd)	DESIGN HRLY FLOW (mgd)	WET I/I (mgd)	DESIGN FLOW (QDES) (mgd)	Pipe Size (IN)	Slope (%)	Capacity (mgd)	Vel. (fps)	Qreq /Qall (%)
RETAIL (PORTION)	6,000	E2		1.23	1.23				15.00	15.00														
LOFT (PORTION)		E2			1.23	2.8	PERSONS/UNIT	16	44.80	59.80														
HOTEL	75	E2			1.23	2.0	PERSONS/KEY		150.00	209.80	70	0.0147	2.50	0.0367	0.0010	0.0157	0.0378	0.0015	0.0393	12	0.31	1.11	2.19	3.5%
SMH IN KUAKINI					49.82					2,456.80	70	0.1720	2.50	0.4299	0.0123	0.1843	0.4422	0.0623	0.5045	12	0.31	1.11	2.19	45.3%
			SMH 17-18		0.00					0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	15	0.17	1.50	1.88	0.0%
COMMERCIAL (PORTION)	18,700	D		3.29	3.29				45.00	45.00														
HOTEL (PORTION)	75	D			3.29	2.0	PERSONS/KEY		150.00	195.00	70	0.0137	2.50	0.0341	0.0010	0.0146	0.0351	0.0041	0.0392	15	0.30	1.99	2.50	2.0%
			SMH 18-19		3.29					195.00	70	0.0137	2.50	0.0341	0.0010	0.0146	0.0351	0.0041	0.0392	15	0.30	1.99	2.50	2.0%
SWR IN KUAKINI TO CONN AT SMH-19			SMH 19-20		53.11					2,651.80	70	0.1856	2.50	0.4641	0.0133	0.1989	0.4773	0.0664	0.5437	15	0.30	1.99	2.50	27.4%
			SMH 20-21		53.11					2,651.80	70	0.1856	2.50	0.4641	0.0133	0.1989	0.4773	0.0664	0.5437	15	0.30	1.99	2.50	27.4%
			SMH 21-22		53.11					2,651.80	70	0.1856	2.50	0.4641	0.0133	0.1989	0.4773	0.0664	0.5437	15	0.30	1.99	2.50	27.4%
Terminate at Kealakehe SPS			SMH 22-23		53.11					2,651.80	70	0.1856	2.50	0.4641	0.0133	0.1989	0.4773	0.0664	0.5437	15	0.30	1.99	2.50	27.4%
								600.00																

SEWER: MPD
DISTRICT: KONA

Park Engineering, Inc. dba park engineering

BY: TSW
DATE: ########

Normal Infilt: 5 (gpcd) [USE 5 OR 35]
Wet Infilt: 1250 (gpad) [USE 1250 OR 2750]

TABLE 4-2
Makalapua Project District
SEWER CALCULATIONS

LAND USE		LOT	NODE/ SEGMENT	TRIB. AREA Increment	TRIB. AREA Total			TRIB. POPULATION Units	TRIB. POPULATION Increment	TRIB. POPULATION Total	AVE FLOW gpcd	BASE SANITARY FLOW (BSF) (mgd)	PEAK FLOW FACT.	PEAK BASE SANITARY FLOW (PBSF) (mgd)	DRY WEATHER FLOW AVE (mgd)	DRY WEATHER FLOW PEAK (mgd)	DESIGN HRLY FLOW (mgd)	WET I/I (mgd)	DESIGN FLOW (QDES) (mgd)	Pipe Size (IN)	Slope (%)	Capacity (mgd)	Vel. (fps)	Qreq /Qall (%)
Makalapua Project District (MPD)																								
MAKALA (TO PUMP STATION)																								
Kona Commons Ph 1 (take off SPS)		EXIST		10.60	10.60	40.0	CPA		424.00	424.00	70	0.0297	2.50	0.0742	0.0021	0.0318	0.0763	0.0133	0.0896	8	0.52	0.49	2.17	18.3%
GROCERY (PORTION)	35,000	A1		2.87	13.47				84.00	508.00	70	0.0356	2.50	0.0889	0.0025	0.0381	0.0914	0.0168	0.1083	8	0.52	0.49	2.17	22.1%
MAA																								
3-STORY FLAT (PORTION)		G2		0.98	0.98	2.8	PERSONS/UNIT	28	78.40	78.40	70	0.0055	2.50	0.0137	0.0004	0.0059	0.0141	0.0012	0.0153	8	0.52	0.49	2.17	3.1%
3-STORY FLAT		A2		2.28	3.26	2.8	PERSONS/UNIT	61	170.80	249.20	70	0.0174	2.50	0.0436	0.0012	0.0187	0.0449	0.0041	0.0489	8	0.52	0.49	2.17	10.0%
COMMERCIAL (PORTION)	13,050	A1		1.58	4.84				32	281.20														
RETAIL (PORTION)	5,160	A1			4.84				13	294.20														
Maa					4.84					294.20	70	0.0206	2.50	0.0515	0.0015	0.0221	0.0530	0.0061	0.0590	8	0.52	0.49	2.17	12.1%
MAKALA																								
3-STORY FLAT		G1		2.54	2.54	2.8	PERSONS/UNIT	81	226.80	226.80														
Before Pawai					20.85					1,029.00	70	0.0720	2.50	0.1801	0.0051	0.0772	0.1852	0.0261	0.2113	8	0.52	0.49	2.17	43.2%
PAWAI																								
RETAIL	7,400	F1		0.87	0.87				18.00	18.00														
LOFT		F1			0.87	2.8	PERSONS/UNIT	12	33.60	51.60	70	0.0036	2.50	0.0090	0.0003	0.0039	0.0093	0.0011	0.0104	8	0.52	0.49	2.17	2.1%
RETAIL	10,000	E1		1.71	2.58				24.00	75.60														
LOFT		E1			2.58	2.8	PERSONS/UNIT	33	92.40	168.00	70	0.0118	2.50	0.0294	0.0008	0.0126	0.0302	0.0032	0.0335	8	0.52	0.49	2.17	6.8%
VILLAGE GREEN				1.08	3.66				4.00	172.00	70	0.0120	2.50	0.0301	0.0009	0.0129	0.0310	0.0046	0.0355	8	0.52	0.49	2.17	7.3%
GREEN				0.51	4.17				4.00	176.00	70	0.0123	2.50	0.0308	0.0009	0.0132	0.0317	0.0052	0.0369	8	0.52	0.49	2.17	7.5%
RETAIL (PORTION)	6,000	F2		1.11	5.28				15.00	191.00														
LOFT (PORTION)		F2			5.28	2.8	PERSONS/UNIT	23	64.40	255.40														
3-STORY FLAT (PORTION)		F2			5.28	2.8	PERSONS/UNIT	25	70.00	325.40	70	0.0228	2.50	0.0569	0.0016	0.0244	0.0586	0.0066	0.0652	8	0.52	0.49	2.17	13.3%
RETAIL (PORTION)	6,000	E2		1.12	6.40				15.00	340.40														
LOFT (PORTION)		E2			6.40	2.8	PERSONS/UNIT	10	28.00	368.40														
MAKALA					27.25					1,397.40	70	0.0978	2.50	0.2445	0.0070	0.1048	0.2515	0.0341	0.2856	8	0.52	0.49	2.17	58.4%
LEFT SIDE OF MAKALA																								
COTTAGES		I2		6.77	6.77	4.0	PERSONS/UNIT	44	176.00	176.00														
3-STORY FLAT		I3		3.51	10.28	2.8	PERSONS/UNIT	83	232.40	408.40	70	0.0286	2.50	0.0715	0.0020	0.0306	0.0735	0.0129	0.0864	8	0.52	0.49	2.17	17.7%
COMMERCIAL (Kipuka)	10,000	I4		0.65	10.93				24.00	432.40														
3-STORY FLAT		H2		3.35	14.28	2.8	PERSONS/UNIT	69	193.20	625.60	70	0.0438	2.50	0.1095	0.0031	0.0469	0.1126	0.0179	0.1305	8	0.52	0.49	2.17	26.7%
COTTAGES/COURTYARD		I1		2.20	16.48	4.0	PERSONS/UNIT	12	48.00	673.60	70	0.0472	2.50	0.1179	0.0034	0.0505	0.1212	0.0206	0.1418	8	0.52	0.49	2.17	29.0%
COTTAGES/COURTYARD		H1		4.86	21.34	4.0	PERSONS/UNIT	44	176.00	849.60	70	0.0595	2.50	0.1487	0.0042	0.0637	0.1529	0.0267	0.1796	8	0.52	0.49	2.17	36.7%
PUMP STATION TO DISCHARGE SMH IN KUAKINI					48.59					2,247.00	70	0.1573	2.50	0.3932	0.0112	0.1685	0.4045	0.0607	0.4652	12	0.31	1.11	2.19	41.8%

SEWER: MPD
DISTRICT: KONA

ParEn,Inc. dba park engineering

BY: TSW
DATE: ########

Normal Infilt: 5 (gpcd) [USE 5 OR 35]
Wet Infilt: 1250 (gpad) [USE 1250 OR 2750]

TABLE 4-2
Makalapua Project District
SEWER CALCULATIONS

LAND USE		LOT	NODE/ SEGMENT	TRIB. AREA Increment	TRIB. AREA Total			TRIB. POPULATION Units	TRIB. POPULATION Increment	TRIB. POPULATION Total	AVE FLOW gpcd	BASE SANITARY FLOW (BSF) (mgd)	PEAK FLOW FACT.	PEAK BASE SANITARY FLOW (PBSF) (mgd)	DRY WEATHER FLOW AVE (mgd)	DRY WEATHER FLOW PEAK (mgd)	DESIGN HRLY FLOW (mgd)	WET I/I (mgd)	DESIGN FLOW (QDES) (mgd)	Pipe Size (IN)	Slope (%)	Capacity (mgd)	Vel. (fps)	Qreq /Qall (%)
LUHIA-ALAPA ST																								
			SMH 3-F																					
7-4-015:013		6	SMH 2-F	1.40	1.40	40.0	CPA		56.12	56.12	70	0.0039	2.50	0.0098	0.0003	0.0042	0.0101	0.0018	0.0119	6	0.61	0.25	1.94	4.8%
ALAPA-EHO ST																								
			SMH 4-H																					
7-4-015:015 (VACANT)		7		0.00	0.00	40.0	CPA		0.00	0.00														
7-4-015:014 (VACANT)		8	SMH 3-H	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	8	5.00	1.52	6.72	0.0%
			SMH 2-H	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	8	2.00	0.96	4.25	0.0%
7-4-015:012		5	SMH 1-H	1.00	1.00	40.0	CPA		40.00	40.00	70	0.0028	2.50	0.0070	0.0002	0.0030	0.0072	0.0013	0.0085	8	2.63	1.10	4.88	0.8%
7-4-015:003		7		1.00	2.00	40.0	CPA		40.00	80.00														
7-4-015:004		6	SMH 6-G	1.00	3.00	40.0	CPA		40.00	120.00	70	0.0084	2.50	0.0210	0.0006	0.0090	0.0216	0.0038	0.0254	8	1.46	0.82	3.63	3.1%
ALAPA -PAWAI ST																								
Exist. Flows East of Palani Rd.[2]			SMH 3-J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.3278					
7-4-010:043		4	SMH 2-J	1.36	1.36	40.0	CPA		54.20	54.20	70	0.0038	2.50	0.0095	0.0003	0.0041	0.0098	0.0017	3.3392	20	0.20	4.01	2.84	83.2%
7-4-010:042		3		1.19	2.55	40.0	CPA		47.60	101.80														
7-4-010:041		2		1.22	3.77	40.0	CPA		48.88	150.68														
7-4-010:040		1	SMH 1-J	1.20	4.97	40.0	CPA		48.12	198.80	70	0.0139	2.50	0.0348	0.0010	0.0149	0.0358	0.0062	3.3698	20	0.20	4.01	2.84	84.0%
			SMH 1-G	0.00	4.97	40.0	CPA		0.00	198.80	70	0.0139	2.50	0.0348	0.0010	0.0149	0.0358	0.0062	3.3698	20	0.58	6.83	4.84	49.3%
PAWAI ST (2)																								
			SMH 6-E																					
7-4-015:022		7	SMH 5-E	1.60	1.60	40.0	CPA		64.00	64.00	70	0.0045	2.50	0.0112	0.0003	0.0048	0.0115	0.0020	0.0135	6	5.90	0.77	6.03	1.8%
7-4-015:021		6	SMH 4-E	1.65	3.25	40.0	CPA		66.06	130.06	70	0.0091	2.50	0.0228	0.0007	0.0098	0.0234	0.0041	0.0275	6	4.30	0.65	5.15	4.2%
7-4-015:020		5		1.65	4.90	40.0	CPA		66.06	196.12														
7-4-015:024		9	SMH 2-F	1.00	5.90	40.0	CPA		40.04	236.16	70	0.0165	2.50	0.0413	0.0012	0.0177	0.0425	0.0074	0.0499	6	4.13	0.64	5.04	7.8%
LUHIA-ALAPA ST			SMH 1-F	1.40	7.31	40.0	CPA		56.12	292.28	70	0.0205	2.50	0.0511	0.0015	0.0219	0.0526	0.0091	0.0617	6	0.68	0.26	2.05	23.8%
7-4-015:023 (VACANT)		8		0.00	7.31	40.0	CPA		0.00	292.28														
7-4-015:005		5	SMH 7-G	1.00	8.31	40.0	CPA		40.00	332.28	70	0.0233	2.50	0.0581	0.0017	0.0249	0.0598	0.0104	0.0702	8	0.50	0.48	2.13	14.6%
			SMH 6-G	0.00	8.31	40.0	CPA		0.00	332.28	70	0.0233	2.50	0.0581	0.0017	0.0249	0.0598	0.0104	0.0702	8	0.50	0.48	2.13	14.6%
ALAPA-EHO ST			SMH 5-G	3.00	11.31	40.0	CPA		120.00	452.28	70	0.0317	2.50	0.0791	0.0023	0.0339	0.0814	0.0141	0.0955	8	0.45	0.46	2.02	21.0%
			SMH 4-G	0.00	11.31	40.0	CPA		0.00	452.28	70	0.0317	2.50	0.0791	0.0023	0.0339	0.0814	0.0141	0.0955	8	3.41	1.25	5.55	7.6%
			SMH 3-G	0.00	11.31	40.0	CPA		0.00	452.28	70	0.0317	2.50	0.0791	0.0023	0.0339	0.0814	0.0141	0.0955	8	0.50	0.48	2.13	19.9%
7-4-010:021		1		1.00	12.31	40.0	CPA		40.04	492.32														
7-4-010:033		2	SMH 2-G	1.00	13.31	40.0	CPA		40.00	532.32	70	0.0373	2.50	0.0932	0.0027	0.0399	0.0958	0.0166	0.1125	8	0.50	0.48	2.13	23.4%
7-4-010:035		4		1.00	14.31	40.0	CPA		40.00	572.32														
7-4-010:034		3	SMH 1-G	1.10	15.41	40.0	CPA		44.00	616.32	70	0.0431	2.50	0.1079	0.0031	0.0462	0.1109	0.0193	0.1302	8	0.49	0.47	2.10	27.4%
ALAPA-PAWAI ST[3]			SMH 5-K	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.5000	24	2.00	20.63	10.16	17.0%
			SMH 4-K	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	3.5000	18	2.40	9.14	8.00	38.3%
			SMH 3-K	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	3.5000	18	0.60	4.57	4.00	76.6%
			SMH 2-K	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	3.5000	18	2.07	8.48	7.43	41.3%
			SMH 1-K	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	3.5000	18	2.07	8.48	7.43	41.3%
LOLOKU FLOWS (MAUKA-MAKAI)																			0.8282					
			SMH 3-D	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	**4.3282**	18	1.18	6.41	5.61	67.6%

SEWER: MPD
DISTRICT: KONA

ParEn,Inc. dba park engineering

BY: TSW
DATE: ########

Normal Infilt: 5 (gpcd) [USE 5 OR 35]
Wet Infilt: 1250 (gpad) [USE 1250 OR 2750]

TABLE 4-2
Makalapua Project District
SEWER CALCULATIONS

LAND USE		LOT	NODE/ SEGMENT	TRIB. AREA Increment	TRIB. AREA Total			TRIB. POPULATION Units	TRIB. POPULATION Increment	TRIB. POPULATION Total	AVE FLOW gpcd	BASE SANITARY FLOW (BSF) (mgd)	PEAK FLOW FACT.	PEAK BASE SANITARY FLOW (PBSF) (mgd)	DRY WEATHER FLOW AVE (mgd)	DRY WEATHER FLOW PEAK (mgd)	DESIGN HRLY FLOW (mgd)	WET I/I (mgd)	DESIGN FLOW (QDES) (mgd)	Pipe Size (IN)	Slope (%)	Capacity (mgd)	Vel. (fps)	Qreq /Qall (%)
KONA INDUSTRIAL SUBDIVISION																								
Kuakini Hwy (1)																								
			SMH 5-C																					
7-4-010:003 & 7-4-010:004			SMH 4-C	4.88	4.88	40.0	CPA		195.16	195.16	70	0.0137	2.50	0.0342	0.0010	0.0146	0.0351	0.0061	0.0412	4	FORCE MAIN			
			SMH 3-C	0.00	4.88	40.0	CPA		0.00	195.16	70	0.0137	2.50	0.0342	0.0010	0.0146	0.0351	0.0061	0.0412	8	1.88	0.93	4.12	4.4%
7-4-010:002		14	SMH 2-C	2.05	6.93	40.0	CPA		81.84	277.00	70	0.0194	2.50	0.0485	0.0014	0.0208	0.0499	0.0087	0.0585	8	1.05	0.70	3.08	8.4%
7-4-010:001		13	SMH 1-C	2.21	9.14	100.0	CPA		221.10	498.10	70	0.0349	2.50	0.0872	0.0025	0.0374	0.0897	0.0114	0.1011	8	0.60	0.53	2.33	19.2%
			SMH 10-D	0.00	9.14	100.0	CPA		0.00	498.10	70	0.0349	2.50	0.0872	0.0025	0.0374	0.0897	0.0114	**0.1011**	8	2.15	0.99	4.41	10.2%
Exist. Flows East of Palani Rd. and South of Kuakini Highway[1]			SMH 9-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.5000	15	3.94	7.20	9.07	48.6%
PAWAI ST (1)																								
			SMH 3-B																					
7-4-010:018		12	SMH 2-B	1.69	1.69	40.0	CPA		67.68	67.68	70	0.0047	2.50	0.0118	0.0003	0.0051	0.0122	0.0021	0.0143	6	2.31	0.48	3.77	3.0%
7-4-010:017		11	SMH 1-B	1.82	3.51	40.0	CPA		72.76	140.44	70	0.0098	2.50	0.0246	0.0007	0.0105	0.0253	0.0044	0.0297	6	2.23	0.47	3.71	6.3%
7-4-010:016		10	SMH 3-A	1.78	5.29	40.0	CPA		71.08	211.52	70	0.0148	2.50	0.0370	0.0011	0.0159	0.0381	0.0066	0.0447	6	1.04	0.32	2.53	13.9%
KAIWI ST																								
			SMH 3-E																					
Portion of 7-4-015:018		4	SMH 2-E	1.71	1.71	40.0	CPA		68.54	68.54	70	0.0048	2.50	0.0120	0.0003	0.0051	0.0123	0.0021	0.0145	6	3.17	0.56	4.42	2.6%
Portion of 7-4-015:018		3		1.71	3.43	40.0	CPA		68.54	137.08														
7-4-015:017		2	SMH 1-E	1.73	5.16	40.0	CPA		69.32	206.40	70	0.0144	2.50	0.0361	0.0010	0.0155	0.0372	0.0065	0.0436	6	1.56	0.39	3.10	11.1%
7-4-015:016		1		3.48	8.64	40.0	CPA		139.16	345.56														
7-4-015:008		11		1.02	9.66	40.0	CPA		40.64	386.20														
7-4-015:009		7	SMH 9-A	1.01	10.67	40.0	CPA		40.44	426.64	70	0.0299	2.50	0.0747	0.0021	0.0320	0.0768	0.0133	0.0901	6	0.90	0.30	2.35	30.2%
7-4-015:010		6		1.00	11.67	40.0	CPA		40.00	466.64														
7-4-015:007		10		1.00	12.67	40.0	CPA		40.08	506.72														
7-4-015:006		9		1.01	13.68	40.0	CPA		40.32	547.04														
7-4-015:011		5	SMH 8-A	1.00	14.68	40.0	CPA		40.00	587.04	70	0.0411	2.50	0.1027	0.0029	0.0440	0.1057	0.0183	0.1240	6	0.92	0.30	2.38	41.0%
7-4-010:026		4		1.00	15.68	40.0	CPA		40.00	627.04														
7-4-010:025		3	SMH 7-A	1.01	16.68	40.0	CPA		40.34	667.38	70	0.0467	2.50	0.1168	0.0033	0.0501	0.1201	0.0209	0.1410	6	1.06	0.32	2.56	43.5%
7-4-010:024		2		1.01	17.69	40.0	CPA		40.34	707.72														
7-4-010:023		1	SMH 6-A	0.86	18.55	40.0	CPA		34.26	741.98	70	0.0519	2.50	0.1298	0.0037	0.0556	0.1336	0.0232	0.1567	6	1.15	0.34	2.66	46.4%
7-4-010:022		HELCo		6.09	24.64	40.0	CPA		243.60	985.58														
7-4-010:014		8	SMH 5-A	0.86	25.50	40.0	CPA		34.26	1,019.84	70	0.0714	2.50	0.1785	0.0051	0.0765	0.1836	0.0319	0.2154	6	1.20	0.35	2.72	62.4%
7-4-010:013		7		1.17	26.67	40.0	CPA		46.80	1,066.64														
7-4-010:015		9		1.82	28.49	40.0	CPA		72.92	1,139.56														
7-4-010:012		6	SMH 4-A	1.01	29.50	40.0	CPA		40.48	1,180.04	70	0.0826	2.50	0.2065	0.0059	0.0885	0.2124	0.0369	0.2493	6	2.36	0.48	3.81	51.5%
7-4-010:011		5		1.10	30.60	40.0	CPA		43.88	1,223.92														
7-4-010:010 (portion of C2)COMM	21,250	4		0.86	31.46				42.00	1,265.92														
PAWAI ST (1)			SMH 3-A	5.29	36.75	40.0	CPA		211.52	1,477.44	70	0.1034	2.50	0.2586	0.0074	0.1108	0.2659	0.0459	0.3119	6	2.60	0.51	4.00	61.4%
7-4-010:009 (portion of D) COMM	18,700	3	SMH 2-A	0.71	37.46				42.00	1,519.44	70	0.1064	2.50	0.2659	0.0076	0.1140	0.2735	0.0468	0.3203	6	1.24	0.35	2.76	91.3%
7-4-010:006		17		1.46	38.92	40.0	CPA		58.52	1,577.96														
7-4-010:008		2		1.00	39.92	40.0	CPA		40.00	1,617.96														
7-4-010:005		18		1.55	41.47	40.0	CPA		62.00	1,679.96														
7-4-010:007		1	SMH 1-A	1.20	42.67	40.0	CPA		47.96	1,727.92	70	0.1210	2.50	0.3024	0.0086	0.1296	0.3110	0.0533	0.3644	6	2.17	0.46	3.66	78.5%
			SMH 6-C	0.00	42.67	40.0	CPA		0.00	1,727.92	70	0.1210	2.50	0.3024	0.0086	0.1296	0.3110	0.0533	0.3644	8	0.93	0.65	2.90	55.7%
			SMH 4-D	0.00	42.67	40.0	CPA		0.00	1,727.92	70	0.1210	2.50	0.3024	0.0086	0.1296	0.3110	0.0533	**0.3650**	8	1.18	0.74	3.27	49.5%

APPENDIX B
Makalapua Project District
Infrastructure Report

Hydrologic Calculations

SEWER: MPD
DISTRICT: KONA

BY: TSW
DATE: ########

Normal Infilt: 5 (gpcd) [USE 5 OR 35]
Wet Infilt: 1250 (gpad) [USE 1250 OR 2750]

PowEn,Inc. dba park engineering

TABLE 4-2
Makalapua Project District
SEWER CALCULATIONS

LAND USE		LOT	NODE/ SEGMENT	TRIB. AREA Increment	TRIB. AREA Total			TRIB. POPULATION Units	TRIB. POPULATION Increment	TRIB. POPULATION Total	AVE FLOW gpcd	BASE SANITARY FLOW (BSF) (mgd)	PEAK FLOW FACT.	PEAK BASE SANITARY FLOW (PBSF) (mgd)	DRY WEATHER FLOW AVE (mgd)	DRY WEATHER FLOW PEAK (mgd)	DESIGN HRLY FLOW (mgd)	WET I/I (mgd)	DESIGN FLOW (QDES) (mgd)	Pipe Size (IN)	Slope (%)	Capacity (mgd)	Vel. (fps)	Qreq /Qall (%)
Kuakini Hwy (2)																								
			SMH 9-D																					
Exist. Flows[4]			SMH 8-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.4000	36	0.10	14.66	3.21	98.2%
			SMH 7-D	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	14.4000	36	0.10	14.66	3.21	98.2%
			SMH 6-D	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	14.4000	36	0.10	14.66	3.21	98.2%
			SMH 5-D	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	14.4000	36	0.62	36.51	7.99	39.4%
			SMH 4-D	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	14.4000	36	0.84	42.50	9.30	33.9%
KA'IWI ST[5]			SMH 3-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.7650	42	0.84	64.11	10.31	23.0%
PAWAI ST (2)[5]			SMH 2-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.0932	42	0.10	22.12	3.56	86.3%
			SMH 1-D	0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	19.0932	42	0.10	22.12	3.56	86.3%
Terminate at Kealakehe SPS (south)				0.00	0.00	40.0	CPA		0.00	0.00	70	0.0000	2.50	0.0000	0.0000	0.0000	0.0000	0.0000	19.0932	42	0.10	22.12	3.56	86.3%

[1]Note: Existing flows obtained from Sht. 7 of Kuakini Highway Interceptor Sewer Part C construction plans, prepared by R.M. Towill Corporation, dated 12/3/87. Sewer flow in 15-inch. pipe from SMH 10-D to SMH 9-D calculated from the difference between Peak Flows of upstream and downstream 36-inch pipes at SMH 9-D (ie. 14.4 MGD - 10.9 MGD = 3.5 MGD).

[2]Note: Existing flows obtained from Sht. 8 of Kuakini Highway Interceptor Sewer Part C construction plans, prepared by R.M. Towill Corporation, dated 12/3/87. Incoming sewer flow upstream of SMH 3-J was determined by taking peak flow downstream of SMH 5-K from the construction plans and subtracting the calculated peak flows for existing condition in the 8-inch pipe between SMH 1-G and SMH 2-G and from TMK: 7-4-010:040 to 043 (ie. 3.5 MGD - 0.1302 MGD - 0.042 MGD = 3.3278 MGD). Sewer calculations downstream of SMH 3-J do not include tributary areas and populations upstream of SMH 3-J due to limited data. However, the peak flows upstream of SMH 3-J are accounted for in the Design Peak Flow.

[3]Note: Design Peak Flow calculated by adding the peak flow from pipe segment SMH 1-G to SMH 2-G and from "ALAPA-PAWAI ST" sewer branch (ie. 0.2381 MGD + 3.2619 MGD = 3.5 MGD). Sewer calculations downstream of SMH 1-G do not include tributary areas and populations upstream of SMH 1-G due to limited data. However, the peak flows upstream of SMH 1-G are accounted for in the Design Peak Flow.

[4]Note: Existing flows obtained from Sht. 7 of Kuakini Highway Interceptor Sewer Part C construction plans, prepared by R.M. Towill Corporation, dated 12/3/87. Peak Flow in 36-inch. pipe from SMH 9-D to SMH 8-D taken from construction plans (ie. 14.4 MGD). Sewer calculations downstream of SMH 8-D do not include tributary areas and populations upstream of SMH 8-D due to limited data. However, the peak flows upstream of SMH 8-D are accounted for in the Design Peak Flow.

[5]Note: Peak flows from KA'IWI ST and PAWAI ST (2) added to peak flow calculated upstream of SMH 3-D (ie. 14.4 MGD + 0.3655 MGD = 14.7665 MGD and 14.7665 MGD + 4.2865 = 19.0530). Sewer calculations downstream of SMH 3-D do not include tributary areas and populations upstream of SMH 3-D due to limited data. However, the peak flows upstream of SMH 3-D are accounted for in the Design Peak Flow.

Proposed Drainage Conditions (Continued)									
Cell	Development Type	acs. A	C	in. I_{10}	min. Tc*	in./hr. i_{10}	cfs Q_{10}	Q_{10}/acre	No. of Drywells**
I2	Residential	6.77	0.47	1.54	5	4.00	12.73	1.88	5
I3	Residential	3.51	0.47	1.54	5	4.00	6.60	1.88	3
I4	Industrial & Business	0.65	0.62	1.54	5	4.00	1.61	2.48	1
ARCH 1	Undeveloped	1.02	0.15	1.54	5	4.00	0.61	0.60	0
ARCH 2	Undeveloped	1.69	0.15	1.54	5	4.00	1.01	0.60	0
ARCH 3	Undeveloped	0.86	0.15	1.54	5	4.00	0.52	0.60	0
OPSP 1	Undeveloped	1.04	0.15	1.54	5	4.00	0.62	0.60	0
OPSP 2	Undeveloped	0.52	0.15	1.54	5	4.00	0.31	0.60	0
Roadways	Industrial & Business	12.00	0.8	1.54	5	4.00	38.40	3.20	27
	Total	**69.55**	--	--	--	--	**150.52**	--	**74**

*Assumed proposed drywells to be located such that the time of concentration is 5 minutes.
**No. of Drywells for lots calculated using 3 cfs per drywell. No. of Drywells for roadways based on appropriate locations for roadway inlets shown in Figure 5-2, including consideration for 500 feet maximum inlet spacing.

Using the Rational Method:

$$Q_{10} = C \times i_{10} \times A$$

where,

A = Drainage Area, acres
C = Runoff Coefficient
I_{10} = 10-year 1-hour Rainfall Depth, inches. From NOAA website.
Tc = Time of Concentration, minutes from Plate 3
i_{10} = 10-year Rainfall Intensity, inches/hour from Plate 4
Q_{10} = 10-year Peak Discharge, cubic feet per second

References: County of Hawaii, Department of Public Works, Storm Drainage Standard, dated October 1970

NOAA Point Precepitation Frequency Estimates from Atlas 14, accessed May 2016, <http://hdsc.nws.noaa.gov>

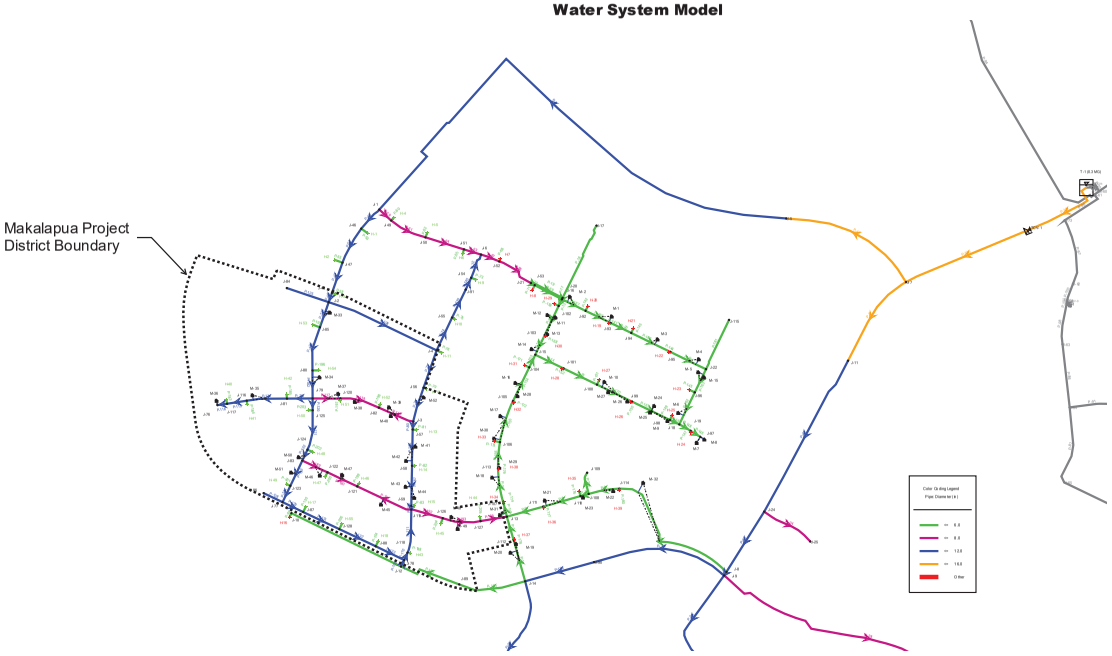
Makalapua Project District
Preliminary Hydrologic Calculations

Existing Drainage Conditions										
Parcel	Development Type	acs. A	C	in. I_{10}	ft Length	% Slope	min. Tc	in./hr. i_{10}	cfs Q_{10}	Q_{10}/acre
Target Access Road	Industrial & Business	1.65	0.62	1.54	800	0.6	11.4	3.05	3.12	1.89
Loloku Street	Industrial & Business	2.80	0.62	1.54	1500	1.3	12.5	2.95	5.12	1.83
BMW	Industrial & Business	2.59	0.62	1.54	800	2.0	8.7	3.45	5.54	2.14
7-4-010:009 & 010	Industrial & Business	2.13	0.62	1.54	300	2.6	5.5	3.90	5.15	2.42
-	Undeveloped	60.38	0.15	1.54	1600	1.6	30	2.15	19.47	0.32
	Total	**69.55**	--	--	--	--	--	--	**38.40**	--

Proposed Drainage Conditions									
Parcel	Development Type	acs. A	C	in. I_{10}	min. Tc*	in./hr. i_{10}	cfs Q_{10}	Q_{10}/acre	No. of Drywells
A1	Industrial & Business	4.45	0.62	1.54	5	4.00	11.04	2.48	4
A2	Residential	2.28	0.62	1.54	5	4.00	5.65	2.48	2
A3	Industrial & Business	2.08	0.62	1.54	5	4.00	5.16	2.48	2
B	Industrial & Business	1.19	0.62	1.54	5	4.00	2.95	2.48	1
C1	Industrial & Business	1.45	0.62	--	--	--	--	--	--
C2	Industrial & Business	1.39	0.62	1.54	5	4.00	3.45	2.48	2
BMW	Industrial & Business	2.59	0.62	1.54	5	4.00	6.42	2.48	3
D	Industrial & Business	3.29	0.62	--	--	--	--	--	--
	Hotel	0.71	0.52	--	--	--	--	--	--
	Total	4.00	0.60	1.54	5	4.00	9.64	2.41	4
E1	Industrial & Business	1.71	0.62	1.54	5	4.00	4.24	2.48	2
E2	Residential	2.35	0.47	1.54	5	4.00	4.42	1.88	2
F1	Residential	0.87	0.47	1.54	5	4.00	1.64	1.89	1
F2	Industrial & Business	2.13	0.62	--	--	--	--	--	--
	Residential	0.77	0.47	--	--	--	--	--	--
	Total	2.90	0.58	1.54	5	4.00	6.73	2.32	3
G1	Residential	2.54	0.47	1.54	5	4.00	4.78	1.88	2
G2	Residential	1.28	0.47	1.54	5	4.00	2.41	1.88	1
H1	Residential	4.86	0.47	1.54	5	4.00	9.14	1.88	4
H2	Residential	3.35	0.47	1.54	5	4.00	6.30	1.88	3
I1	Residential	2.20	0.47	1.54	5	4.00	4.14	1.88	2

Makalapua Hydrologic Calculations_7-28-23.xls Revision: October 8, 2018

Water System Model



APPENDIX C

Makalapua Project District
Infrastructure Report

Waterline Sizing Calculations

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-32	159.85	J-31	J-32	12	Ductile Iron	110	1,109.91	3.15	0.004
P-33	671.18	J-31	J-34	16	Ductile Iron	120	-2,620.86	4.18	0.004
P-34	51.71	J-34	J-33	12	Ductile Iron	110	67.00	0.19	0.000
P-35	567.05	J-34	J-35	16	Ductile Iron	120	-2,687.86	4.29	0.005
P-36	134.00	J-35	J-36	8	Ductile Iron	110	1,262.86	8.06	0.038
P-37	5,852.39	T-9 (2.0 MG)	J-35	16	Ductile Iron	120	3,950.72	6.30	0.009
P-38	1,604.99	J-36	J-38	8	Ductile Iron	110	1,048.30	6.69	0.027
P-39	1,444.88	J-38	J-39	6	Ductile Iron	100	-435.20	4.94	0.026
P-40	797.73	J-39	J-40	6	Ductile Iron	100	-91.62	1.04	0.001
P-41	1,906.01	J-40	J-41	6	Ductile Iron	100	66.06	0.75	0.001
P-42	635.79	J-41	J-27	12	Ductile Iron	110	66.06	0.19	0.000
P-43	1,139.15	J-28	J-42	8	Ductile Iron	110	456.79	2.92	0.006
P-44	3,019.89	J-42	J-43	8	Ductile Iron	110	-364.21	2.32	0.004
P-45	24.27	J-36	J-44	8	Ductile Iron	110	214.56	1.37	0.001
P-46	1,602.42	J-44	J-37	8	Ductile Iron	110	3.00	0.02	0.000
P-47	982.63	J-43	J-44	8	Ductile Iron	110	-211.56	1.35	0.001
P-48	555.03	J-43	J-32	8	Ductile Iron	110	-152.65	0.97	0.001
P-49	582.66	J-32	J-45	8	Ductile Iron	110	501.26	3.20	0.007
P-50	911.75	J-45	J-40	12	Ductile Iron	110	157.68	0.45	0.000
P-51	363.69	J-45	J-39	8	Ductile Iron	110	343.58	2.19	0.003
P-52	197.12	J-46	J-1	12	Ductile Iron	110	-1,366.74	3.88	0.006
P-53	59.27	J-46	H-1	6	Ductile Iron	100	0.00	0.00	0.000
P-54	291.27	J-47	J-46	12	Ductile Iron	110	-1,366.74	3.88	0.006
P-55	59.47	J-47	H-2	6	Ductile Iron	100	0.00	0.00	0.000
P-56	73.54	J-2	J-48	12	Ductile Iron	110	-1,366.74	3.88	0.006
P-57	240.36	J-48	J-47	12	Ductile Iron	110	-1,366.74	3.88	0.006
P-58	28.65	J-48	H-3	6	Ductile Iron	100	0.00	0.00	0.000
P-59	120.88	J-49	J-1	8	Ductile Iron	110	-522.13	3.33	0.007
P-60	28.79	J-49	H-4	6	Ductile Iron	100	0.00	0.00	0.000
P-61	287.99	J-50	J-49	8	Ductile Iron	110	-522.13	3.33	0.007
P-62	36.05	J-50	H-5	6	Ductile Iron	100	0.00	0.00	0.000

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-1	4,029.06	J-5	J-1	12	Ductile Iron	110	1,888.87	5.36	0.011
P-2	32.29	J-8	J-9	12	Ductile Iron	110	1,989.46	5.64	0.012
P-3	744.95	J-7	J-11	16	Ductile Iron	120	2,840.70	4.53	0.005
P-4	912.51	J-12	J-10	6	Ductile Iron	100	0.00	0.00	0.000
P-5	1,125.87	J-8	J-114	6	Ductile Iron	100	244.64	2.78	0.009
P-6	232.98	J-114	J-108	6	Ductile Iron	100	203.34	2.31	0.006
P-7	63.19	J-108	J-110	6	Ductile Iron	100	127.11	1.44	0.003
P-8	290.20	J-110	J-111	6	Ductile Iron	100	80.61	0.91	0.001
P-9	282.38	J-111	J-13	6	Ductile Iron	100	67.99	0.77	0.001
P-10	315.53	J-14	J-112	6	Ductile Iron	100	256.78	2.91	0.010
P-11	186.68	J-112	J-13	6	Ductile Iron	100	220.58	2.50	0.007
P-12	1,067.26	J-7	J-5	16	Ductile Iron	120	1,888.87	3.01	0.002
P-13	54.86	J-102	J-16	6	Ductile Iron	100	-300.95	3.41	0.013
P-14	234.66	J-15	J-101	6	Ductile Iron	100	315.46	3.58	0.014
P-15	278.28	J-101	J-100	6	Ductile Iron	100	315.46	3.58	0.014
P-16	77.67	J-98	J-18	6	Ductile Iron	100	183.06	2.08	0.005
P-17	11.92	J-16	J-20	6	Ductile Iron	100	-326.74	3.71	0.015
P-18	611.09	J-20	J-17	6	Ductile Iron	100	0.00	0.00	0.000
P-19	269.77	J-20	J-21	6	Ductile Iron	100	-326.74	3.71	0.015
P-20	171.43	J-94	J-93	6	Ductile Iron	100	-294.09	3.34	0.012
P-21	1,085.33	J-14	J-23	12	Ductile Iron	110	738.50	2.09	0.002
P-22	1,295.98	J-11	J-24	12	Ductile Iron	110	2,840.70	8.06	0.024
P-23	532.19	J-24	J-8	12	Ductile Iron	110	2,261.20	6.41	0.016
P-24	416.07	J-24	J-25	8	Ductile Iron	110	579.50	3.70	0.009
P-25	798.35	J-9	J-26	12	Ductile Iron	110	688.52	1.95	0.002
P-26	1,845.61	J-26	J-27	12	Ductile Iron	110	126.02	0.36	0.000
P-27	784.52	J-27	J-28	12	Ductile Iron	110	-300.92	0.85	0.000
P-28	2,432.52	J-9	J-28	8	Ductile Iron	110	121.76	0.78	0.001
P-29	22.59	J-28	J-29	12	Ductile Iron	110	-981.95	2.79	0.003
P-30	893.61	J-29	J-30	8	Ductile Iron	110	529.00	3.38	0.008
P-31	3,829.26	J-29	J-31	16	Ductile Iron	120	-1,510.95	2.41	0.002

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-115	148.19	J-116	J-117	12	Ductile Iron	110	16.67	0.05	0.000
P-116	73.40	J-117	J-76	12	Ductile Iron	110	16.67	0.05	0.000
P-117	207.87	J-79	J-120	8	Ductile Iron	110	144.96	0.93	0.001
P-118	300.62	J-120	J-82	8	Ductile Iron	110	46.35	0.30	0.000
P-119	278.03	J-82	J-3	8	Ductile Iron	110	-47.12	0.30	0.000
P-120	88.83	J-79	J-125	12	Ductile Iron	110	321.41	0.91	0.000
P-121	300.80	J-125	J-124	12	Ductile Iron	110	321.41	0.91	0.000
P-122	89.64	J-124	J-83	12	Ductile Iron	110	273.50	0.78	0.000
P-123	210.16	J-83	J-123	12	Ductile Iron	110	72.74	0.21	0.000
P-124	134.94	J-123	J-77	12	Ductile Iron	110	42.19	0.12	0.000
P-125	331.00	J-2	J-84	12	Ductile Iron	110	0.00	0.00	0.000
P-126	331.98	J-80	J-85	12	Ductile Iron	110	-725.03	2.06	0.002
P-127	198.84	J-85	J-2	12	Ductile Iron	110	-739.98	2.10	0.002
P-128	156.62	J-86	J-77	12	Ductile Iron	110	0.00	0.00	0.000
P-129	170.57	J-77	J-87	12	Ductile Iron	110	42.19	0.12	0.000
P-130	42.48	J-87	H-17	6	Ductile Iron	100	0.00	0.00	0.000
P-131	299.89	J-87	J-128	12	Ductile Iron	110	42.19	0.12	0.000
P-132	301.03	J-128	J-88	12	Ductile Iron	110	42.19	0.12	0.000
P-133	236.85	J-88	J-78	12	Ductile Iron	110	42.19	0.12	0.000
P-134	42.40	J-88	H-18	6	Ductile Iron	100	0.00	0.00	0.000
P-135	508.40	J-14	J-89	6	Ductile Iron	100	147.70	1.68	0.003
P-136	489.36	J-89	J-12	6	Ductile Iron	100	147.70	1.68	0.003
P-137	1,036.77	J-9	J-90	12	Ductile Iron	110	1,179.19	3.35	0.005
P-138	536.25	J-90	J-14	12	Ductile Iron	110	1,179.19	3.35	0.005
P-139	233.74	J-55	J-91	12	Ductile Iron	110	223.31	0.63	0.000
P-140	97.33	J-91	J-54	12	Ductile Iron	110	144.56	0.41	0.000
P-141	17.12	J-93	H-19	6	Ductile Iron	100	0.00	0.00	0.000
P-142	36.47	J-92	H-20	6	Ductile Iron	100	0.00	0.00	0.000
P-143	37.19	J-94	H-21	6	Ductile Iron	100	0.00	0.00	0.000
P-144	17.29	J-95	H-22	6	Ductile Iron	100	0.00	0.00	0.000
P-145	45.26	J-96	H-23	6	Ductile Iron	100	0.00	0.00	0.000

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-63	133.54	J-6	J-51	8	Ductile Iron	110	-522.13	3.33	0.007
P-64	302.25	J-51	J-50	8	Ductile Iron	110	-522.13	3.33	0.007
P-65	35.94	J-51	H-6	6	Ductile Iron	100	0.00	0.00	0.000
P-66	300.78	J-21	J-52	8	Ductile Iron	110	-666.69	4.26	0.012
P-67	145.91	J-52	J-6	8	Ductile Iron	110	-666.69	4.26	0.012
P-68	21.82	J-52	H-7	6	Ductile Iron	100	0.00	0.00	0.000
P-69	229.33	J-16	J-53	6	Ductile Iron	100	-339.95	3.86	0.016
P-70	32.43	J-53	J-21	6	Ductile Iron	100	-339.95	3.86	0.016
P-71	41.09	J-53	H-8	6	Ductile Iron	100	0.00	0.00	0.000
P-72	194.76	J-54	J-6	12	Ductile Iron	110	144.56	0.41	0.000
P-73	36.94	J-54	H-9	6	Ductile Iron	100	0.00	0.00	0.000
P-74	270.45	J-4	J-55	12	Ductile Iron	110	223.31	0.63	0.000
P-75	22.42	J-55	H-10	6	Ductile Iron	100	0.00	0.00	0.000
P-76	42.32	J-4	H-11	6	Ductile Iron	100	0.00	0.00	0.000
P-77	296.16	J-4	J-56	12	Ductile Iron	110	388.50	1.10	0.001
P-78	264.77	J-56	J-3	12	Ductile Iron	110	382.30	1.08	0.001
P-79	20.94	J-56	H-12	6	Ductile Iron	100	0.00	0.00	0.000
P-80	60.23	J-57	J-3	12	Ductile Iron	110	-291.75	0.83	0.000
P-81	28.79	J-57	H-13	6	Ductile Iron	100	0.00	0.00	0.000
P-82	21.42	J-58	H-14	6	Ductile Iron	100	0.00	0.00	0.000
P-83	22.03	J-59	H-15	6	Ductile Iron	100	0.00	0.00	0.000
P-84	33.20	J-10	H-16	6	Ductile Iron	100	0.00	0.00	0.000
P-104	626.65	T-1 (0.3 MG)	TCV-1	16	Ductile Iron	120	4,729.57	7.55	0.013
P-105	991.33	TCV-1	J-7	16	Ductile Iron	120	4,729.57	7.55	0.013
P-108	885.86	J-4	J-2	12	Ductile Iron	110	-611.81	1.74	0.001
P-109	54.60	J-78	J-12	12	Ductile Iron	110	-147.70	0.42	0.000
P-110	59.83	J-78	J-118	12	Ductile Iron	110	189.89	0.54	0.000
P-111	325.85	J-118	J-119	12	Ductile Iron	110	189.89	0.54	0.000
P-112	29.01	J-119	J-59	12	Ductile Iron	110	-92.76	0.26	0.000
P-113	191.78	J-79	J-81	12	Ductile Iron	110	199.83	0.57	0.000
P-114	302.50	J-81	J-116	12	Ductile Iron	110	108.25	0.31	0.000

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-177	10.40	J-111	H-36	6	Ductile Iron	100	0.00	0.00	0.000
P-178	16.32	J-112	H-37	6	Ductile Iron	100	0.00	0.00	0.000
P-179	7.43	J-113	H-38	6	Ductile Iron	100	0.00	0.00	0.000
P-180	10.42	J-114	H-39	6	Ductile Iron	100	0.00	0.00	0.000
P-181	409.02	J-22	J-115	6	Ductile Iron	100	0.00	0.00	0.000
P-182	210.33	J-80	J-79	12	Ductile Iron	110	716.80	2.03	0.002
P-183	29.77	H-40	J-117	6	Ductile Iron	130	0.00	0.00	0.000
P-184	28.48	H-41	J-116	6	Ductile Iron	130	0.00	0.00	0.000
P-185	30.99	H-42	J-81	6	Ductile Iron	130	0.00	0.00	0.000
P-186	271.38	J-57	J-58	12	Ductile Iron	110	249.48	0.71	0
P-187	299.42	J-58	J-59	12	Ductile Iron	110	149.99	0.43	0
P-188	21.85	H-43	J-118	6	Ductile Iron	130	0	0	0
P-189	207.68	J-83	J-122	8	Ductile Iron	110	90.46	0.58	0
P-190	246.46	J-122	J-121	8	Ductile Iron	110	45.77	0.29	0
P-191	443.54	J-121	J-119	8	Ductile Iron	110	-10.41	0.07	0
P-192	244.22	J-119	J-126	8	Ductile Iron	110	228.93	1.46	0.002
P-193	287.94	J-126	J-127	8	Ductile Iron	110	191.53	1.22	0.001
P-194	199.07	J-127	J-13	8	Ductile Iron	110	154.14	0.98	0.001
P-195	58.53	H-53	J-85	6	Ductile Iron	130	0	0	0
P-196	47.56	H-54	J-80	6	Ductile Iron	130	0	0	0
P-197	16.96	H-51	J-120	6	Ductile Iron	130	0	0	0
P-198	28.84	H-52	J-82	6	Ductile Iron	130	0	0	0
P-199	25.63	H-46	J-121	6	Ductile Iron	130	0	0	0
P-200	37.82	H-47	J-122	6	Ductile Iron	130	0	0	0
P-201	30.39	H-49	J-123	6	Ductile Iron	130	0	0	0
P-202	45.21	H-48	J-124	6	Ductile Iron	130	0	0	0
P-203	31.1	H-50	J-125	6	Ductile Iron	130	0	0	0
P-204	42.54	H-45	J-126	6	Ductile Iron	130	0	0	0
P-205	33.48	H-44	J-127	6	Ductile Iron	130	0	0	0
P-206	42.84	H-55	J-128	6	Ductile Iron	130	0	0	0

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-146	84.53	J-19	J-97	6	Ductile Iron	100	35.35	0.40	0.000
P-147	17.30	J-19	H-24	6	Ductile Iron	100	0.00	0.00	0.000
P-148	98.76	J-18	J-19	6	Ductile Iron	100	375.65	4.26	0.020
P-149	39.75	J-98	H-25	6	Ductile Iron	100	0.00	0.00	0.000
P-150	17.26	J-99	H-26	6	Ductile Iron	100	0.00	0.00	0.000
P-151	40.19	J-100	H-27	6	Ductile Iron	100	0.00	0.00	0.000
P-152	16.83	J-101	H-28	6	Ductile Iron	100	0.00	0.00	0.000
P-153	104.85	J-15	J-104	6	Ductile Iron	100	-112.26	1.27	0.002
P-154	280.03	J-104	J-105	6	Ductile Iron	100	-168.53	1.91	0.004
P-155	323.72	J-105	J-106	6	Ductile Iron	100	-244.83	2.78	0.009
P-156	199.37	J-106	J-113	6	Ductile Iron	100	-289.86	3.29	0.012
P-157	263.16	J-113	J-107	6	Ductile Iron	100	-329.51	3.74	0.015
P-158	103.26	J-107	J-13	6	Ductile Iron	100	-358.73	4.07	0.018
P-159	37.42	J-102	H-29	6	Ductile Iron	100	0.00	0.00	0.000
P-160	240.12	J-102	J-103	6	Ductile Iron	100	265.98	3.02	0.010
P-161	164.82	J-103	J-15	6	Ductile Iron	100	217.10	2.46	0.007
P-162	266.42	J-18	J-96	6	Ductile Iron	100	-199.54	2.26	0.006
P-163	193.39	J-96	J-22	6	Ductile Iron	100	-216.24	2.45	0.007
P-164	296.67	J-22	J-95	6	Ductile Iron	100	-237.09	2.69	0.008
P-165	325.76	J-95	J-94	6	Ductile Iron	100	-271.14	3.08	0.011
P-166	208.40	J-93	J-92	6	Ductile Iron	100	-317.89	3.61	0.014
P-167	196.79	J-92	J-16	6	Ductile Iron	100	-353.72	4.01	0.018
P-168	14.75	J-103	H-30	6	Ductile Iron	100	0.00	0.00	0.000
P-169	314.87	J-98	J-99	6	Ductile Iron	100	-213.81	2.43	0.007
P-170	291.74	J-99	J-100	6	Ductile Iron	100	-280.01	3.18	0.011
P-171	37.94	J-104	H-31	6	Ductile Iron	100	0.00	0.00	0.000
P-172	21.49	J-105	H-32	6	Ductile Iron	100	0.00	0.00	0.000
P-173	45.25	J-106	H-33	6	Ductile Iron	100	0.00	0.00	0.000
P-174	17.17	J-107	H-34	6	Ductile Iron	100	0.00	0.00	0.000
P-175	166.27	J-108	J-109	1.5	Ductile Iron	100	28.15	5.11	0.139
P-176	38.31	J-110	H-35	6	Ductile Iron	100	0.00	0.00	0.000

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-32	0.00	456.00	264.91	114.6
J-33	0.00	67.00	268.48	116.2
J-34	0.00	0.00	268.48	116.2
J-35	0.00	0.00	271.04	117.3
J-36	0.00	0.00	265.90	115.0
J-37	0.00	3.00	265.86	115.0
J-38	0.00	1,483.50	222.31	96.2
J-39	0.00	0.00	259.63	112.3
J-40	0.00	0.00	260.77	112.8
J-41	0.00	0.00	259.27	112.2
J-42	0.00	821.00	252.91	109.4
J-43	0.00	0.00	264.49	114.4
J-44	0.00	0.00	265.87	115.0
J-45	0.00	0.00	260.88	112.9
J-46	34.83	0.00	255.27	95.4
J-47	30.61	0.00	253.48	96.4
J-48	29.57	0.00	252.00	96.2
J-49	36.06	0.00	255.58	95.0
J-50	39.31	0.00	253.43	92.6
J-51	42.66	0.00	251.17	90.2
J-52	45.89	0.00	248.46	87.6
J-53	50.05	0.00	244.40	84.1
J-54	40.68	0.00	250.20	90.6
J-55	38.69	0.00	250.26	91.5
J-56	36.86	6.20	250.14	92.3
J-57	32.47	42.27	249.96	94.1
J-58	33.25	99.50	249.89	93.7
J-59	29.21	57.23	249.86	95.5
J-76	14.55	16.67	250.08	101.9
J-77	16.00	0.00	249.93	101.2
J-78	23.12	0.00	249.92	98.1

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-1	37.63	0.00	256.49	94.7
J-2	31.58	14.95	251.54	95.2
J-3	32.89	43.42	249.98	93.9
J-4	40.16	0.00	250.31	90.9
J-5	192.12	0.00	301.67	47.4
J-6	43.85	0.00	250.18	89.3
J-7	197.59	0.00	304.18	46.1
J-8	30.00	27.10	261.18	100.0
J-9	30.00	0.00	260.78	99.8
J-10	14.60	0.00	249.92	101.8
J-11	143.50	0.00	300.45	67.9
J-12	15.25	0.00	249.92	101.5
J-13	29.00	83.98	248.97	95.2
J-14	19.91	36.20	253.41	101.0
J-15	51.18	13.90	236.27	80.1
J-16	55.06	12.02	240.65	80.3
J-17	95.86	0.00	240.83	62.7
J-18	84.75	6.95	223.05	59.8
J-19	88.09	340.30	221.11	57.6
J-20	55.06	0.00	240.83	80.4
J-21	50.05	0.00	244.93	84.3
J-22	108.35	20.85	226.05	50.9
J-23	15.00	738.50	251.27	102.2
J-24	73.70	0.00	269.51	84.7
J-25	80.65	579.50	265.74	80.1
J-26	5.59	562.50	259.40	109.8
J-27	0.00	493.00	259.26	112.2
J-28	0.00	346.00	259.55	112.3
J-29	0.00	0.00	259.63	112.3
J-30	0.00	529.00	252.79	109.4
J-31	0.00	0.00	265.58	114.9

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-110	37.96	46.50	249.53	91.5
J-111	30.89	12.63	249.20	94.5
J-112	23.83	36.20	250.34	98.0
J-113	38.53	39.65	243.04	88.5
J-114	43.73	41.3	251.17	89.7
J-115	0	0	226.05	97.8
J-116	18.65	91.58	250.08	100.1
J-117	16.26	0	250.08	101.2
J-118	22.54	0	249.91	98.4
J-119	28.34	43.31	249.86	95.8
J-120	33.14	98.61	249.98	93.8
J-121	26.89	56.18	249.85	96.5
J-122	22.08	44.69	249.87	98.6
J-123	19.86	30.56	249.93	99.5
J-124	18.32	47.91	249.96	100.2
J-125	23.36	0	250.09	98.1
J-126	32.58	37.39	249.46	93.8
J-127	30.89	37.39	249.12	94.4
J-128	19.3	0	249.92	99.8

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-79	24.58	50.59	250.13	97.6
J-80	27.97	8.23	250.52	96.3
J-81	17.96	91.58	250.09	100.4
J-82	31.85	93.47	249.96	94.4
J-83	17.89	110.30	249.94	100.4
J-84	30.89	0.00	251.54	95.5
J-85	30.71	14.95	251.15	95.4
J-86	15.88	0.00	249.93	101.3
J-87	16.82	0.00	249.93	100.9
J-88	22.47	0.00	249.92	98.4
J-89	22.07	0.00	251.63	99.3
J-90	26.00	0.00	255.92	99.5
J-91	40.59	78.75	250.21	90.7
J-92	57.53	35.82	237.19	77.7
J-93	64.37	23.80	234.18	73.5
J-94	76.35	22.95	232.04	67.4
J-95	91.84	34.05	228.53	59.1
J-96	93.93	16.70	224.68	56.6
J-97	90.88	35.35	221.09	56.3
J-98	82.06	30.75	223.46	61.2
J-99	70.83	66.20	225.64	67.0
J-100	68.10	35.45	228.97	69.6
J-101	62.95	0.00	232.93	73.5
J-102	54.62	34.97	239.94	80.2
J-103	52.70	48.88	237.44	79.9
J-104	50.54	56.27	236.49	80.5
J-105	47.00	76.30	237.74	82.5
J-106	43.30	45.02	240.62	85.4
J-107	31.93	29.23	247.10	93.1
J-108	39.38	48.07	249.70	91.0
J-109	43.43	28.15	226.63	79.3

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Customer Meter			
Label	Associated Element	Elevation (ft)	Demand (Base) (gpm)
M-32	P-5	46.50	54.2
M-33	P-127	31.23	29.9
M-34	P-182	27.10	16.5
M-35	P-114	20.42	183.2
M-36	J-76	14.55	16.7
M-37	P-117	32.61	84.7
M-38	P-118	29.11	112.5
M-39	P-119	33.76	21.7
M-40	P-119	31.73	52.8
M-41	P-186	32.50	15.1
M-42	P-186	33.10	69.4
M-43	P-187	32.73	87.5
M-44	P-187	30.86	27.0
M-45	P-191	29.93	86.6
M-46	P-189	19.69	63.7
M-47	P-190	26.15	25.7
M-48	P-193	32.77	14.5
M-49	P-193	33.43	60.3
M-50	P-122	17.78	95.8
M-51	P-123	0.00	61.1
M-52	P-78	35.78	12.4

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Customer Meter			
Label	Associated Element	Elevation (ft)	Demand (Base) (gpm)
M-1	P-166	63.21	47.6
M-2	P-167	53.44	24.1
M-3	P-165	84.58	45.9
M-4	P-164	108.03	22.2
M-5	P-163	103.72	19.5
M-6	P-162	83.92	13.9
M-7	J-97	90.88	16.6
M-8	J-97	90.88	18.8
M-9	P-169	81.09	33.7
M-10	P-170	67.99	27.8
M-11	P-160	53.49	14.1
M-12	P-160	53.41	28.0
M-13	P-160	52.38	27.9
M-14	P-161	57.16	27.8
M-15	P-163	102.43	0.0
M-16	P-154	48.27	28.0
M-17	P-155	42.75	23.8
M-18	P-157	37.22	29.3
M-19	P-10	22.92	41.9
M-20	P-10	21.34	30.6
M-21	P-8	31.11	25.3
M-22	P-6	42.55	28.4
M-23	P-7	38.22	67.8
M-24	P-169	75.53	13.9
M-25	P-169	75.30	13.9
M-26	P-170	69.85	15.3
M-27	P-170	68.46	27.8
M-28	P-154	47.21	84.6
M-29	P-156	38.74	50.0
M-30	P-155	43.86	16.3
M-31	P-158	30.00	29.2

Legend

Scenario: Peak Hour

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-32	159.85	J-31	J-32	12	Ductile Iron	110	333.14	0.95	0.000
P-33	671.18	J-31	J-34	16	Ductile Iron	120	-789.74	1.26	0.000
P-34	51.71	J-34	J-33	12	Ductile Iron	110	20.10	0.06	0.000
P-35	567.05	J-34	J-35	16	Ductile Iron	120	-809.84	1.29	0.000
P-36	134.00	J-35	J-36	8	Ductile Iron	110	379.50	2.42	0.004
P-37	5,852.39	T-9 (2.0 MG)	J-35	16	Ductile Iron	120	1,189.35	1.90	0.001
P-38	1,604.99	J-36	J-38	8	Ductile Iron	110	314.55	2.01	0.003
P-39	1,444.88	J-38	J-39	6	Ductile Iron	100	-130.50	1.48	0.003
P-40	797.73	J-39	J-40	6	Ductile Iron	100	-27.44	0.31	0.000
P-41	1,906.01	J-40	J-41	6	Ductile Iron	100	20.33	0.23	0.000
P-42	635.79	J-41	J-27	12	Ductile Iron	110	20.33	0.06	0.000
P-43	1,139.15	J-28	J-42	8	Ductile Iron	110	136.73	0.87	0.001
P-44	3,019.89	J-42	J-43	8	Ductile Iron	110	-109.57	0.70	0.000
P-45	24.27	J-36	J-44	8	Ductile Iron	110	64.95	0.41	0.000
P-46	1,602.42	J-44	J-37	8	Ductile Iron	110	0.90	0.01	0.000
P-47	982.63	J-43	J-44	8	Ductile Iron	110	-64.05	0.41	0.000
P-48	555.03	J-43	J-32	8	Ductile Iron	110	-45.52	0.29	0.000
P-49	582.66	J-32	J-45	8	Ductile Iron	110	150.82	0.96	0.001
P-50	911.75	J-45	J-40	12	Ductile Iron	110	47.77	0.14	0.000
P-51	363.69	J-45	J-39	8	Ductile Iron	110	103.06	0.66	0.000
P-52	197.12	J-46	J-1	12	Ductile Iron	110	-413.37	1.17	0.001
P-53	59.27	J-46	H-1	6	Ductile Iron	100	0.00	0.00	0.000
P-54	291.27	J-47	J-46	12	Ductile Iron	110	-413.37	1.17	0.001
P-55	59.47	J-47	H-2	6	Ductile Iron	100	0.00	0.00	0.000
P-56	73.54	J-2	J-48	12	Ductile Iron	110	-413.37	1.17	0.001
P-57	240.36	J-48	J-47	12	Ductile Iron	110	-413.37	1.17	0.001
P-58	28.65	J-48	H-3	6	Ductile Iron	100	0.00	0.00	0.000
P-59	120.88	J-49	J-1	8	Ductile Iron	110	-157.86	1.01	0.001
P-60	28.79	J-49	H-4	6	Ductile Iron	100	0.00	0.00	0.000
P-61	287.99	J-50	J-49	8	Ductile Iron	110	-157.86	1.01	0.001
P-62	36.05	J-50	H-5	6	Ductile Iron	100	0.00	0.00	0.000

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-1	4,029.06	J-5	J-1	12	Ductile Iron	110	571.23	1.62	0.001
P-2	32.29	J-8	J-9	12	Ductile Iron	110	598.34	1.70	0.001
P-3	744.95	J-7	J-11	16	Ductile Iron	120	855.56	1.37	0.001
P-4	912.51	J-12	J-10	6	Ductile Iron	100	0.00	0.00	0.000
P-5	1,125.87	J-8	J-114	6	Ductile Iron	100	75.24	0.85	0.001
P-6	232.98	J-114	J-108	6	Ductile Iron	100	62.84	0.71	0.001
P-7	63.19	J-108	J-110	6	Ductile Iron	100	39.97	0.45	0.000
P-8	290.20	J-110	J-111	6	Ductile Iron	100	26.02	0.30	0.000
P-9	282.38	J-111	J-13	6	Ductile Iron	100	22.23	0.25	0.000
P-10	315.53	J-14	J-112	6	Ductile Iron	100	80.85	0.92	0.001
P-11	186.68	J-112	J-13	6	Ductile Iron	100	70.00	0.79	0.001
P-12	1,067.26	J-7	J-5	16	Ductile Iron	120	571.23	0.91	0.000
P-13	54.86	J-102	J-16	6	Ductile Iron	100	-90.98	1.03	0.001
P-14	234.66	J-15	J-101	6	Ductile Iron	100	94.52	1.07	0.002
P-15	278.28	J-101	J-100	6	Ductile Iron	100	94.52	1.07	0.002
P-16	77.67	J-98	J-18	6	Ductile Iron	100	54.82	0.62	0.001
P-17	11.92	J-16	J-20	6	Ductile Iron	100	-98.41	1.12	0.002
P-18	611.09	J-20	J-17	6	Ductile Iron	100	0.00	0.00	0.000
P-19	269.77	J-20	J-21	6	Ductile Iron	100	-98.41	1.12	0.002
P-20	171.43	J-94	J-93	6	Ductile Iron	100	-88.32	1.00	0.001
P-21	1,085.33	J-14	J-23	12	Ductile Iron	110	221.55	0.63	0.000
P-22	1,295.98	J-11	J-24	12	Ductile Iron	110	855.56	2.43	0.003
P-23	532.19	J-24	J-8	12	Ductile Iron	110	681.71	1.93	0.002
P-24	416.07	J-24	J-25	8	Ductile Iron	110	173.85	1.11	0.001
P-25	798.35	J-9	J-26	12	Ductile Iron	110	203.58	0.58	0.000
P-26	1,845.61	J-26	J-27	12	Ductile Iron	110	34.83	0.10	0.000
P-27	784.52	J-27	J-28	12	Ductile Iron	110	-92.74	0.26	0.000
P-28	2,432.52	J-9	J-28	8	Ductile Iron	110	35.37	0.23	0.000
P-29	22.59	J-28	J-29	12	Ductile Iron	110	-297.90	0.85	0.000
P-30	893.61	J-29	J-30	8	Ductile Iron	110	158.70	1.01	0.001
P-31	3,829.26	J-29	J-31	16	Ductile Iron	120	-456.60	0.73	0.000

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-115	148.19	J-116	J-117	12	Ductile Iron	110	5	0.01	0
P-116	73.40	J-117	J-76	12	Ductile Iron	110	5	0.01	0
P-117	207.87	J-79	J-120	8	Ductile Iron	110	43.85	0.28	0
P-118	300.62	J-120	J-82	8	Ductile Iron	110	14.27	0.09	0
P-119	278.03	J-82	J-3	8	Ductile Iron	110	-13.77	0.09	0
P-120	88.83	J-79	J-125	12	Ductile Iron	110	97.98	0.28	0
P-121	300.8	J-125	J-124	12	Ductile Iron	110	97.98	0.28	0
P-122	89.64	J-124	J-83	12	Ductile Iron	110	83.6	0.24	0
P-123	210.16	J-83	J-123	12	Ductile Iron	110	22.55	0.06	0
P-124	134.94	J-123	J-77	12	Ductile Iron	110	13.39	0.04	0
P-125	331	J-2	J-84	12	Ductile Iron	110	0	0	0
P-126	331.98	J-80	J-85	12	Ductile Iron	110	-219.42	0.62	0
P-127	198.84	J-85	J-2	12	Ductile Iron	110	-223.91	0.64	0
P-128	156.62	J-86	J-77	12	Ductile Iron	110	0	0	0
P-129	170.57	J-77	J-87	12	Ductile Iron	110	13.39	0.04	0
P-130	42.48	J-87	H-17	6	Ductile Iron	100	0	0	0
P-131	299.89	J-87	J-128	12	Ductile Iron	110	13.39	0.04	0
P-132	301.03	J-128	J-88	12	Ductile Iron	110	13.39	0.04	0
P-133	236.85	J-88	J-78	12	Ductile Iron	110	13.39	0.04	0
P-134	42.4	J-88	H-18	6	Ductile Iron	100	0	0	0
P-135	508.4	J-14	J-89	6	Ductile Iron	100	46.13	0.52	0
P-136	489.36	J-89	J-12	6	Ductile Iron	100	46.13	0.52	0
P-137	1,036.77	J-9	J-90	12	Ductile Iron	110	359.39	1.02	0.001
P-138	536.25	J-90	J-14	12	Ductile Iron	110	359.39	1.02	0.001
P-139	233.74	J-55	J-91	12	Ductile Iron	110	66.57	0.19	0
P-140	97.33	J-91	J-54	12	Ductile Iron	110	42.94	0.12	0
P-141	17.12	J-93	H-19	6	Ductile Iron	100	0	0	0
P-142	36.47	J-92	H-20	6	Ductile Iron	100	0	0	0
P-143	37.19	J-94	H-21	6	Ductile Iron	100	0	0	0
P-144	17.29	J-95	H-22	6	Ductile Iron	100	0	0	0
P-145	45.26	J-96	H-23	6	Ductile Iron	100	0	0	0

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-63	133.54	J-6	J-51	8	Ductile Iron	110	-157.86	1.01	0.001
P-64	302.25	J-51	J-50	8	Ductile Iron	110	-157.86	1.01	0.001
P-65	35.94	J-51	H-6	6	Ductile Iron	100	0.00	0.00	0.000
P-66	300.78	J-21	J-52	8	Ductile Iron	110	-200.80	1.28	0.001
P-67	145.91	J-52	J-6	8	Ductile Iron	110	-200.80	1.28	0.001
P-68	21.82	J-52	H-7	6	Ductile Iron	100	0.00	0.00	0.000
P-69	229.33	J-16	J-53	6	Ductile Iron	100	-102.39	1.16	0.002
P-70	32.43	J-53	J-21	6	Ductile Iron	100	-102.39	1.16	0.002
P-71	41.09	J-53	H-8	6	Ductile Iron	100	0.00	0.00	0.000
P-72	194.76	J-54	J-6	12	Ductile Iron	110	42.94	0.12	0.000
P-73	36.94	J-54	H-9	6	Ductile Iron	100	0.00	0.00	0.000
P-74	270.45	J-4	J-55	12	Ductile Iron	110	66.57	0.19	0.000
P-75	22.42	J-55	H-10	6	Ductile Iron	100	0.00	0.00	0.000
P-76	42.32	J-4	H-11	6	Ductile Iron	100	0.00	0.00	0.000
P-77	296.16	J-4	J-56	12	Ductile Iron	110	118.40	0.34	0.000
P-78	264.77	J-56	J-3	12	Ductile Iron	110	116.54	0.33	0.000
P-79	20.94	J-56	H-12	6	Ductile Iron	100	0.00	0.00	0.000
P-80	60.23	J-57	J-3	12	Ductile Iron	110	-89.75	0.25	0.000
P-81	28.79	J-57	H-13	6	Ductile Iron	100	0.00	0.00	0.000
P-82	21.42	J-58	H-14	6	Ductile Iron	100	0.00	0.00	0.000
P-83	22.03	J-59	H-15	6	Ductile Iron	100	0.00	0.00	0.000
P-84	33.20	J-10	H-16	6	Ductile Iron	100	0.00	0.00	0.000
P-104	626.65	T-1 (0.3 MG)	TCV-1	16	Ductile Iron	120	1,426.79	2.28	0.001
P-105	991.33	TCV-1	J-7	16	Ductile Iron	120	1,426.79	2.28	0.001
P-108	885.86	J-4	J-2	12	Ductile Iron	110	-184.98	0.52	0
P-109	54.6	J-78	J-12	12	Ductile Iron	110	-46.13	0.13	0
P-110	59.83	J-78	J-118	12	Ductile Iron	110	59.52	0.17	0
P-111	325.85	J-118	J-119	12	Ductile Iron	110	59.52	0.17	0
P-112	29.01	J-119	J-59	12	Ductile Iron	110	-30.06	0.09	0
P-113	191.78	J-79	J-81	12	Ductile Iron	110	59.94	0.17	0
P-114	302.5	J-81	J-116	12	Ductile Iron	110	32.47	0.09	0

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-177	10.4	J-111	H-36	6	Ductile Iron	100	0	0	0
P-178	16.32	J-112	H-37	6	Ductile Iron	100	0	0	0
P-179	7.43	J-113	H-38	6	Ductile Iron	100	0	0	0
P-180	10.42	J-114	H-39	6	Ductile Iron	100	0	0	0
P-181	409.02	J-22	J-115	6	Ductile Iron	100	0	0	0
P-182	210.33	J-80	J-79	12	Ductile Iron	110	216.95	0.62	0
P-183	29.77	H-40	J-117	6	Ductile Iron	130	0	0	0
P-184	28.48	H-41	J-116	6	Ductile Iron	130	0	0	0
P-185	30.99	H-42	J-81	6	Ductile Iron	130	0	0	0
P-186	271.38	J-57	J-58	12	Ductile Iron	110	77.07	0.22	0
P-187	299.42	J-58	J-59	12	Ductile Iron	110	47.22	0.13	0
P-188	21.85	H-43	J-118	6	Ductile Iron	130	0	0	0
P-189	207.68	J-83	J-122	8	Ductile Iron	110	27.96	0.18	0
P-190	246.46	J-122	J-121	8	Ductile Iron	110	14.56	0.09	0
P-191	443.54	J-121	J-119	8	Ductile Iron	110	-2.3	0.01	0
P-192	244.22	J-119	J-126	8	Ductile Iron	110	74.29	0.47	0
P-193	287.94	J-126	J-127	8	Ductile Iron	110	63.07	0.4	0
P-194	199.07	J-127	J-13	8	Ductile Iron	110	51.86	0.33	0
P-195	58.53	H-53	J-85	6	Ductile Iron	130	0	0	0
P-196	47.56	H-54	J-80	6	Ductile Iron	130	0	0	0
P-197	16.96	H-51	J-120	6	Ductile Iron	130	0	0	0
P-198	28.84	H-52	J-82	6	Ductile Iron	130	0	0	0
P-199	25.63	H-46	J-121	6	Ductile Iron	130	0	0	0
P-200	37.82	H-47	J-122	6	Ductile Iron	130	0	0	0
P-201	30.39	H-49	J-123	6	Ductile Iron	130	0	0	0
P-202	45.21	H-48	J-124	6	Ductile Iron	130	0	0	0
P-203	31.1	H-50	J-125	6	Ductile Iron	130	0	0	0
P-204	42.54	H-45	J-126	6	Ductile Iron	130	0	0	0
P-205	33.48	H-44	J-127	6	Ductile Iron	130	0	0	0
P-206	42.84	H-55	J-128	6	Ductile Iron	130	0	0	0

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Pipe									
Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Headloss Gradient (ft/ft)
P-146	84.53	J-19	J-97	6	Ductile Iron	100	10.61	0.12	0
P-147	17.3	J-19	H-24	6	Ductile Iron	100	0	0	0
P-148	98.76	J-18	J-19	6	Ductile Iron	100	112.69	1.28	0.002
P-149	39.75	J-98	H-25	6	Ductile Iron	100	0	0	0
P-150	17.26	J-99	H-26	6	Ductile Iron	100	0	0	0
P-151	40.19	J-100	H-27	6	Ductile Iron	100	0	0	0
P-152	16.83	J-101	H-28	6	Ductile Iron	100	0	0	0
P-153	104.85	J-15	J-104	6	Ductile Iron	100	-32.86	0.37	0
P-154	280.03	J-104	J-105	6	Ductile Iron	100	-49.74	0.56	0
P-155	323.72	J-105	J-106	6	Ductile Iron	100	-72.63	0.82	0.001
P-156	199.37	J-106	J-113	6	Ductile Iron	100	-86.14	0.98	0.001
P-157	263.16	J-113	J-107	6	Ductile Iron	100	-98.04	1.11	0.002
P-158	103.26	J-107	J-13	6	Ductile Iron	100	-112.85	1.28	0.002
P-159	37.42	J-102	H-29	6	Ductile Iron	100	0	0	0
P-160	240.12	J-102	J-103	6	Ductile Iron	100	80.48	0.91	0.001
P-161	164.82	J-103	J-15	6	Ductile Iron	100	65.82	0.75	0.001
P-162	266.42	J-18	J-96	6	Ductile Iron	100	-59.96	0.68	0.001
P-163	193.39	J-96	J-22	6	Ductile Iron	100	-64.97	0.74	0.001
P-164	296.67	J-22	J-95	6	Ductile Iron	100	-71.23	0.81	0.001
P-165	325.76	J-95	J-94	6	Ductile Iron	100	-81.44	0.92	0.001
P-166	208.4	J-93	J-92	6	Ductile Iron	100	-95.46	1.08	0.002
P-167	196.79	J-92	J-16	6	Ductile Iron	100	-106.21	1.21	0.002
P-168	14.75	J-103	H-30	6	Ductile Iron	100	0	0	0
P-169	314.87	J-98	J-99	6	Ductile Iron	100	-64.04	0.73	0.001
P-170	291.74	J-99	J-100	6	Ductile Iron	100	-83.89	0.95	0.001
P-171	37.94	J-104	H-31	6	Ductile Iron	100	0	0	0
P-172	21.49	J-105	H-32	6	Ductile Iron	100	0	0	0
P-173	45.25	J-106	H-33	6	Ductile Iron	100	0	0	0
P-174	17.17	J-107	H-34	6	Ductile Iron	100	0	0	0
P-175	166.27	J-108	J-109	1.5	Ductile Iron	100	8.44	1.53	0.015
P-176	38.31	J-110	H-35	6	Ductile Iron	100	0	0	0

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction Data				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-32	0.00	136.80	318.49	137.8
J-33	0.00	20.10	318.88	138.0
J-34	0.00	0.00	318.88	138.0
J-35	0.00	0.00	319.16	138.1
J-36	0.00	0.00	318.60	137.8
J-37	0.00	0.90	318.60	137.8
J-38	0.00	445.05	313.91	135.8
J-39	0.00	0.00	317.92	137.6
J-40	0.00	0.00	318.05	137.6
J-41	0.00	0.00	317.88	137.5
J-42	0.00	246.30	317.20	137.2
J-43	0.00	0.00	318.45	137.8
J-44	0.00	0.00	318.60	137.8
J-45	0.00	0.00	318.06	137.6
J-46	34.83	0.00	317.40	122.3
J-47	30.61	0.00	317.20	124.0
J-48	29.57	0.00	317.04	124.4
J-49	36.06	0.00	317.43	121.7
J-50	39.31	0.00	317.20	120.2
J-51	42.66	0.00	316.95	118.7
J-52	45.89	0.00	316.66	117.1
J-53	50.05	0.00	316.22	115.2
J-54	40.68	0.00	316.84	119.5
J-55	38.69	0.00	316.85	120.3
J-56	36.86	1.86	316.84	121.1
J-57	32.47	12.68	316.82	123.0
J-58	33.25	29.84	316.81	122.7
J-59	29.21	17.16	316.81	124.4
J-76	14.55	5	316.83	130.8
J-77	16	0	316.81	130.1
J-78	23.12	0	316.81	127.1

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction Data				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-1	37.63	0.00	317.53	121.1
J-2	31.58	4.49	316.99	123.5
J-3	32.89	13.03	316.82	122.8
J-4	40.16	0.00	316.86	119.7
J-5	192.12	0.00	322.46	56.4
J-6	43.85	0.00	316.84	118.1
J-7	197.59	0.00	322.74	54.1
J-8	30.00	8.13	318.08	124.6
J-9	30.00	0.00	318.03	124.6
J-10	14.60	0.00	316.81	130.8
J-11	143.50	0.00	322.33	77.4
J-12	15.25	0.00	316.81	130.5
J-13	29.00	31.24	316.69	124.5
J-14	19.91	10.86	317.22	128.6
J-15	51.18	4.16	315.33	114.3
J-16	55.06	3.61	315.81	112.8
J-17	95.86	0.00	315.83	95.2
J-18	84.75	2.09	313.91	99.1
J-19	88.09	102.08	313.70	97.6
J-20	55.06	0.00	315.83	112.8
J-21	50.05	0.00	316.27	115.2
J-22	108.35	6.26	314.24	89.1
J-23	15.00	221.55	316.99	130.7
J-24	73.70	0.00	318.98	106.1
J-25	80.65	173.85	318.58	102.9
J-26	5.59	168.75	317.89	135.1
J-27	0.00	147.90	317.88	137.5
J-28	0.00	103.80	317.91	137.5
J-29	0.00	0.00	317.92	137.5
J-30	0.00	158.70	317.18	137.2
J-31	0.00	0.00	318.57	137.8

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction Data				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-110	37.96	13.95	316.76	120.6
J-111	30.89	3.79	316.72	123.7
J-112	23.83	10.86	316.86	126.8
J-113	38.53	11.89	316.04	120.1
J-114	43.73	12.39	316.95	118.2
J-115	0	0	314.24	136
J-116	18.65	27.47	316.83	129
J-117	16.26	0	316.83	130
J-118	22.54	0	316.81	127.3
J-119	28.34	12.99	316.81	124.8
J-120	33.14	29.58	316.82	122.7
J-121	26.89	16.85	316.81	125.4
J-122	22.08	13.4	316.81	127.5
J-123	19.86	9.16	316.81	128.5
J-124	18.32	14.37	316.82	129.1
J-125	23.36	0	316.83	127
J-126	32.58	11.22	316.76	122.9
J-127	30.89	11.22	316.71	123.7
J-128	19.3	0	316.81	128.7

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Junction Data				
Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-79	24.58	15.18	316.84	126.4
J-80	27.97	2.47	316.88	125
J-81	17.96	27.47	316.83	129.3
J-82	31.85	28.04	316.82	123.3
J-83	17.89	33.09	316.82	129.3
J-84	30.89	0	316.99	123.8
J-85	30.71	4.49	316.95	123.8
J-86	15.88	0	316.81	130.2
J-87	16.82	0	316.81	129.8
J-88	22.47	0	316.81	127.3
J-89	22.07	0	317.01	127.6
J-90	26	0	317.5	126.1
J-91	40.59	23.63	316.85	119.5
J-92	57.53	10.75	315.44	111.6
J-93	64.37	7.14	315.11	108.5
J-94	76.35	6.88	314.88	103.2
J-95	91.84	10.22	314.5	96.3
J-96	93.93	5.01	314.09	95.3
J-97	90.88	10.61	313.7	96.4
J-98	82.06	9.22	313.96	100.3
J-99	70.83	19.85	314.19	105.3
J-100	68.1	10.63	314.55	106.6
J-101	62.95	0	314.97	109
J-102	54.62	10.49	315.73	113
J-103	52.7	14.66	315.46	113.7
J-104	50.54	16.88	315.35	114.6
J-105	47	22.89	315.48	116.2
J-106	43.3	13.51	315.79	117.9
J-107	31.93	14.81	316.47	123.1
J-108	39.38	14.43	316.78	120
J-109	43.43	8.44	314.3	117.2

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Customer Meter			
Label	Associated Element	Elevation (ft)	Demand (Base) (gpm)
M-32	P-5	46.50	16.3
M-33	P-127	31.23	9.0
M-34	P-182	27.10	4.9
M-35	P-114	20.42	54.9
M-36	J-76	14.55	5.0
M-37	P-117	32.61	25.4
M-38	P-118	29.11	33.8
M-39	P-119	33.76	6.5
M-40	P-119	31.73	15.8
M-41	P-186	32.50	4.5
M-42	P-186	33.10	20.8
M-43	P-187	32.73	26.2
M-44	P-187	30.86	8.1
M-45	P-191	29.93	26.0
M-46	P-189	19.69	19.1
M-47	P-190	26.15	7.7
M-48	P-193	32.77	4.3
M-49	P-193	33.43	18.1
M-50	P-122	17.78	28.8
M-51	P-123	0.00	18.3
M-52	P-78	35.78	3.7

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Customer Meter			
Label	Associated Element	Elevation (ft)	Demand (Base) (gpm)
M-1	P-166	63.21	14.3
M-2	P-167	53.44	7.2
M-3	P-165	84.58	13.8
M-4	P-164	108.03	6.7
M-5	P-163	103.72	5.9
M-6	P-162	83.92	4.2
M-7	J-97	90.88	5.0
M-8	J-97	90.88	5.7
M-9	P-169	81.09	10.1
M-10	P-170	67.99	8.3
M-11	P-160	53.49	4.2
M-12	P-160	53.41	8.4
M-13	P-160	52.38	8.4
M-14	P-161	57.16	8.3
M-15	P-163	102.43	0.0
M-16	P-154	48.27	8.4
M-17	P-155	42.75	7.1
M-18	P-157	37.22	8.8
M-19	P-10	22.92	12.6
M-20	P-10	21.34	9.2
M-21	P-8	31.11	7.6
M-22	P-6	42.55	8.5
M-23	P-7	38.22	20.3
M-24	P-169	75.53	4.2
M-25	P-169	75.30	4.2
M-26	P-170	69.85	4.6
M-27	P-170	68.46	8.3
M-28	P-154	47.21	25.4
M-29	P-156	38.74	15.0
M-30	P-155	43.86	4.9
M-31	P-158	30.00	20.8

Legend

Scenario: Maximum Daily

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Fire Flow							
Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (gpm)	Flow (Total Needed) (gpm)	Flow (Total Available) (gpm)	Pressure (Calculated Residual) (psi)	Velocity of Maximum Pipe (ft/s)	Pipe w/ Maximum Velocity
H-32	FALSE	2,000	2,000	1,614	67.5	10.0	P-158
H-33	FALSE	2,000	2,000	1,348	82.0	10.0	P-158
H-34	FALSE	2,000	2,000	998	110.9	10.0	P-158
H-35	FALSE	2,000	2,000	1,439	83.9	10.0	P-9
H-36	FALSE	2,000	2,000	1,258	102.6	10.0	P-9
H-37	FALSE	2,000	2,000	1,747	103.3	10.0	P-11
H-38	FALSE	2,000	2,000	1,205	96.5	10.0	P-158
H-39	FALSE	2,000	2,000	1,646	72.2	10.0	P-9
H-40	TRUE	2,000	2,000	2,001	105.4	5.9	P-113
H-41	TRUE	2,000	2,000	2,001	105.3	5.9	P-113
H-42	TRUE	2,000	2,000	2,001	107.0	5.9	P-113
H-43	TRUE	2,000	2,000	2,001	117.0	5.7	P-10
H-44	TRUE	2,000	2,000	2,001	98.9	7.1	P-10
H-45	TRUE	2,000	2,000	2,001	98.1	8.0	P-192
H-46	TRUE	2,000	2,000	2,001	100.5	6.6	P-191
H-47	TRUE	2,000	2,000	2,001	102.1	8.3	P-189
H-48	TRUE	2,000	2,000	2,001	106.0	5.7	P-10
H-49	TRUE	2,000	2,000	2,001	115.5	5.7	P-10
H-50	TRUE	2,000	2,000	2,001	105.6	5.7	P-10
H-51	TRUE	2,000	2,000	2,001	100.1	8.1	P-117
H-52	TRUE	2,000	2,000	2,001	98.9	7.5	P-119
H-53	TRUE	2,000	2,000	2,001	99.9	5.7	P-10
H-54	TRUE	2,000	2,000	2,001	114.0	5.7	P-10
H-55	TRUE	2,000	2,000	2,001	105.6	5.7	P-10
J-1	TRUE	2,000	2,000	2,001	105.1	5.4	P-10
J-2	TRUE	2,000	2,004	2,005	106.7	5.6	P-10
J-3	TRUE	2,000	2,013	2,014	105.4	5.7	P-10
J-4	TRUE	2,000	2,000	2,001	102.4	5.7	P-10
J-5	TRUE	2,000	2,000	2,001	51.7	4.9	P-105
J-6	TRUE	2,000	2,000	2,001	99.1	5.7	P-10
J-7	TRUE	2,000	2,000	2,001	51.0	5.0	P-105

Legend

Scenario: Maximum Daily + Fire Flow

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Fire Flow							
Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (gpm)	Flow (Total Needed) (gpm)	Flow (Total Available) (gpm)	Pressure (Calculated Residual) (psi)	Velocity of Maximum Pipe (ft/s)	Pipe w/ Maximum Velocity
H-1	TRUE	2,000	2,000	2,001	93.8	5.5	P-10
H-2	TRUE	2,000	2,000	2,001	95.0	5.6	P-10
H-3	TRUE	2,000	2,000	2,001	101.3	5.6	P-10
H-4	TRUE	2,000	2,000	2,001	96.8	9.6	P-59
H-5	TRUE	2,000	2,000	2,001	91.6	7.2	P-59
H-6	TRUE	2,000	2,000	2,001	90.7	7.6	P-63
H-7	FALSE	2,000	2,000	1,557	97.3	10.0	P-67
H-8	FALSE	2,000	2,000	1,087	97.6	10.0	P-70
H-9	TRUE	2,000	2,000	2,001	92.8	5.7	P-10
H-10	TRUE	2,000	2,000	2,001	97.0	5.7	P-10
H-11	TRUE	2,000	2,000	2,001	94.4	5.7	P-10
H-12	TRUE	2,000	2,000	2,001	99.7	5.7	P-10
H-13	TRUE	2,000	2,000	2,001	100.2	5.7	P-10
H-14	TRUE	2,000	2,000	2,001	101.2	5.7	P-10
H-15	TRUE	2,000	2,000	2,001	103.1	5.8	P-10
H-16	FALSE	2,000	2,000	1,454	20.0	4.5	P-10
H-17	TRUE	2,000	2,000	2,001	103.6	5.7	P-10
H-18	TRUE	2,000	2,000	2,001	101.5	5.7	P-10
H-19	FALSE	2,000	2,000	1,092	75.6	10.0	P-167
H-20	FALSE	2,000	2,000	983	88.1	10.0	P-167
H-21	FALSE	2,000	2,000	1,167	60.3	10.0	P-167
H-22	FALSE	2,000	2,000	1,302	39.4	10.0	P-167
H-23	FALSE	2,000	2,000	1,420	20.0	9.4	P-167
H-24	FALSE	2,000	2,000	769	65.9	10.0	P-148
H-25	FALSE	2,000	2,000	1,440	24.1	10.0	P-14
H-26	FALSE	2,000	2,000	1,309	46.5	10.0	P-14
H-27	FALSE	2,000	2,000	1,192	60.4	10.0	P-14
H-28	FALSE	2,000	2,000	1,074	78.3	10.0	P-14
H-29	FALSE	2,000	2,000	1,100	92.5	10.0	P-13
H-30	FALSE	2,000	2,000	1,448	78.3	10.0	P-13
H-31	FALSE	2,000	2,000	1,508	71.2	10.0	P-153

Legend

Scenario: Maximum Daily + Fire Flow

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Fire Flow							
Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (gpm)	Flow (Total Needed) (gpm)	Flow (Total Available) (gpm)	Pressure (Calculated Residual) (psi)	Velocity of Maximum Pipe (ft/s)	Pipe w/ Maximum Velocity
J-39	TRUE	2,000.00	2,000.00	2,001.00	112.3	4.05	P-22
J-40	TRUE	2,000.00	2,000.00	2,001.00	115.6	4.05	P-22
J-41	TRUE	2,000.00	2,000.00	2,001.00	125.8	4.36	P-22
J-42	TRUE	2,000.00	2,246.30	2,247.30	106.6	4.13	P-22
J-43	TRUE	2,000.00	2,000.00	2,001.00	124.3	4.02	P-22
J-44	TRUE	2,000.00	2,000.00	2,001.00	126.7	3.96	P-22
J-45	TRUE	2,000.00	2,000.00	2,001.00	117.8	4.05	P-22
J-46	TRUE	2,000.00	2,000.00	2,001.00	105.9	5.49	P-10
J-47	TRUE	2,000.00	2,000.00	2,001.00	107.3	5.56	P-10
J-48	TRUE	2,000.00	2,000.00	2,001.00	107.6	5.61	P-10
J-49	TRUE	2,000.00	2,000.00	2,001.00	103.1	9.59	P-59
J-50	TRUE	2,000.00	2,000.00	2,001.00	99.2	7.17	P-59
J-51	TRUE	2,000.00	2,000.00	2,001.00	98.3	7.6	P-63
J-52	FALSE	2,000.00	2,000.00	1,556.54	100.7	10	P-67
J-53	FALSE	2,000.00	2,000.00	1,086.79	101	10	P-70
J-54	TRUE	2,000.00	2,000.00	2,001.00	100.8	5.71	P-10
J-55	TRUE	2,000.00	2,000.00	2,001.00	102.4	5.7	P-10
J-56	TRUE	2,000.00	2,001.86	2,002.86	103.7	5.7	P-10
J-57	TRUE	2,000.00	2,012.68	2,013.68	105.6	5.72	P-10
J-58	TRUE	2,000.00	2,029.84	2,030.84	105.2	5.74	P-10
J-59	TRUE	2,000.00	2,017.16	2,018.16	107.2	5.77	P-10
J-76	TRUE	2,000.00	2,005.00	2,006.00	109.2	5.85	P-113
J-77	TRUE	2,000.00	2,000.00	2,001.00	112	5.7	P-10
J-78	TRUE	2,000.00	2,000.00	2,001.00	109.6	5.69	P-10
J-79	TRUE	2,000.00	2,015.18	2,016.18	108.8	5.68	P-10
J-80	TRUE	2,000.00	2,002.47	2,003.47	107.4	5.67	P-10
J-81	TRUE	2,000.00	2,027.47	2,028.47	110.6	5.85	P-113
J-82	TRUE	2,000.00	2,028.04	2,029.04	102.3	7.51	P-119
J-83	TRUE	2,000.00	2,033.08	2,034.08	111.4	5.69	P-10
J-84	TRUE	2,000.00	2,000.00	2,001.00	105.2	5.68	P-125
J-85	TRUE	2,000.00	2,004.48	2,005.48	106.6	5.65	P-10

Legend

Scenario: Maximum Daily + Fire Flow

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Fire Flow							
Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (gpm)	Flow (Total Needed) (gpm)	Flow (Total Available) (gpm)	Pressure (Calculated Residual) (psi)	Velocity of Maximum Pipe (ft/s)	Pipe w/ Maximum Velocity
J-8	TRUE	2,000	2,008	2,009	117.3	4.8	P-22
J-9	TRUE	2,000	2,000	2,001	117.2	4.7	P-22
J-10	FALSE	2,000	2,000	1,480	20.9	4.5	P-10
J-11	TRUE	2,000	2,000	2,001	73.3	4.9	P-105
J-12	TRUE	2,000	2,000	2,001	112.8	5.7	P-10
J-13	TRUE	2,000	2,031	2,032	103.9	7.6	P-10
J-14	TRUE	2,000	2,011	2,012	116.1	4.8	P-138
J-15	FALSE	2,000	2,004	1,711	68.9	10.0	P-13
J-16	FALSE	2,000	2,004	1,811	78.0	10.0	P-67
J-17	FALSE	2,000	2,000	881	57.9	10.0	P-18
J-18	FALSE	2,000	2,002	1,477	23.1	10.0	P-15
J-19	FALSE	2,000	2,102	871	66.4	10.0	P-148
J-20	FALSE	2,000	2,000	1,802	77.9	10.0	P-67
J-21	FALSE	2,000	2,000	1,685	90.3	10.0	P-67
J-22	FALSE	2,000	2,006	1,425	20.0	9.9	P-167
J-23	TRUE	2,000	2,222	2,223	111.1	4.8	P-138
J-24	TRUE	2,000	2,000	2,001	99.1	5.1	P-22
J-25	TRUE	2,000	2,174	2,175	77.2	5.1	P-22
J-26	TRUE	2,000	2,169	2,170	126.2	4.6	P-22
J-27	TRUE	2,000	2,148	2,149	128.4	4.4	P-22
J-28	TRUE	2,000	2,104	2,105	129.2	4.3	P-22
J-29	TRUE	2,000	2,000	2,001	129.2	4.3	P-22
J-30	TRUE	2,000	2,159	2,160	89.2	4.3	P-22
J-31	TRUE	2,000	2,000	2,001	130.5	4.1	P-22
J-32	TRUE	2,000	2,137	2,138	129.7	4.1	P-22
J-33	TRUE	2,000	2,020	2,021	130.5	4.0	P-22
J-34	TRUE	2,000.00	2,000.00	2,001.00	130.8	4	P-22
J-35	TRUE	2,000.00	2,000.00	2,001.00	131.2	3.94	P-22
J-36	TRUE	2,000.00	2,000.00	2,001.00	127.2	3.96	P-22
J-37	TRUE	2,000.00	2,000.90	2,001.90	64.3	3.96	P-22
J-38	TRUE	2,000.00	2,445.05	2,446.05	82.7	3.99	P-22

Legend

Scenario: Maximum Daily + Fire Flow

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Fire Flow							
Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (gpm)	Flow (Total Needed) (gpm)	Flow (Total Available) (gpm)	Pressure (Calculated Residual) (psi)	Velocity of Maximum Pipe (ft/s)	Pipe w/ Maximum Velocity
J-117	TRUE	2,000.00	2,000.00	2,001.00	108.8	5.85	P-113
J-118	TRUE	2,000.00	2,000.00	2,001.00	109.8	5.7	P-10
J-119	TRUE	2,000.00	2,012.99	2,013.99	107.6	5.78	P-10
J-120	TRUE	2,000.00	2,029.58	2,030.58	102.1	8.09	P-117
J-121	TRUE	2,000.00	2,016.85	2,017.86	103.5	6.58	P-191
J-122	TRUE	2,000.00	2,013.41	2,014.41	106.5	8.25	P-189
J-123	TRUE	2,000.00	2,009.16	2,010.16	110.4	5.7	P-10
J-124	TRUE	2,000.00	2,014.37	2,015.38	111.3	5.69	P-10
J-125	TRUE	2,000.00	2,000.00	2,001.00	109.2	5.68	P-10
J-126	TRUE	2,000.00	2,011.21	2,012.21	103.1	8	P-192
J-127	TRUE	2,000.00	2,011.21	2,012.21	102.8	7.13	P-10
J-128	TRUE	2,000.00	2,000.00	2,001.00	110.6	5.7	P-10

Legend

Scenario: Maximum Daily + Fire Flow

Existing water system outside the limits of the proposed Makalapua Project District

Makalapua Project District
Waterline Sizing Calculations

Fire Flow							
Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (gpm)	Flow (Total Needed) (gpm)	Flow (Total Available) (gpm)	Pressure (Calculated Residual) (psi)	Velocity of Maximum Pipe (ft/s)	Pipe w/ Maximum Velocity
J-86	TRUE	2,000.00	2,000.00	2,001.00	111.2	5.7	P-10
J-87	TRUE	2,000.00	2,000.00	2,001.00	111.6	5.7	P-10
J-88	TRUE	2,000.00	2,000.00	2,001.00	109.5	5.7	P-10
J-89	FALSE	2,000.00	2,000.00	1,735.12	98.3	10	P-135
J-90	TRUE	2,000.00	2,000.00	2,001.00	115	5.06	P-137
J-91	TRUE	2,000.00	2,023.63	2,024.63	101	5.7	P-10
J-92	FALSE	2,000.00	2,010.75	993.48	89.8	10	P-167
J-93	FALSE	2,000.00	2,007.14	1,098.38	76.3	10	P-167
J-94	FALSE	2,000.00	2,006.88	1,173.81	62.8	10	P-167
J-95	FALSE	2,000.00	2,010.21	1,312.23	40.5	10	P-167
J-96	FALSE	2,000.00	2,005.01	1,477.66	20	9.73	P-167
J-97	FALSE	2,000.00	2,010.61	779.20	62.4	10	P-148
J-98	FALSE	2,000.00	2,009.22	1,449.45	28	10	P-14
J-99	FALSE	2,000.00	2,019.85	1,328.69	47.8	10	P-14
J-100	FALSE	2,000.00	2,010.63	1,202.59	63.1	10	P-14
J-101	FALSE	2,000.00	2,000.00	1,073.94	79	10	P-14
J-102	FALSE	2,000.00	2,010.49	1,110.73	94.7	10	P-13
J-103	FALSE	2,000.00	2,014.66	1,462.52	79.6	10	P-13
J-104	FALSE	2,000.00	2,016.88	1,524.42	75.3	10	P-153
J-105	FALSE	2,000.00	2,022.89	1,636.97	69.9	10	P-158
J-106	FALSE	2,000.00	2,013.51	1,361.66	86	10	P-158
J-107	FALSE	2,000.00	2,014.81	1,012.78	111.8	10	P-158
J-108	FALSE	2,000.00	2,014.43	1,494.69	84.5	10	P-9
J-109	FALSE	2,000.00	2,008.44	55.08	83.4	10	P-175
J-110	FALSE	2,000.00	2,013.95	1,453.08	87.7	10	P-9
J-111	FALSE	2,000.00	2,003.79	1,261.63	103.2	10	P-9
J-112	FALSE	2,000.00	2,010.85	1,757.51	105.9	10	P-11
J-113	FALSE	2,000.00	2,011.89	1,217.14	97	10	P-158
J-114	FALSE	2,000.00	2,012.39	1,658.67	73.3	10	P-9
J-115	FALSE	2,000.00	2,000.00	881.28	86.9	10	P-181
J-116	TRUE	2,000.00	2,027.47	2,028.47	108.6	5.85	P-113

Legend

Scenario: Maximum Daily + Fire Flow

Existing water system outside the limits of the proposed Makalapua Project District

Electrical Calculations

APPENDIX D

Makalapua Project District
Infrastructure Report

Makalapua Power Projection
for Lili'uokalani Trust

Date: 14 August 2024

Phase	Development Block (Parcel)	Anticipated Completion	Residential Unit Count	Retail [SF]	Restaurant [SF]	Light Industrial [SF]	Diverse Load per Unit Estimate					Diverse Peak Load (kVA) Estimate				
							Residential kVA Per Unit	Common Area kVA Load	Retail VA per SF	Restauarant VA per SF	Light Industrial VA per SF	Residential Load	Retail Load	Restaurant Load	Light Industrial Load	Total
PHASE 1	Grocery (G1)		-	35,000	-	-	5	3	5	11	5	-	175	-	-	175
	Medical Office (G1)		-	-	-	13,050	5	3	5	11	5	-	-	-	65	65
	Retail (G1)		-	5,160	-	-	5	3	5	11	5	-	26	-	-	26
	Office (G2)		-	-	-	14,850	5	3	5	11	5	-	-	-	74	74
	Retail (G2)		-	7,560	-	-	5	3	5	11	5	-	38	-	-	38
	Commercial (K1)		-	-	-	14,400	5	3	5	11	5	-	-	-	72	72
	Industrial Flex (K2)		-	-	-	18,700	5	3	5	11	5	-	-	-	94	94
	Phase 1 Totals		**-**	**47,720**	**-**	**61,000**	**5**	**3**	**5**	**11**	**5**	**-**	**239**	**-**	**305**	**544**
PHASE 2A	Commercial (P1)		-	-	-	21,250	5	3	5	11	5	-	-	-	106	106
	Commercial (P2)		-	-	-	18,700	5	3	5	11	5	-	-	-	94	94
	Commercial (P3)		-	-	-	18,700	5	3	5	11	5	-	-	-	94	94
	Hotel (P3)		75	-	-	-	5	3	5	11	5	600	-	-	-	600
	Retail (P4)		-	2,100	-	-	5	3	5	11	5	-	11	-	-	11
	Phase 2A Totals		**75**	**2,100**	**-**	**58,650**	**5**	**3**	**5**	**11**	**5**	**600**	**11**	**-**	**293**	**904**
PHASE 2B	Loft (P5)		33	-	-	-	5	3	5	11	5	264	-	-	-	264
	Retail (P5)		-	10,000	-	-	5	3	5	11	5	-	50	-	-	50
	Loft (P5)		26	-	-	-	5	3	5	11	5	208	-	-	-	208
	Retail (P5)		-	12,000	-	-	5	3	5	11	5	-	60	-	-	60
	Hotel (P5)		75	-	-	-	5	3	5	11	5	600	-	-	-	600
	Loft (M1)		12	-	-	-	5	3	5	11	5	96	-	-	-	96
	Retail (M1)		-	7,400	-	-	5	3	5	11	5	-	37	-	-	37
	Loft (M1)		47	-	-	-	5	3	5	11	5	376	-	-	-	376
	Retail (M1)		-	12,000	-	-	5	3	5	11	5	-	60	-	-	60
	3-Story Flat (M1)		50	-	-	-	5	3	5	11	5	400	-	-	-	400
	Phase 2B Totals		**243**	**41,400**	**-**	**-**	**5**	**3**	**5**	**11**	**5**	**1,944**	**207**	**-**	**-**	**2,151**
PHASE 2C	3-Story Flat (G3)		61	-	-	-	5	3	5	11	5	488	-	-	-	488
	3-Story Flat (M2)		81	-	-	-	5	3	5	11	5	648	-	-	-	648
	3-Story Flat (M2)		38	-	-	-	5	3	5	11	5	304	-	-	-	304
	Phase 2C Totals		**180**	**-**	**-**	**-**	**5**	**3**	**5**	**11**	**5**	**1,440**	**-**	**-**	**-**	**1,440**
PHASE 3	Courtyard Homes (R4)		32	-	-	-	5	3	5	11	5	256	-	-	-	256
	Cottage (R4)		12	-	-	-	5	3	5	11	5	96	-	-	-	96
	3-Story Flat (R4)		69	-	-	-	5	3	5	11	5	552	-	-	-	552
	Phase 3 Totals		**113**	**-**	**-**	**-**	**5**	**3**	**5**	**11**	**5**	**904**	**-**	**-**	**-**	**904**
PHASE 4	Cottage (R5)		6	-	-	-	5	3	5	11	5	48	-	-	-	48
	Courtyard Homes (R5)		6	-	-	-	5	3	5	11	5	48	-	-	-	48
	Cottage (R5)		44	-	-	-	5	3	5	11	5	352	-	-	-	352
	3-Story Flat (R5)		83	-	-	-	5	3	5	11	5	664	-	-	-	664
	Commerical (R5)		-	-	-	10,000	5	3	5	11	5	-	-	-	50	50
	Phase 4 Totals		**139**	**-**	**-**	**10,000**	**5**	**3**	**5**	**11**	**5**	**1,112**	**-**	**-**	**50**	**1,162**
Re-Development Totals			**750**	**91,220**	**-**	**129,650**	**5**	**3**	**5**	**11**	**5**	**6,000**	**456**	**-**	**648**	**7,104**

APPENDIX

C

FLORA AND FAUNA SURVEY

A Flora and Fauna Survey for the Makalapua Project District TMKs :(3)7-4-008:002 (por.), (3)7-4-010:009, 010, and (3)7-4-025:001, 002, 003, 005, 015, and 021

LeGrande Biological Surveys Inc
4348 Waialae Ave 940
Honolulu HI 96816

Prepared by: Maya L. LeGrande and Reginald David

Prepared for: Lili'uokalani Trust

June 28, 2023

Introduction

The Lili'uokalani Trust (LT) is proposing development, enhancement, and refinement of approximately 68 acres of land in Kailua-Kona on the island of Hawai'i. The Project Area (PA), known as the Makalapua Project District (see figure 1) is located in North Kona, makai of the Kona Commons Shopping Center. The PA is located within the Keahuolū ahupua'a on land owned by LT and includes TMKs :(3)7-4-008:002 (por.), (3)7-4-010:009, 010, and (3)7-4-025:001, 002, 003, 005, 015, and 021. A flora and fauna survey that included the same PA was carried out by Robert Hobdy in 2015 (Hobdy 2015).

Site Description

The PA is divided into a few distinct parcels including lots that have been cleared and covered in gravel. These lots are located to the east of Loloku Street, mauka and makai of Ma'a Way. A few parcels that reach to Kaiwi Street are currently occupied by warehouse buildings for automobile repair. Two larger parcels are located to the west; one between Loloku Street and Makala Blvd. and the other to the west of Makala Blvd. (Fig. 1). Soils are classified as Pahoehoe Lava Flow (rLW) for the entirety of the PA (NRCS, 2023).

Methods

Botanical Survey

Maya LeGrande surveyed the PA on June 10, 2023. Plant species were identified as they were encountered during transects and along boundaries. Notes were made on plant associations and distribution, disturbances, topography, substrate type, exposure, and drainage. Species names follow: *Manual of the Flowering Plants of Hawai'i* (Wagner, Herbst, & Sohmer, 1990; Wagner & Herbst, 1999) for native and naturalized flowering plants, *Hawai'i's Ferns and Fern Allies* (Palmer, 2003) and *Taxonomic and Nomenclatural Updates to the Fern and Lycophyte Flora of the Hawaiian Islands* (Ranker et al, 2019) for ferns, and *A Tropical Garden Flora* (Staples & Herbst, 2005) for ornamental plants. More recent name changes for naturalized plant species follow Imada (2019). A full plant species list is provided in Table 1.

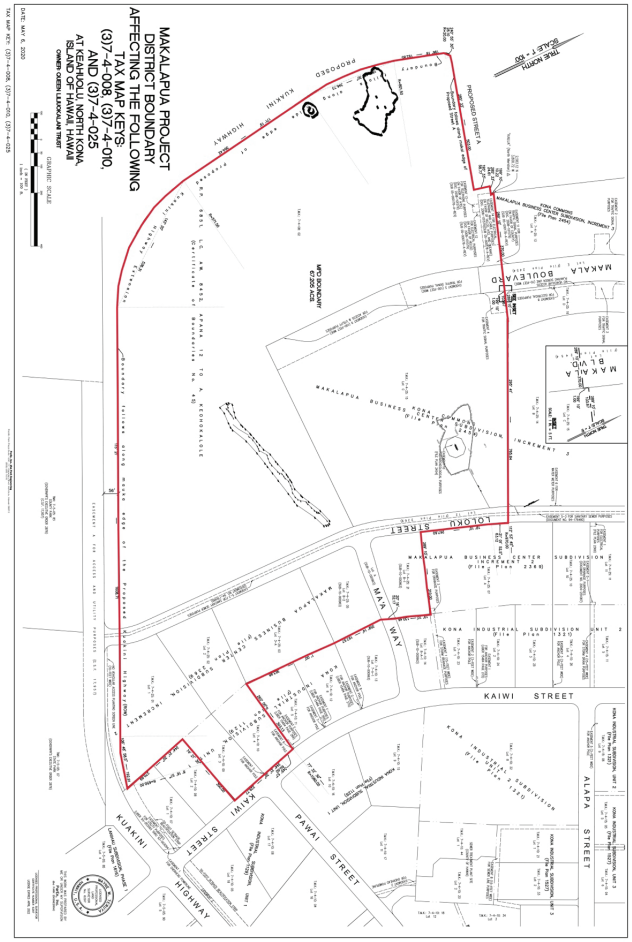


Figure 1. Project Area (PA) outlined in red. All parcels within the PA were included in the flora and fauna surveys.

Figure 2. Shrubby vegetation with fountain grass, ʻuhaloa, maiapilo, Christmas berry, and noni.

Figure 3. Exisiting dirt access road in parcel to the west of Makala Blvd. leading from the old golf range.

Terrestrial Vertebrates Survey

Avian Survey

A bird survey was conducted by Reginald David in the morning hours on June 10, 2023. Birds were identified by visual observations aided by Leica 8 X 42 binoculars, and by listening for vocalizations. Five eight-minute avian point-count stations were sighted approximately equidistant from each other across the PA. A single eight-minute point count was made at each of the five stations. Weather conditions were ideal with unlimited visibility, no precipitation, and winds between 1 and 5 kilometers per hour. The avian phylogenetic order and nomenclature used in this report follows the AOU *Check-List of North and Middle American Birds* 2021, and the 63rd supplement to the checklist (Chesser et al., 2021, 2022).

Mammalian Survey

A list was made of mammals encountered during the survey. Indicators of mammalian presence, such as tracks, scat, and additional signs were noted. Mammalian phylogenetic order and nomenclature follow *Mammal Species of the World* (Wilson and Reeder, 2005).

Results

Vegetation

The PA consists of several distinct parcels. The parcels that lie to the east of Loloku Street have all been graded and have a top layer of gravel with sparse vegetation or are occupied by warehouses and active businesses. The remaining 2 parcels are located to the west of Loloku Street and one west of Makala Blvd. The vegetation on both of these larger parcels are characterized by an open grassland dominated by fountain grass (*Cenchrus setaceus*) with scattered kiawe (*Prosopis pallida*) and ironwood (*Casuarina equisetifolia*) trees.

Flora

The entire PA is dominated by naturalized non-native species. A total of 59 plant species were documented with one endemic, six indigenous, and one Polynesian introduction. The lone endemic is maiapilo (*Capparis sandwichiana*), a native of the caper family. We noted at least 14 individuals and mapped 12 plant locations (Fig.6). The indigenous species were all rarely or uncommonly observed except the ubiquitous ʻuhaloa (*Waltheria indica*) which was abundant throughout the project area. The remaining five indigenous species uncommonly seen were kou (*Cordia subcordata*), naupaka kahakai (*Scaevola taccada*), ʻilima (*Sida fallax*), milo (*Thespesia populnea*), and alahe'e (*Psydrax odorata*). The Polynesian introduced noni (*Morinda citrifolia*) was observed uncommonly scattered throughout the two large parcels. The following is a list of all plant species observed during the June 2023 survey.

Table 1. Plant species observed at the Makalapua Project District PA

Scientific Name	Common Name	Status
Pteridophytes		
Ferns and fern allies		
NEPHROLEPIDACEAE		
Nephrolepis brownii (Desv.) Hovenkamp & Miyam.		Nat
Monocotyledons		
ARECACEAE		
Pritchardia pacifica Seeman & Wendl.	Fiji fan palm	Nat
COMMELINACEAE		
Commelina diffusa N. L. Burm.	day flower	Nat
CYPERACEAE		
Cyperus gracilis R.Br.	McCoy grass	Nat
POACEAE		
Bothriochloa pertusa (L.) A.Camus	pitted beardgrass	Nat
Cenchrus ciliaris L.	buffelgrass	Nat
Cenchrus echinatus L.	common sandbur	Nat
Cenchrus setaceus (Forssk.) Morrone	fountain grass	Nat
Chloris barbata (L.) Sw.	swollen finger-grass	Nat
Cynodon dactylon (L.) Pers.	Bermuda grass	Nat
Melinis repens (Willd.) Zizka	Natal redtop	Nat
Dicotyledons		
ACANTHACEAE		
Asystacia gangetica subsp. T.Anderson *gangetica*	Chinese violet	Nat
AMARANTHACEAE		
Amaranthus spinosus L.	spiny amaranth	Nat
ANACARDIACEAE		
Schinus terebinthifolius Raddi	Christmas berry	Nat
APOCYNACEAE		
Asclepias physocarpa (E.May.) Schltr.	balloon plant	Nat
Catharanthus roseus G.Don	Madagascar periwinkle	Nat

Plumeria obtusa L.	Singapore plumeria	Orn
Stapelia gigantea N.E.Br.	Zulu giant	Nat
Thevetia peruviana (Pers.) K.Schum.	be-still-flower	Nat
ASTERACEAE		
Pluchea carolinensis (Jacq.) G. Don	sourbush	Nat
Tridax procumbens L.	coat buttons	Nat
BORAGINACEAE		
Cordia subcordata Lam.	kou	**Ind**
CAPPARACEAE		
Capparis sandwichiana DC.	maiapilo, pua pilo	**End**
CASUARINACEAE		
*Casuarina equisetifolia*L.	ironwood	Nat
CACTACEAE		
Hylocereus undatus (Haworth)Britton&Rose	night-blooming cereus	Nat
CLUSIACEAE		
Clusia rosea Jacq.	autograph tree	Nat
EUPHORBIACEAE		
Euphorbia hirta L.	garden spurge	Nat
Euphorbia thymifolia L.	thyme-leaved spurge	Nat
FABACEAE		
Chamaecrista nictitans (L.) Moench	partridge pea	Nat
Crotalaria pallida Aiton	smooth rattlepod	Nat
Delonix regia (Bojer) Raf.	royal poinciana	Nat
Desmanthus pernambucanus (L.)Thellung	slender mimosa	Nat
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	Nat
Indigofera suffruticosa Mill.	iniko	Nat
Leucaena leucocephala (Lam.) de Wit	koa haole	Nat
Pithecellobium dulce (Roxb.) Benth.	opiuma	Nat
Prosopis pallida Kunth	kiawe	Nat
Samanea saman (Jacq.) Merr.	monkeypod	Nat
Vachellia farnesiana (L.) Wight &Arnott	klu	Nat
GOODENIACEAE		
Scaevola taccada (Gaertn.) Roxb.	naupaka kahakai	**Ind**
MALVACEAE		
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	Nat
Melochia umbellata (Houtt.) Stapf	---	Nat
Sida ciliaris L.	red-flowered sida	Nat
Sida fallax Walp.	ʻilima	**Ind**
Sida spinosa L.	prickly sida	Nat
Thespesia populnea (L.) Sol.ex Correa	milo	**Ind**
Waltheria indica L.	ʻuhaloa	**Ind**
MOLLUGINACEAE		
Mollugo cerviana (L.) Ser.	threadstem carpetweed	Nat
MORACEAE		
Ficus microcarpa L. fil.	Chinese banyan	Nat
NYCTAGINACEAE		
Boerhavia coccinea Mill.	scarlet spiderling	Nat
Bougainvillea spectabilis Willd.	bougainvillea	Nat
PETIVERIACEAE		
Rivina humilis L.	coral berry	Nat
POLYGONACEAE		
Coccoloba uvifera (L.) L.	sea grape	Nat
PORTULACACEAE		
Portulaca pilosa L.	ʻakulikuli	Nat
RUBIACEAE		
Morinda citrifolia L.	*noni*	**Pol**
Psydrax odorata (G.Forst) Smith&Darwin	alaheʻe	**Ind**
Richardia brasiliensis Gomes		Nat
TILANICEAE		
Talinum fruticosum (L.) Juss.	fameflower	Nat
VERBENACEAE		
Lantana camara L.	lantana	Nat

Legend to Table 1

STATUS = distributional status for the Hawaiian Islands:

End= endemic; native to Hawaiʻi and nowhere else in the world.

Ind = indigenous; native to Hawaiʻi, but not unique to the Hawaiian Islands.

Nat = naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.

Orn = A cultivated plant; a species not known to be naturalized (spreading on its own) in Hawaiʻi.

Pol = An early Polynesian introduction, introduced before 1778.

Figure 4. Historic trail located on the middle parcel between Makala Blvd. and Loloku Street with cleared vegetation. Fountain grass, koa haole, and klu at edges of cleared area. ʻuhaloa is scattered on trail.

Avian Fauna

A total of 171 individual birds of 17 species, representing 11 separate families, was recorded during the station count (Table 2). No additional species were recorded while transiting the site between survey points.

Avian diversity and densities were in keeping with the location and vegetation present within the study site. Three species—Common Myna (*Acridotheris tristis)*, House Finch (*Haemorhous mexica*nus) and Zebra Dove (*Geopelia striata*) — accounted for 46% of all birds recorded during station counts. The most frequently recorded species was Common Myna, accounting for 22% of the total number of individual birds recorded.

Table 2. Avian species detected for the Makalapua Project District PA

Common Name	Species	Status	RA
	Order Family		
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Ortygornis pondicerianus*	A	0.20
Red Junglefowl	*Gallus gallus*	A	0.60
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	0.20
Zebra Dove	*Geopelia striata*	A	3.80
	PELECANIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	0.60
Black-crowned Night-Heron	*Nycticorax nycticorax hoactli*	IR	0.40
	PSITTACIFORMES		
	PSITTACULIDAE - Lories, Lovebirds, and Indomalayan and Papua-Australasian Parrots		
Rose-ringed parakeet	*Psittacula krameri*	A	0.80
	ZOSTEROPIDAE - White-eyes		
Warbling White-eye	*Zosterops japonicus*	A	3.00
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	7.60
	ESTRILDIDAE - Estrildid Finches		
African Silverbill	*Euodice cantans*	A	0.40
Common Waxbill	*Estrilda astrild*	A	0.60
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	A	2.00
	FRINGILLIDAE - Fringilline and Carduline Finches & Allies		
	Carduelinae - Carduline Finches and Hawaiian Honeycreepers		
House Finch	*Haemorhous mexicanus*	A	4.40
Yellow-fronted Canary	*Ceithagra mozambica*	A	2.00
	CARDINALIDAE - Cardinals & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.20
	THRAUPIDAE - Tanagers		
	Thraupinae - Core Tanagers		
Saffron Finch	*Sicalis flaveola*	A	3.40

Legend to Table 1

Status

A Alien – introduced by humans, naturalized

RA Relative Abundance-number of individuals counted divide by the number of station n~5

Mammalian Fauna

Four terrestrial mammalian species were detected during this survey. We heard several dogs (*Canis lupus familiaris*), barking from outside the site. We saw, heard numerous small Asian mongoose (*Herpestes javanicus),* and at least five cats (*Felis catus*) were seen as were tracks, scat of both species. Several horses (*Equus caballus*) were heard and seen on the road makai of the site (The annual King Kamehameha Day Celebration Parade was in progress and participants start at the Old Kona Airport State Recreation Area along Kuakini Hwy. which is south of the PA). We did not record ʻōpeʻapeʻa – the endemic Hawaiian hoary bat (*Lasiurus cinereus semotus*), currently recognized as an endemic species *Lasiurus semotus* (Pinzari et al. 2020) during this survey, nor were any detected during the 2015 survey of the parcel that became the Swing Zone driving range (Hobdy, 2015).

Discussion and Recommendations

The plant and animal species extant on the PA are dominated by non-native species, nevertheless, several recommedations are included in the following discussion.

Floral Resources

Native plant habitat within the proposed project area has been modified by human activities and invasive non-native plant species, namely fountain grass, dominates the lava substrate. Seven native species were documented at the site, *maiapilo, kou, naupaka kahakai, ʻilima, milo, ʻuhaloa,* and *alaheʻe*. Although none of the plant species observed are listed as endangered or threatened under either the federal or State of Hawaiʻi endangered species statutes (HDLNR, 1998; USFWS, nd-a), *maiapilo* is quickly becoming rare and has been listed as Vulnerable (VU) by the International Union for Conservation of Nature (IUCN). This beautiful endemic Hawaiian caper species is threatened by non-native plants, goats, rats, fire, sea-level rise, and coastal development. LT could possibly incorporate the preservation of this species into their outdoor curriculum by utilizing surrounding undeveloped habitat in the region as outplanting sites for *maiapilo*. Including students and caretakers in the process of collecting *maiapilo* propagules (seeds and cuttings) from plants planned for removal for any future projects in the area and rearing them for outplanting in either landscaping or natural areas would be beneficial for both the species continuation and the the students knowledge.

Figure 5. A large maiapilo in flower at the corner of Makala Blvd. at the mauka extent of the PA.

Figure 6. Green markers showing locations of maiapilo plants within the PA.

The following are recommended propagation techniques for *maiapilo* from the College of Tropical Agriculture and Human Resources, University of Hawai'i at Mānoa:

Propagation by Seeds
The fruit of *Capparis sandwichiana* is an oval orange berry about 1 1/2 inch long. The small reddish-brown seeds are embedded in the smelly orange fruit pulp. Boche and Moss recommend collecting the fruit before it is completely ripened in order to avoid insect damage. Green fruits that are almost mature can be ripened in a sealed plastic bag. The fruits will become orange when they are ripe which takes about 7 to 10 days. Remove the seeds from the soft, ripe fruit by mashing them by hand in a bowl of water. Pour off the pulp and any seeds that float. Boche recommends planting the seeds as soon as they are removed from the fruit. Plant the seeds in a well-drained mix such as 3 parts perlite to 1 part sand or sterile potting mix. Mature seeds germinate readily. In his germination studies, Obata found that untreated seeds of *Capparis sandwichiana* had germination rates ranging from 30 to 75%. Lilleeng-Rosenberger obtained a germination rate of 70% when fresh seeds were soaked in cold water for 4 days. (Boche 1994; Lilleeng-Rosenberger 1996; NTBG 1994; Obata 1967)
Propagation by Cuttings
Mew reported that he had success using cuttings in a planting mixture of 1 part peat moss to 1 part perlite. Boche recommends using root cuttings planted in 100% red cinder; after sprouting, these should be transplanted to a medium consisting of 1-part black cinder and 1 part compost. (Boche 1994; Mew 1987)

No other listed plant species and none of the five Threatened and Endangered plant species listed by the USFWS Information for Planning and Consultation (IPaC) were observed during our survey of the PA. They are; Carter's Panicgrass (*Panicum faurei* var. *carteri*), 'ihi (*Portulaca villosa*), ko'oko'olau (*Bidens micrantha* ssp. *ctenophylla*), loulu (*Pritchardia maideniana*), and 'ohai (*Sesbania tomentosa*) (USFWS, 2023).

Several native species observed during Hobdy's 2015 survey were not relocated during this survey including the endemic pā'ūohi'iaka (*Jacquemontia ovalifolia* subsp. *sandwicensis*), the indigenous naio (*Myoporum sandwicense*), and two Polynesian introductions- kamani (*Calophyllum inophyllum*) and hau (*Hibiscus tiliaceus*).

Avian Resources

Recommendations are partly based on U.S. Fish and Wildlife Service, Animal Avoidance and Minimization Measures (USFWS-PIFWO, 2022). Implementation of the recommendations (provided below as bulleted items) by the Project contractor will minimize potential impacts to listed species to the maximum extent practicable.

All avian species detected are alien to the Hawaiian Islands. No native species were detected nor expected given the habitats present within the PA, and its location (HDLNR, 1998; USFWS, nd-a).

No listed faunal species and none of the 11 Threatened and Endangered faunal species listed by the USFWS Information for Planning and Consultation (IPaC) were observed during our survey of the PA. They are; Hawaiian hoary bat, Band-rumped Storm-Petrel (*Hydrobates* castro)[1], Hawaiian Duck (*Anas wyvilliana*), Hawaiian Coot (*Fulica alai*), Hawaiian Goose (*Branta sandvicensis*), Hawaiian Petrel (*Pretodroma sandwichensis*), the endemic subspecies of the Black-necked Stilt (*Himantopus mexicanus knudseni*). Newell's Shearwater (*Puffinus n*ewelli), Short-tailed Albatross (*Phoebastria albatrus*). Green sea turtle (*Chelonia mydas*), and Blackburn's Sphinx moth (*Manduca blackburni*).

Seabirds

It is possible that the endangered Hawaiian Petrel, Band-rumped Storm-Petrel, and the threatened Newell's Shearwater over-fly the PA between April and the middle of December each year in small numbers. The primary cause of mortality in Hawaiian Petrels, Newell's Shearwaters and Band-rumped Storm-Petrels in Hawai'i is thought to be predation by alien mammalian species at the nesting colonies (USFWS, 1983; Simons and Hodges, 1998; Ainley et al., 2001). Collision with man-made structures is considered the second most significant cause of mortality of these seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. Disoriented seabirds may collide with man-made structures and, if not killed outright, become easy targets of opportunity for feral mammals (Hadley, 1961; Telfer, 1979; Sincock, 1981; Reed et al., 1985; Telfer et al., 1987; Cooper and Day, 1998; Podolsky et al., 1998; Ainley et al., 2001; Hue et al., 2001; Day et al., 2003). No suitable nesting habitat exists within or close to the PA for any of these three seabird species.

The principal potential impact that changes to the current habitat of the PA poses to protected seabirds is an increased threat that birds will be downed after becoming disoriented by lights. The two ways outdoor lighting can pose a threat to nocturnally flying seabirds is if: 1) during construction it is deemed expedient or necessary to

[1] In this report we use the most current names for all faunal species, bird names follow: AOU Check-List of North and Middle American Birds 2021, and the 63rd supplement to the checklist (Chesser et al., 2021, 2022), Mammals follow Mammal Species of the World (Wilson and Reeder, 2005).

conduct night-time construction activities; or, 2) following build-out, security lighting is operated during the seabird nesting season.

- If night-time construction activity or equipment maintenance is proposed during any construction phases of the project, all associated lights should be shielded, and when large flood/work lights are used, they should be placed on poles that are high enough to allow the lights to be pointed directly at the ground (Reed et al., 1985; Tellfer et al., 1987). Deleterious impacts to transiting seabirds can be avoided if construction occurs during daylight hours and all outdoor lighting installed is fully "dark sky compliant" (HDLNR-DOFAW, 2016). DLNR recommends avoiding construction-related night-time lighting between September 15 and December 15 (DLNR, 2016).

Mammalian Resources

The findings of the mammalian survey are consistent with the location of the property and habitats present on the site. Although no rodents were recorded it is likely that some of the four established Muridae found on Hawai'i Island—roof rat (*Rattus rattus*), brown rat (*Rattus norvegicus*), Polynesian rat (*Rattus exulans hawaiiensis*), and European house mouse (*Mus musculus domesticus*) use resources within the general PA on a seasonal basis. These introduced rodents are deleterious to native ecosystems and native faunal species.

No mammalian species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs were detected during this survey (DLNR, 2015; USFWS, nd-a).

Hawaiian hoary bat

It is probable that the Hawaiian hoary bat overflies the PA on a seasonal basis as they are regularly recorded in the greater Kona area (David, 2023). The removal of trees within the PA could temporarily displace individual bats using the trees for roosting. As bats use multiple roosts within their home territories, the potential disturbance resulting from the removal of the vegetation is likely to be minimal. However, during the pupping season, females carrying their pups may be less able to vacate a roost site if the tree is felled. Further, adult female bats sometimes leave their pups in the roost tree while they forage. Very small pups may be unable to flee a tree that is being felled.

- Potential adverse impacts from such disturbance can be avoided or minimized by not clearing woody vegetation taller than 4.6 m (15 ft) between June 1 and September 15, the period in which bats may have pups.

Other Resources of Potential Concern

Invertebrates

We made passive insect observations during the surveys. The only native insect observed was the indigenous globe skimmer (*Pantala flavescens*) dragonfly. 'Ilima flowers were monitored during mid-day to try to locate any native *Hyleus* spp. bee activity but none were observed. Tree tobacco (*Nicotiana glauca*) was also surveyed for, as the plants are the preferred host plant for the endangered Blackburn's Sphinx moth. Two tree tobacco plants were observed during the 2015 survey but none were located during the current survey of the PA.

Critical Habitat

No federally delineated Critical Habitat for any species occurs within the Project Area (USFWS, nd-b). There is no equivalent designation under State of Hawai'i endangered species statutes.

Wetlands/Riparian Habitat

No wetlands are delineated or previously mapped within the Project Area and no signs of wetlands or streams were noted during the current surveys.

References Cited

Ainley, D. G, R. Podolsky, L. Deforest, G. Spencer, and N. Nur. 2001. The Status and Population Trends of the Newell's Shearwater on Kaua'i: Insights from Modeling, in: Scott, J. M, S. Conant, and C. Van Riper III (editors) *Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A Vanishing Avifauna. Studies in Avian Biology No. 22*. Cooper's Ornithological Society, Allen Press, Lawrence, Kansas. Pp. 108-123.

Chesser, R. T., S. M. Billerman, K. J. Burns, C. Cicero, J. L. Dunn, B.E. Hernández-Baños, A. W. Kratter, I. J. Lovette, N. A. Mason, P. C. Rassmusen, J. V. Remsen Jr., D. F. Stotz, and K. Winker. 2021. Check-list of North American Birds. American Ornithological Society. Available online at URL: http://checklist.aou.org/taxa; last retrieved May 20, 2022.

Chesser, R. T., S. M. Billerman, K. J. Burns, C. Cicero, J. L. Dunn, B.E. Hernández-Baños, R. A. Jiménez, A. W. Kratter, N. A. Mason, P. C. Rassmusen, J. V. Remsen Jr., D. F. Stotz, and K. Winker. 2022. Sixty-third supplement to the American Ornithological Society's *Check-list of North American Birds*. Ornithology, Volume 138, 2022, pp. 1-13.

Cooper, B. A., and R. H. Day. 1998. Summer Behavior and Mortality of Dark-rumped Petrels and Newells' Shearwaters at Power Lines on Kauai. *Colonial Waterbirds*, 21 (1): 11-19.

David, R. E. 2023. Unpublished field notes – Hawai'i 1980 - 2023.

Day, R. H., B. Cooper, and T. C. Telfer. 2003. Decline of Townsend's (Newell's Shearwaters (*Puffinus auricularis newelli*) on Kauai, Hawaii. *The Auk,* 120: 669-679.

Frazier, A. G., Giambelluca, T. W., Diaz, H. F. and Needham, H. L. (2016), Comparison of geostatistical approaches to spatially interpolate month-year rainfall for the Hawaiian Islands. *Int. J. Climatol.*, 36(3), 1459-1470. doi: 10.1002/joc.4437

Hadley, T. H. 1961. Shearwater calamity on Kauai. '*Elepaio* 21: 60.

Hue, D., C. Glidden, J. Lippert, L. Schnell, J. MacIvor and J. Meisler. 2001. Habitat Use and Limiting Factors in a Population of Hawaiian Dark-rumped Petrels on Mauna Loa, Hawai'i. Pp. 234-242, in: Scott, J. M, S. Conant, and C. Van Riper III (eds), Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A Vanishing Avifauna. Studies in Avian Biology No. 22. Cooper's Ornithological Society, Allen Press, Lawrence, Kansas.

Hawaii Department of Land and Natural Resources (HDLNR). 1998. Indigenous Wildlife, Endangered and Threatened Wildlife And Plants, And Introduced Wild Birds. Department of Land and Natural Resources. State of Hawaii. Administrative Rule §13-134-1 through §13-134-10, dated March 02, 1998.

HDLNR. 2015. Hawai'i Administrative Rules, Title 13, Department of Land and Natural Resources, Subtitle 5 Forestry and Wildlife, Part 2 Wildlife, Chapter 124, Indigenous Wildlife, Endangered and Threatened Wildlife, Injurious Wildlife, Introduced Wild Birds, and Introduced Wildlife. February 27, 2015. 16 pp.

Hawai'i Department of Land and Natural Resources-Division of Forestry and Wildlife (HDLNR-DOFAW). 2016. Wildlife Lighting. PDF available at URL: http://dlnr.hawaii.gov/wildlife/files/2016/03/DOC439.pdf; last retrieved February 21, 2020.

Hobdy, Robert W. 2015. Flora and Fauna Survey Makalapua Project District, Kailua, North Kona, Hawaii. Prepared for Queen Liliuokanlani Trust.

Imada, C. T. 2019. Hawaiian Naturalized Vascular Plants Checklist (February 2019 update). *Bishop Museum Tech. Rept. 69*. 209 pp.

Natural Resource Conservation Service (NRCS). 2023. Accessed June 12, 2023. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Palmer, D. D. 2003. *Hawai`i's ferns and fern allies*. University of Hawaii Press, Honolulu. 324 pp.

Pinzari, C., Kang,L. P. Michalak, L.S. Jermiin, D.K. Price, and F.J. Bonaccorso. 202. Analysis of the Genomic Sequence Data Reveals the Origin and Evolutionsay Seperation of Hawaiian Hoary Bat Populations. Genome Biology and Evolution. 12(9): 1504-1514.

Podolsky, R., D. G. Ainley, G. Spencer, L. de Forest, and N. Nur. 1998. Mortality of Newell's Shearwaters Caused by Collisions with Urban Structures on Kaua'i. *Colonial Waterbirds*, 21: 20-34.

Ranker, T.A., C.T. Imada, K. Lynch, D.D. Palmer, A.L. Vernon, and M.K. Thomas. 2019. Taxonomic Nomenclature Updates to the Fern and Lycophyte Fora of the Hawaiian Islands. American Fern Journal 109(1):54-72. Published on 30 April 2019.

Reed, J. R., J. L Sincock, and J. P. Hailman 1985. Light Attraction in Endangered Procellariform Birds: Reduction by Shielding Upward Radiation. *The Auk*, 102: 377-383.

Simons, T. R., and C. N. Hodges. 1998. Dark-rumped Petrel (*Pterodroma phaeopygia*). In A. Poole and F. Gill (editors). The Birds of North America, No. 345. The Academy of

Natural Sciences, Philadelphia, PA. and the American Ornithologists Union, Washington, D.C.

Staples, G. W. and D. R. Herbst. 2005. *A Tropical Garden Flora. Plants Cultivated in the Hawaiian Islands and other Tropical Places.* Bishop Museum, Honolulu. 908 pp.

Sincock, J. L. 1981. Saving the Newell's Shearwater. Pp 76-78 *in*: Proceedings of the Hawaii Forestry and Wildllife Conference, 2-4 October 1980. Department of Land and Natural Resources, State of Hawaii, Honolulu.

Telfer, T. C. 1979. Successful Newell's Shearwater Salvage on Kauai. *'Elepaio*, 39:71

Telfer, T. C., J. L. Sincock, G. V. Byrd, and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: Conservation efforts and effects of moon phase. *Wildlife Soc. Bull.*, 15:406-413.

U.S. Fish & Wildlife Service (USFWS). 1983. Hawaiian Dark-Rumped Petrel & Newell's Manx Shearwater Recovery Plan. USFWS, Portland, Oregon. February 1983.

USFWS. Undated (nd-a). USFWS Endangered Species. Available online at URL: https://www.fws.gov/endangered/; Last visited on June 2, 2023 and Environmental Conservation Online System (ECOS), online at URL: https://ecos.fws.gov/ecp/species-reports; last retrieved June 2, 2023.

USFWS. Undated website (nd-b). Critical Habitat Portal. Available online at URL: https://ecos.fws.gov/ecp/report/table/ critical-habitat.html; last retrieved January 21, 2023.

U.S. Fish & Wildlife Service-Pacific Islands Fish and Wildlife Office (USFWS-PIFWO). 2022. FINAL Avoidance and Minimization Measures (AMMs). Revised April 2022. Available online at URL: fws.gov/sites/ default/files/documents/Animal%20Avoidance%20and%20Minimization%20Measures-April%202022.pdf.

Wagner, W. L., D. R. Herbst, and S. H. Sohmer. 1990. *Manual of the Flowering Plants of Hawai'i: Volume I and II*. Bishop Museum Special Publication 83. University of Hawai'i Press. 1853 pp.

Wagner, W. L. and D. R. Herbst, 1999. *Supplement to the Manual of the flowering plants of Hawai'i*, pp. 1855-1918. *In:* Wagner, W. L., D. R. Herbst, and S. H. Sohmer, Manual of the flowering plants of Hawai'i. Revised edition. 2 vols. University of Hawaii Press and B.P. Bishop Museum.

Wilson, D. E., and D. M. Reeder (editors), 2005. *Mammal species of the world: a taxonomic and geographic reference.* 3rd edition. 2 vols. John Hopkins University Press. Baltimore, Maryland. 2142 pp.

APPENDIX D

SUPPLEMENTAL ARCHAEOLOGICAL INVENTORY SURVEY

Pacific Legacy

Historic Preservation

CULTURAL RESOURCES CONSULTANTS

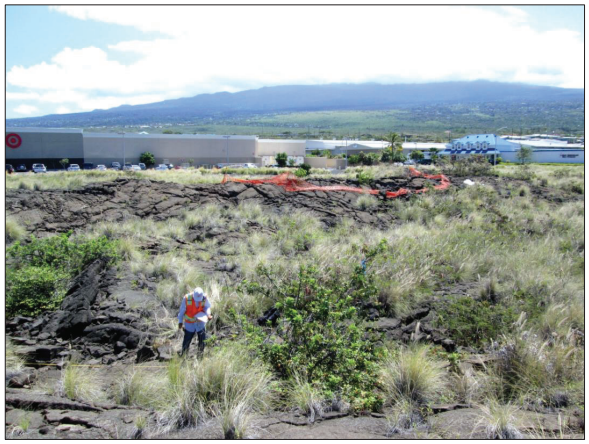
Hawai'i Offices:
Kailua, O'ahu
Hilo, Hawai'i

California Offices:
Business Office
Bay Area
Sierra/Central Valley

FINAL

SUPPLEMENTAL ARCHAEOLOGICAL INVENTORY SURVEY OF THE 110 ACRE KONA COMMONS PARCEL OF QUEEN LILI'UOKALANI TRUST LANDS IN KEAHUOLŪ, NORTH KONA ISLAND OF HAWAI'I

[TMK (3) 7-4-008:002 Por.; (3) 7-4-025:001-003, 005, 007, 010-022]



Pacific Legacy: Exploring the past, informing the present, enriching the future.

FINAL

SUPPLEMENTAL ARCHAEOLOGICAL INVENTORY SURVEY OF THE 110 ACRE KONA COMMONS PARCEL OF QUEEN LILI'UOKALANI TRUST LANDS IN KEAHUOLŪ, NORTH KONA, ISLAND OF HAWAI'I

[TMK (3) 7-4-008:002 Por.; (3) 7-4-025:001-003, 005, 007, 010-022]

Prepared by:
James McIntosh, B.A.
Tanya Lizama, M.A.
Rowland B. Reeve, M.A.
Jessie Kaleinohea Cleghorn, B.A.
and
Paul L. Cleghorn, Ph.D.

Pacific Legacy, Inc.
30 Aulike Street, Suite 301
Kailua, HI 96734
(808) 263-4800

Prepared for:
Queen Lili'uokalani Trust
1100 Alakea Street, Suite 1100
Honolulu, HI 96813

August 2015

ABSTRACT

At the request of the Queen Liliʻuokalani Trust, Pacific Legacy, Inc. conducted a Supplemental Archaeological Inventory Survey of approximately 110 acres of Trust lands located within the *ahupuaʻa* of Keahuolū in the district of North Kona on the Island of Hawaiʻi [TMK (3) 7-4-008:002 Por., (3) 7-4-025:001, 002, 003, 005, 007, 010, 011, 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 022]. The 110 acre Kona Commons project area, which has been zoned for urban use, is located *makai* of the Queen Kaʻahumanu Highway, between the Kona industrial area and the Trust's Urban Phase III parcel. At present, this property is partially developed, with its more *mauka* portion being occupied by existing commercial properties and parking areas, while its southwestern corner was formerly occupied by the Swing Zone driving range.

The greater portion of the project area has been the subject of a previous Archaeological Inventory Survey (AIS) conducted in 1992 by Paul H. Rosendahl, Ph.D. Inc. (PHRI) (O'Hare and Rosendahl 1993). This survey, which covered approximately 100 aces of the present project area (excluding a portion of the former Swing Zone), identified and recorded a number of historic properties on the parcel. The present survey was undertaken as a supplement to the previous AIS, its purpose being to assess the current state of the previously identified historic properties located within the subject parcel and to determine if any additional historic properties exist within the 110 acres. The information obtained through this survey will be used to assist the Queen Liliʻuokalani Trust in planning for the future development of the Kona Commons parcel.

During the current Supplemental Archaeological Inventory Survey, a total of 11 archaeological sites (consisting of 21 component features) were identified within the project area. These sites consist primarily of small and crudely constructed features or modified natural features, including stone mounds, modified depressions, modified overhangs, C-shaped walls and alignments, small enclosures, a historic petroglyph, and a historic trail. The most significant of these sites are a lava tube containing human remains (Site 50-10-27-18511, Feature C) that was initially identified during the 1992 PHRI survey, and the remnants of a historic trail that crosses diagonally through roughly the center of the survey area. The present survey also identified and recorded the locations of six lava excavations. Excavations of this type were found to be scattered throughout the project area. These excavations provide evidence of human activity, possibly related to the quarrying of stone for building material or the creation of mulch pits for dryland agriculture.

Of the 11 sites identified during the present Supplemental Archaeological Inventory Survey, four had been previously recorded, while seven sites were newly discovered. The majority of the 19 sites recorded during the previous 1992 PHRI inventory survey appear to have been destroyed by development and ground disturbing activities which have taken place within the project area between the time of the survey and the present. The construction of the Kona Commons Shopping Center and the former Swing Zone driving range resulted in the bulldozing and landscaping of major portions of the survey area. Bulldozing associated with these activities appears to have had a significant impact upon archaeological remains.

The various features documented during the Supplemental Archaeological Inventory Survey of the 110 acre Kona Commons parcel appear to have served a range of functions. These included temporary habitation, storage, visual markers, possibly stone quarrying and/or crop cultivation (in the case of the lava excavations), communication (in the case of the historic petroglyph), travel, and burial.

The results of the current survey indicate that the majority of the sites located within the Kona Commons project area date from the pre-Contact period. Three sites, a modified depression (Site 50-10-27-18502), the petroglyph (Site 50-10-27-30211, which consists of two English letters, possibly representing personal initials), and the trail appear to date from the historic or modern periods. The remainder of the sites possess a more traditional style of construction, suggesting that they are pre-Contact in age.

All of the sites identified during the present survey appear to have been associated with relatively short term activities. Among these activities was the modification and use of natural overhangs and lava tubes to serve as temporary shelters, storage areas, and burial crypts. Small stone enclosures and walled shelters appear to have been erected to serve as temporary camping areas. Low stone mounds were built to serve as markers. Rough excavations were created in the lava surface, either to supply stone for the construction of nearby surface features, or to open pits that could be filled with mulch and used to grow dryland crops.

An additional component of the current Supplemental Archaeological Inventory Survey was the testing for subsurface lava tubes undertaken within the *makai* portion of the survey area. This testing was conducted by Geolabs Hawaiʻi with the assistance of archaeologists from Pacific Legacy. It was undertaken to determine whether any large, subsurface lava tubes were present in that portion of the survey area located just inland of the Kuakini Highway. As part of its planned development of the Old Kona Airport Park, the County of Hawaiʻi is considering rerouting a portion of the present Kuakini Highway by moving it slightly inland and running it parallel to the present road. This new alignment would take it through the *makai* portion of the Kona Commons project area. In order to determine whether this proposed route is feasible, the County wished to test for the possible presence of large, subsurface lava tubes along the new alignment. Testing took the form of drilling to obtaining subsurface core samples at five locations along the route. Following consultation with the Hawaiʻi State Historic Preservation Division, it was agreed that this subsurface boring would be considered part of the testing phase of the present supplemental archaeological survey and its procedures and results would be included in this report. None of the borings revealed the presence of subsurface lava tubes.

The eleven historic properties identified during the present Supplemental Archaeological Inventory Survey were assessed as to their significance under the Secretary of Interior's standards for listing on the National Register of Historic Places (NRHP). All of the 11 sites were assessed as significant for their information content (Criterion D). The burial feature at Site 50-10-27-18511 (Feature C) was also designated significant for its importance to Native Hawaiian culture (Criterion E).

Treatment recommendations were made for the archaeological sites located within the 110 acre project area. Given its significance as a repository for *iwi kupuna* (ancestral remains), the Site 50-

10-27-18511, Feature C lava tube burial was recommended for preservation. The Site 50-10-27-30287 trail was recommended for partial preservation with interpretation. The remainder of the sites (with the exception of one lava excavation) were found to possess no excavation potential. The detailed recording undertaken during the present archaeological inventory survey was deemed sufficient to document all of the information these sites are likely to yield. As a result, no further work has been recommended for the remainder of the sites with the exception of Site 50-10-27-30210, Feature B. This single lava excavation was found to contain a small amount of soil. Soil samples taken from similar lava excavations located in other areas of North Kona have yielded starch grains belonging to ʻ*uala* (sweet potato, *Ipomoea batatas*). This suggests that these features may have been utilized as planting depressions. The possibility exists that similar microbotanical remains may be recovered from Site 50-10-27-30210, Feature B. For this reason, it is recommended that data recovery excavations be undertaken at the feature, and that a recovered soil sample be submitted for pollen, phytolith and starch analysis.

One of the purposes of this Supplemental Archaeological Inventory Survey report is to serve as a planning document to assist Queen Liliʻuokalani Trust in managing the archaeological resources present within its Keahuolū lands. It provides detailed information on the location, character and relative significance of the archaeological remains present within the Kona Commons parcel. It should not, however, be considered an exhaustive document. The present program of site recording was undertaken to gather information about the sites, not to mitigate any adverse impacts to these archaeological remains. Prior to the initiation of any additional development within the Kona Commons parcel, various preservation/mitigation plans will need to be prepared so as to best anticipate and mitigate the adverse impacts of any such development upon the archaeological resources present.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Frontispiece: Field recording at Site 50-10-27-18511 with Hualālai in background (view northeast).

1.0 INTRODUCTION

Pacific Legacy, Inc., at the request of the Queen Lili'uokalani Trust, conducted a Supplemental Archaeological Inventory Survey (SAIS) of approximately 110 acres of Trust lands located within the *ahupua'a* of Keahuolū in the district of North Kona on the Island of Hawai'i [TMK (3) 7-4-008:002 Por.; (3) 7-4-025:001, 002, 003, 005, 007, 010, 011, 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 022]. The 110 acre Kona Commons project area, which has been zoned for urban use, is located *makai* of the Queen Ka'ahumanu Highway, between the Kona industrial area and the Trust's Urban Phase III parcel. At present, this property is partially developed, with its more *mauka* portion being occupied by existing commercial properties and parking areas, while its southwestern corner was formerly occupied by the Swing Zone driving range.

The majority of the project area has been the subject of a previous Archaeological Inventory Survey (AIS) conducted in 1992 by Paul H. Rosendahl, Ph.D. Inc. (PHRI). This survey identified and recorded a number of historic properties on the parcel. The present survey was undertaken as a supplement to the previous AIS, its purpose being to assess the current state of the previously identified historic properties located within the subject parcel and to determine if any additional historic properties exist. The information obtained through this survey will be used to assist the Queen Lili'uokalani Trust (QLT) in planning for the future development of the Kona Commons expansion parcel.

The fieldwork phase of the present supplemental archaeological inventory survey was undertaken over a period of one week between 23 June and 27 June of 2014. The survey was under the overall supervision of Principal Investigator Paul Cleghorn, Ph.D. Field operations were supervised by James McIntosh, B.A. The Pacific Legacy field crew included Mr. Caleb Fechner, B.A. and Ms. U'ilani Macabio, B.A.

1.1 KEAHUOLŪ ROADWAY AND PROMENADE PROJECT

The present Supplemental Archaeological Inventory Survey was undertaken in part to support the Queen Lili'uokalani Trust's Special Management Area-Major Use Permit Application for the proposed Keahuolū Roadway and Promenade Design project. This project, initiated and headed by the Queen Lili'uokalani Trust, is being undertaken in support of and in conjunction with the County of Hawai'i Kailua Park Master Plan Improvements, which will involve modifications to the existing Old Kona Airport Park property.

The Keahuolū Roadway and Promenade Design project area covers the *makai* portion of the Kona Commons expansion. The route of the north entrance to the park (Park Access Road 3 north) crosses into and through the area formerly occupied by the Swing Zone driving range. The former Swing Zone was examined both during the present survey and during the Archaeological Inventory Survey of Queen Lili'uokalani Trust's Urban Phase III parcel, the report for which is in preparation (Reeve et al. in prep.). These lands were found to be extensively disturbed and landscaped (see Section 2.3, Figure 8), and to be devoid of any surface archaeological remains.

1.2 Report Organization

This report is composed of 12 sections and two appendices. Following this introductory section, **Section 2** presents the background to the project and the environment of the project area. **Sections 3 and 4** provide the historical background and the results of previous archaeological studies in the area. **Section 5** details the field methods employed during the present survey. **Section 6** presents the findings of the survey. **Section 7** describes the subsurface test boring that was undertaken as an adjunct component of the survey. **Section 8** presents the significance assessments for the various sites identified, while **Section 9** indicates the various treatments recommended for the identified sites. **Section 10** provides a summary and discussion of the findings. **Section 11** gives our recommendations for the management and mitigation of effects on the archaeological resources present. **Section 12** lists the references cited in this report.

The data appendices that support the written report consist of two tables:

Appendix A — Site Attributes
Appendix B — Site Coordinates

2.0 PROJECT BACKGROUND

2.1 Project Area

The 110 acre project area is located within the lands of the Queen Lili'uokalani Trust, in the *ahupua'a* of Keahuolū in the district (*moku*) of North Kona on the island of Hawai'i (Figure 1). The survey area is situated at the northern edge of Kailua town, and is located *makai* (seaward) of the Queen Ka'ahumanu Highway, between the Kona industrial area and the Trust's Urban Phase III parcel.

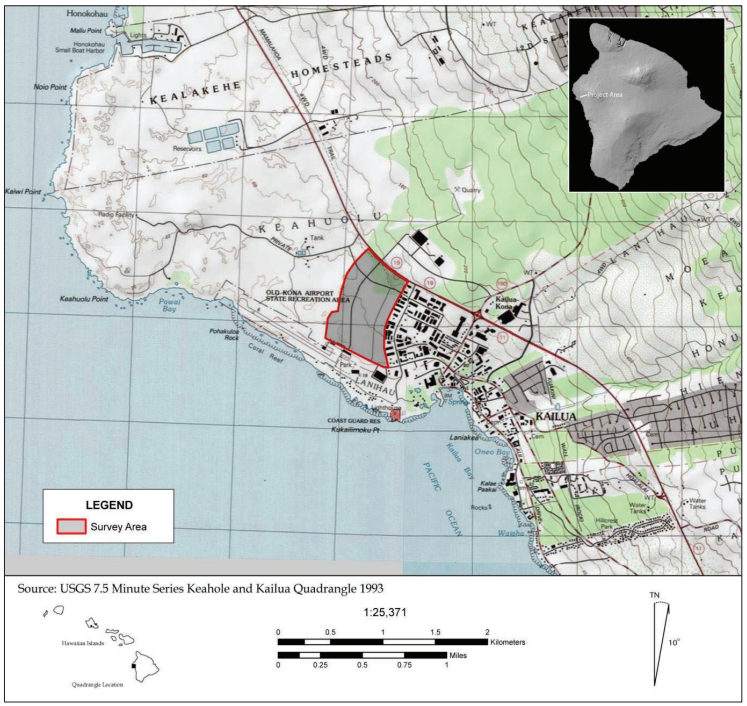


Figure 1. Location of the project area (base map USGS Kailua and Keāhole Point quads).

The project area is bounded to the northeast by the Queen Kaʻahumanu Highway, to the northwest by the 213 acre Queen Liliʻuokalani Trust Urban Phase III parcel, which contains the Queen Liliʻuokalani Childrens' Center complex, to the southeast by commercially developed land that forms part of the Kona industrial area, and to the southwest by playing fields that form part of the Old Kona Airport State Recreation Area (Figure 2 and Figure 3).

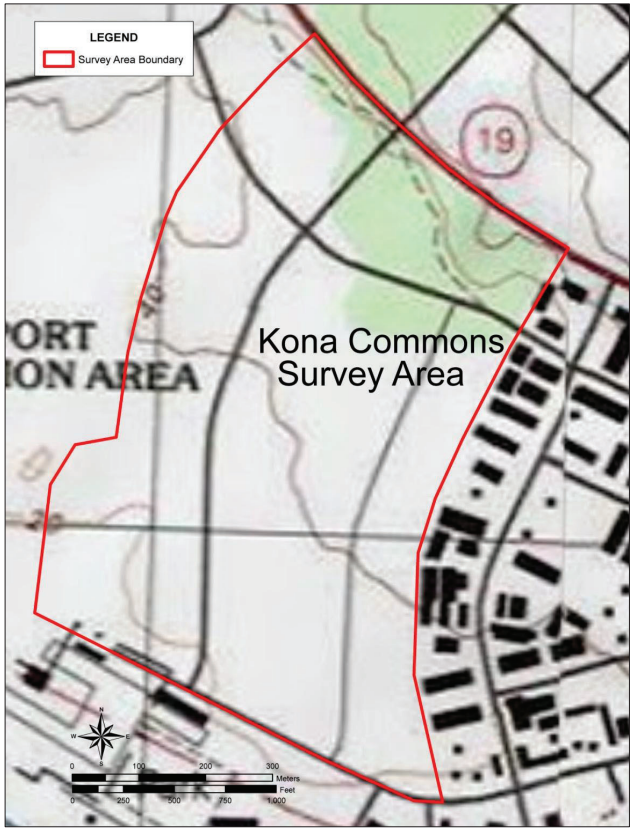


Figure 2. Topographic map of the Kona Commons project area (base map USGS Keāhole Point quadrangle).

Figure 3. Aerial photograph of the project area (background aerial from Google Earth accessed 2015).

2.2 Environmental Setting

The present survey area is located at the foot of the volcanic peak of Hualālai, on the drier leeward side of the island of Hawai'i. It is situated between roughly 20 and 80 feet in elevation and approximately 150 to 250 meters inland of the shoreline (Figure 1). The geology underlying the project area consists of lava flows of two very different ages, both of which originated from Hualālai. The vast majority of the project area is covered by a flow that was laid down sometime between 1,500 to 3,000 years ago (Figure 4). Remnants of a much older lava flow, dating from between 11,000 to 30,000 years ago, exist in the northeastern portion of the parcel (Wolfe and Morris 1996).

Figure 4. The age of lava flows within the project area (background aerial from Google Earth accessed 2015, data from Wolfe and Morris 1996).

The lavas that cover most of the survey area are gently undulating *pāhoehoe* flows (rLW) (Sato et al. 1973:Map 85). These *pāhoehoe* flows are scarred by upthrust pressure ridges, fissures, collapsed blisters, and lava sinks. Subsurface lava tubes and blisters are also present. Several of these natural geologic features show evidence of having been modified and utilized by the pre-Contact inhabitants of coastal Keahuolū.

These younger *pāhoehoe* lava flows possess very little in the way of surface soil, most of which consist of thin aeolian sediments that have accumulated in depressions and low lying areas. The small area of rougher *'a'ā* lava (rLV) (Sato et al. 1973:Map 85) that occupies the northwestern corner of the project area is also relatively free of soil (Figure 5). It is only on the older lava flows located in the northern portion of the survey area that deeper soil deposits have developed (Figure 5). These soils belong to the Punaluu Series of extremely rocky peats (rPYD). They are thin, well drained organic soils that have developed atop *pāhoehoe* lava bedrock and are suitable for dryland cultivation (Sato et al. 1973:48). All of these former soil areas have, however, been disturbed by modern development and are now located beneath commercial properties (Figure 5).

Figure 5. Lava flows and soil types within the project area (background aerial from Google Earth accessed 2015, data from NRCS 2001).

There are no perennial streams on the leeward slopes of Hualālai and no surface water sources within the project area. Less than 750 millimeters (c. 29.5 inches) of rain fall in a year along this stretch of the Kona coast (Giambelluca et al, 1986). Due to the limited amount of rainfall, vegetation in the project area is relatively sparse. The younger *pāhoehoe* flows are covered in a

dense ground cover of fountain grass (*Pennisetum setaceum*), with occasional stunted *kiawe* (*Prosopis pallida*) and Christmas berry (*Schinus terebinthifolius*) trees, as well as *koa haole* (*Leucaena leucocephala*), klu *(Acacia farnesiana)*, lantana (*Lantana camara*), and bougainvillea (*Bougainvillea spp.*) shrubs (Figure 6 and Figure 7). Scattered native shrubs such as ʻ*uhaloa* (*Waltheria indica*), are also present, with Polynesian introduced *noni* (*Morinda citrifolia*) trees growing out of lava sinks and other natural depressions in the terrain. The former Swing Zone and the surrounding the existing commercial properties have been landscaped with both native and introduced plants. During the pre-Contact period the dominant vegetation throughout the project area would most probably have been *pili* (*Heteropogon contortus*) grass.

Figure 6. Vegetation within the southern undisturbed portion of the project area (view north).

Figure 7. Vegetation within the more northern section of the undisturbed portion of the project area (view north).

2.3 Recent Impacts to the Project Area

In recent years, portions of the 110 acre Kona Commons property have been developed for commercial use. Most of this development has been concentrated in the *mauka* half of the project area. These *mauka* lands are now occupied by a mix of commercial properties and parking areas. Some sections of the property that are located southeast of Loloku Street have also been developed (Figure 3). At present, approximately 41 acres of the Kona Commons property remain undeveloped. Portions of this undeveloped land have, however, been disturbed by bulldozing and by landscaping associated with the construction of the former Swing Zone driving range (Figure 8). This extensive ground disturbance, the full extent of which can be seen in Figure 8, has resulted in the destruction of numerous historic properties identified during previous archaeological studies of the area. Even within those areas that have not been grubbed or graded, there is evidence, in the form of bulldozer track scars on the *pāhoehoe* lava, that heavy equipment has traversed the terrain.

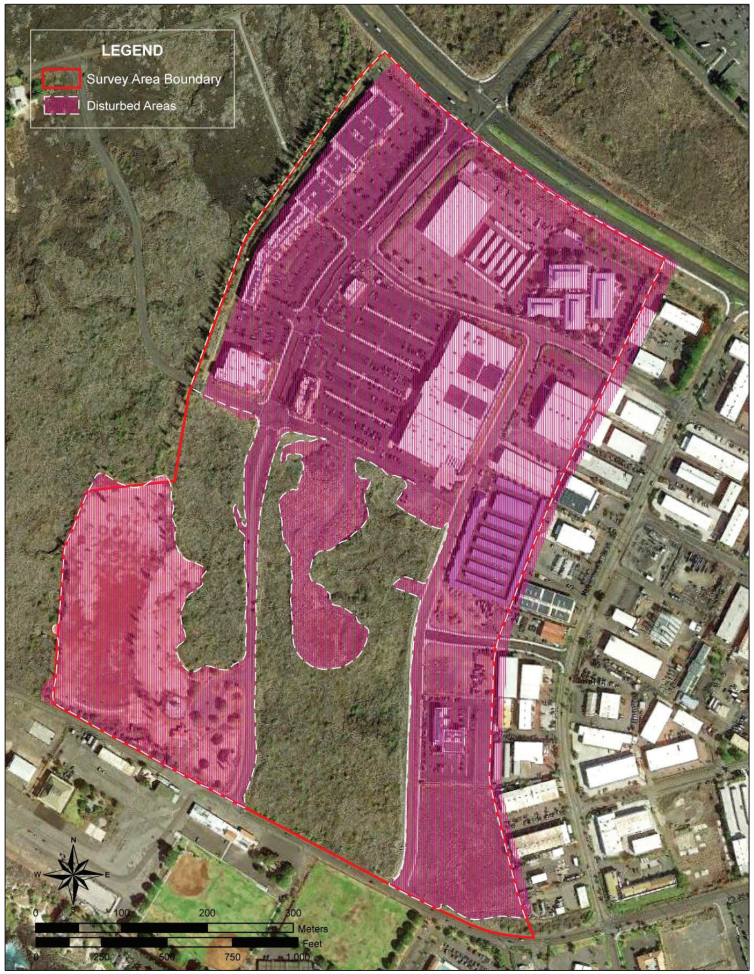


Figure 8. Location of developed and disturbed areas within the Kona Commons project area (background aerial from Google Earth accessed 2015).

3.0 HISTORIC BACKGROUND

3.1 THE *AHUPUA'A* OF KEAHUOLŪ

The *ahupua'a* (land division) of Keahuolū, which follows the traditional *mauka* to *makai* (from the mountains to the sea) pattern, extending from the upper slopes of Hualālai to the coastal waters north of Kailua Bay (Figure 9). The land division of Keahuolū is bounded to the north by the *ahupua'a* of Kealakehe and to the south by the *ahupua'a* of Lanihaunui (large Lanihau, also referred to as Lanihau 1) (Figure 10). The name Lanihau can be translated as "cool heaven" (Pukui et al. 1974:128). A Hawai'i Territorial Survey map drafted in 1952 (Figure 11) shows the extent of the *ahupua'a* and its relationship to the surrounding land divisions.

As can be seen in this 1952 map, Keahuolū and the land divisions to the north of it are relatively wide, while the numerous land divisions to the south are much narrower. This appears to be a reflection of the relative fertility of the *ahupua'a*. Keahuolū is situated in the transition zone between the barren lava lands of *Kekaha wai 'ole* (the waterless place) to the north and the more fertile agricultural lands of *Kona kai 'ōpua* (Kona of the distant horizon clouds above the ocean) to the south (Maly 1994:A3, Maly and Maly 2007:12). The more northern land divisions, with their scarce rainfall and thin soils, were not well suited for crop cultivation. They needed to be larger in order to provide more land (and more importantly, ocean frontage) to support the *'ohana* (families) that dwelt within them. The more southern *ahupua'a*, which possess greater rainfall and deeper soils, were well suited for agriculture and could support a greater population on less land area.

An interesting artifact of this division of lands is that the narrow *ahupua'a* of Lanihaunui, which are located immediately south of Keahuolū, expands as it nears the coast. This relatively thin sliver of land would be expected to possess only a small area of shoreline. Instead, as this *ahupua'a* nears the coast, it bends northwest, taking in a somewhat broader area of sea frontage (Figure 12). This alteration in the normal *ahupua'a* pattern might have been undertaken to allow the residents of Lanihaunui access to a wider array of marine resources. The result of this shift in the land boundary is that a substantial portion of southern coastal Keahuolū does not possess direct access to the shoreline. During the traditional and early historic periods, the portion of shoreline subsumed by Lanihaunui contained a coconut grove and a sizeable settlement known as Maka'eo.

At its *mauka* end, the *ahupua'a* of Keahuolū does not extend all of the way to the summit of Hualālai. Instead, it is cut off by another *ahupua'a*, which occupies the lands located inland of the *mauka* boundary of Keahuolū. While historic Boundary Commission testimony suggests that Keahuolū is cut off by the *ahupua'a* of Lanihauiki, which also cuts off the uppers end of the adjacent *ahupua'a* of Lanihaunui, more recent maps suggest that Lanihauiki, Lanihaunui, and Keahuolū are cut off by the *ahupua'a* of Honua'ula (Figure 11) or Kealakehe (Figure 10).

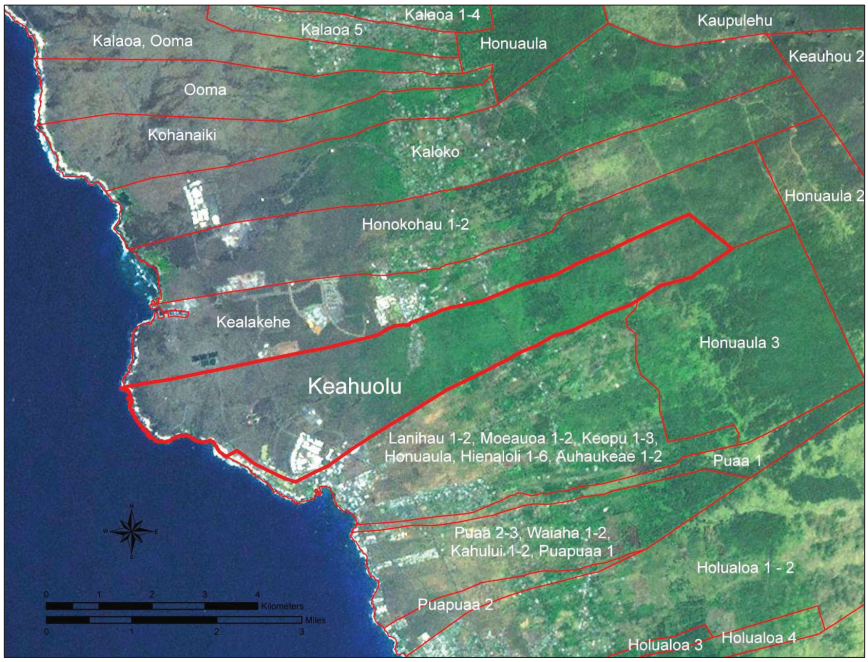


Figure 10. The relative location of the *ahupua'a* of Keahuolū (aerial base from ESRI ArcGIS Online and data partners, including imagery from agencies supplied via the Content Sharing Program; image date 2009; data from the Hawai'i Biodiversity and Mapping Program).

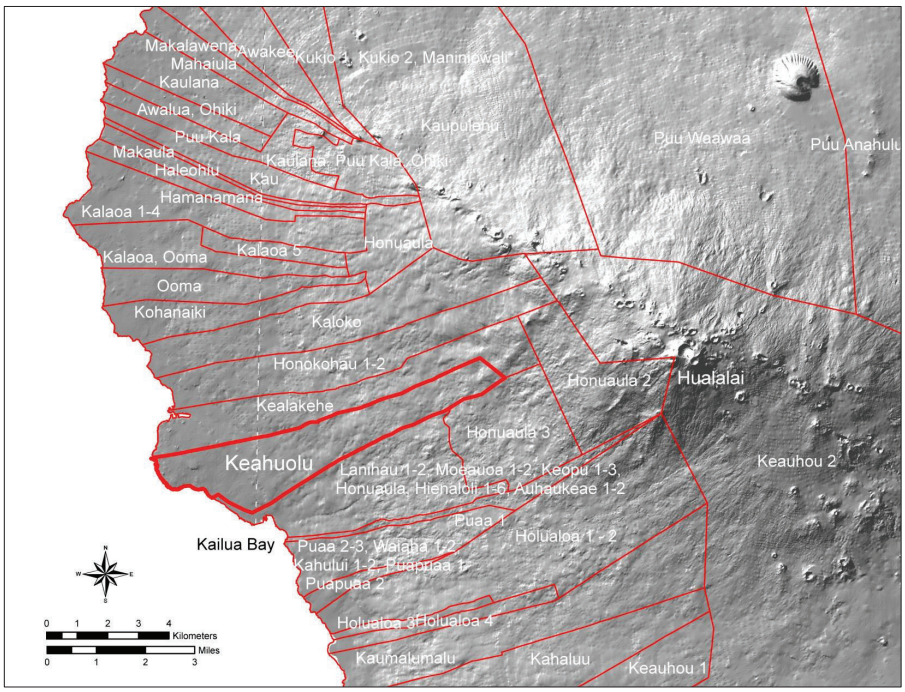


Figure 9. The relative location of the *ahupua'a* of Keahuolū (base hillshade from Office of Planning, State of Hawai'i, data from the Hawai'i Biodiversity and Mapping Program).

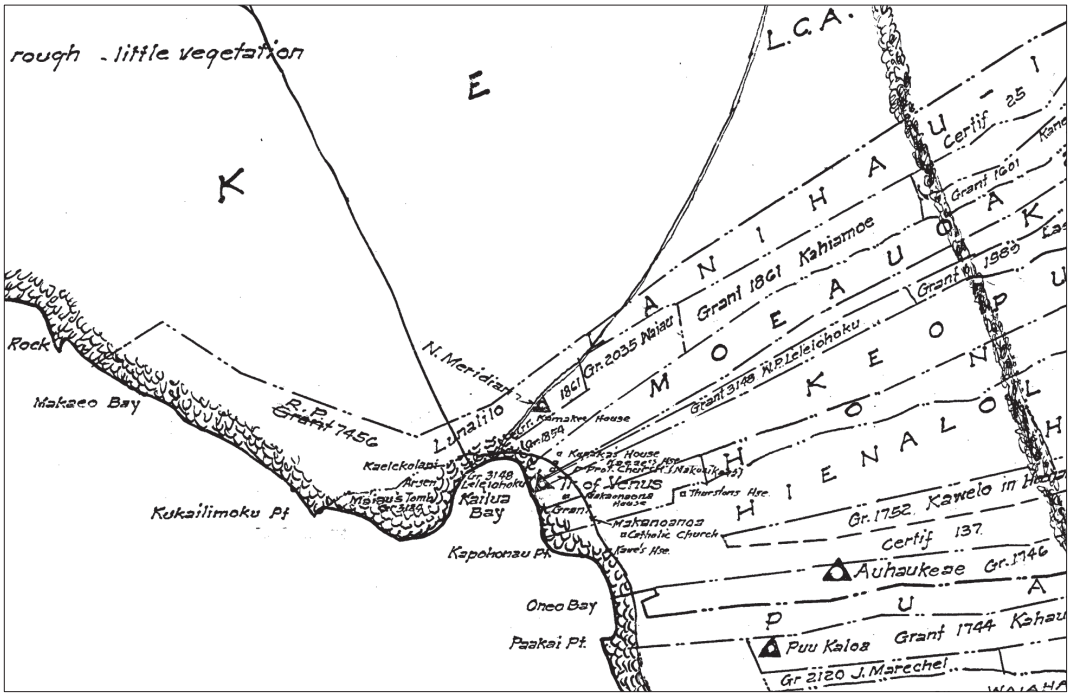


Figure 12. Detail of the Territorial Survey map of Kailua showing the relative coastal boundaries of the *ahupua'a* of Keahuolū, Lanihaunui, and Lanihauiki (Awana 1952 map).

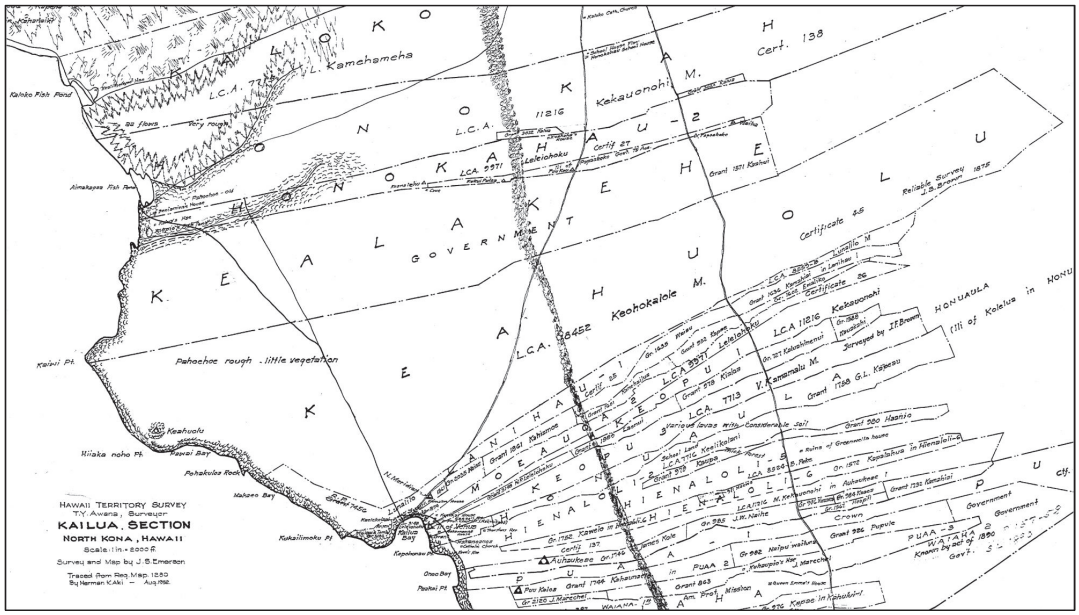


Figure 11. Territorial Survey map of Kailua showing the *ahupua'a* of Keahuolū and its adjacent land divisions. This map is based upon surveys conducted by J. S. Emerson in the 1880s (Awana 1952 map).

3.2 THE NAME OF THE *AHUPUAʻA*

As is often the case with Hawaiian place names, there exist variant spellings and translations for the name of this *ahupuaʻa*. In their book *Place Names of Hawaiʻi*, Mary Kawena Pukui and her collaborators give the name of the land division as "Ke-ahu-o-Lū." The literal translation they offer is "the heap of Lū" (Pukui et al. 1974:101). While the primary definition of the word *ahu* is "heap, pile, collection" (Pukui and Elbert 1971:8), the word may also refer to a stone cairn, altar or small shrine (Pukui and Elbert 1971:8). Thus, the place name "Ke-ahu-o-Lū" could alternately be translated as "the shrine of Lū". In their Cultural Impact Assessment for Kealakehe and Keahuolū, Taupouri Tangaro, Kuʻulei Higashi Kanahele, and William Mahealani Pai translate the name of the *ahupuaʻa* as the "Shrine of Lū, a legendary voyager" (Tangaro et al. 2006, referred to in Wong Smith 2007:3). They do not, however, provide any reference for this translation (unless they are referring to the chiefess Luʻukia, wife of the legendary voyaging chief ʻOlopana, Kamakau 1991:102-105), nor do they indicate in what way Lū was associated with the *ahupuaʻa*. No other reference could be found that provides information on this legendary figure.

Another variation on the name of the *ahupuaʻa* is Keʻohuʻolu, which appears to be the one preferred by many of the lineal descendants of the area. In his testimony given before the Land Commission regarding Land Commission Award 11071 claimed by Aki, a native by the name of Kuia stated that, "He has seen Aki's land that which he had cultivated himself, it is in the ili land of Pauaaiki of Keohuolu ahupuaa in Hawaii" (Native Testimony Vol. 4:527, translation from Wong Smith 2007:12, see Section 3.5.4). It is not clear whether this spelling represents a variation of the name of the *ahupuaʻa*, or simply an error on the part of the clerk recording the testimony. The name of the *ahupuaʻa*, however, appears as Keahuolu in the immediately preceding testimonies taken down in the same hand, suggesting that the clerk knew the more common spelling of the name and wrote down this variant as an accurate representation of the name as given by Kuia.

In 1994, Kaiokekoa, a native Hawaiian resident of the Kekaha region, told the ethno-historian Kepā Maly that he recalled his elders pronouncing the name of the *ahupuaʻa* as Ke-ʻohu-ʻolu (Maly 1994:A-3). This variation of the place name can be translated as "the cool mist" (or "the cool mists," Wong Smith 2007:3, Maly 1994:A-3). The word *ke* is the definite single article usually translated as "the" (Pukui and Elbert 1971:130), while the word *ʻohu* means "mist, fog, vapor, light cloud on a mountain" (Pukui and Elbert 1971:256), and the word *ʻolu* means "cool, refreshing; soft" (Pukui and Elbert 1971:263). Margret Pelekane and Solomon Kaʻelemakule, the grandparents of Ms. Nicole Kealohaokalani Lui, whose families had been residents of Keahuolū for generations, were also known to refer to the name of the *ahupuaʻa* as Keʻohuʻolu, which Ms. Lui translates as "the refreshing mist" (Lui, pers. comm. 1913).

The second variation of this place name may derive from the *ahupuaʻa*'s traditional association with two *wahi pana* (storied places), the plain of Kanoenoe (which literally translates as "the mist") and the low hill of Puʻu o Kaloa (the "mound" or "hill of Kaloa"), which rests along the boundary between the *ahupuaʻa* of Keahuolū and Kealakehe. Ethno-historic accounts suggest that the hill of Kaloa marked the boundary between *Kekaha wai ʻole* and *Kona kai ʻopua*.

The role of Puʻu o Kaloa as a boundary marker is mentioned in the traditional tale entitled "Kaʻao Hoʻoniua Puʻuwai no Ka-Miki," (The Heart Stirring Story of Kamiki), recorded by John Wise and John Whalley Hermosa Issac Kihe and published serially over a four year period from 1914 to 1917 in the Hawaiian language newspaper *Ka Hoku o Hawaii*. The ethnohistorian Kepā Maly, who translated this lengthy and complex account, noted that, "While "*Ka-Miki*" is not an ancient account, the authors used a mixture of local stories, tales, and family traditions in association with place names to tie together fragments of site-specific histories that had been handed down over the generations. Also, while the personification of individuals and their associated place names may not be entirely "ancient," such place name-person accounts are common throughout Hawaiian (and Polynesian) traditions (Maly 1994:16).

This *kaʻao* is set during the reign of Pili-a-Kaʻaiea, who was sovereign chief of Kona around the 13th century. It tells the story of two supernatural brothers, Ka-Miki (The Quick, or Adept, One) and Maka-ʻiole (Rat [Squinting] Eyes), who traveled around the Island of Hawaiʻi along the ancient *ala loa* and *ala hele* (trails and paths) that encircled the island (Maly 1994:A-3). The *kaʻao* of Ka-Miki speaks of :

> Kekahawaiʻole, mai Ke-ahu-a-Lonoike ā o Kaniku a hoʻea i ke kula o Kanoenoe i ka puʻu o Puʻu-o-Kaloa
>
> Waterless Kekaha; which extends from Keahualono on the rocky plain of Kaniku, to the plain of Kanoenoe at the hill of Puʻuokaloa (Wise and Kihe in *Ka Hoku o Hawaii* October 18, 1917; transcribed and translated in Maly 1994:A-3).

The tale mentions that:

> The mound-hill called Puʻu-o-Kaloa sits upon the plain of Kanoenoe which is associated with both Keahuolu and Kealakehe. The settling of mists upon Puʻu-o-Kaloa was a sign of pending rains; thus the traditional farmers of this area would prepare their fields. This plain was referenced by Pili when he described to Ka-Miki the extent of the lands which Ka-Miki would oversee upon marrying the sacred chiefess Paehala of Honokōhau. The inheritance lands included everything from the uplands of Hikuhia above Nāpuʻu and the lands of the waterless Kekaha, which spanned from the rocky plain of Kanikū (Keahualono) to the plain of Kanoenoe at Puʻukaloa (Wise and Kihe in *Ka Hoku o Hawaii* October 25, 1917; transcribed and translated in Maly 1994:A-4).

Puʻu o Kaloa is referred to in the narrative of Ka-Miki as "Puʻuokaloa i ka malo o Kaʻeha e waiho ala... Puʻuokaloa where Kaʻeha's loin cloth (symbolic of the mists) was spread out" (Wise and Kihe in *Ka Hoku o Hawaii* October 25, 1917; transcribed and translated in Maly 1994: A-4).

Another traditional account that associates Puʻu o Kaloa with mist was also authored by John Whalley Hermosa Isaac Kihe and published in *Ka Hoku o Hawaii*. Kihe, one of the most prolific native writers of the late nineteenth and early twentieth centuries, was a *kamaʻāina* of the Kekaha region, his parent having come from Honokōhau and Kaloko (Maly and Maly 2006:15). Among the numerous newspaper articles he authored is one entitled "Nā Hoʻonanea o ka Manawa, Kekāhai mau Wahi Pana o Kekaha ma Kona" (A Pleasant Passing of Time, [Stories From] Some Famous Places of Kekaha at Kona). In this article, Kihe says of Puʻu o Kaloa that,

> Puʻu-o-kaloa is a mound-hill site in the lands of Keahuolu-Kealakehe, not far from the shore of Kaiwi and Hiʻiakanoholae. During periods of dry weather (*Ka lā maloʻo*) when planted crops, from the grassy plains to the *ʻāmaʻumaʻu* (fern forest zone), and even the ponds (*kiʻo wai*) were dry, people would watch this hill for signs of coming rains. When the *līhau* (light dew mists) sat atop the hill of Puʻuokaloa, rains were on the way. Planters of the districts agricultural fields watched for omens at Puʻuokaloa, and it was from keen observation and diligent work that people prospered on the land. If a native of the land was hungry and came asking for food, the person would be asked:
>
> > *Ua ka ua i Puʻukaloa, ihea ʻoe?*
> > When rains fell at Puʻukaloa, where were you? (If the answer was…)
> >
> > *I Kona nei no*!
> > In Kona! (there would be no sweet potatoes for this person.)
> >
> > But if the answer was…
> >
> > *I Kohala nei no!*
> > In Kohala! (The person would be given food to eat for they had been away, thus unable to accomplish the planting) (Kihe in *Ka Hoku o Hawaii* March 19, 1914; transcribed and translated in Maly 1994:A-5).

The place names of Kaiwi and Hiʻiakanoholae, mentioned by J. W. H. Issac Kihe, are located along the northern coast of the *ahupuaʻa* of Keahuolū. Lae o Kaiwi (the point of "the bone" Pukui et al 1974:71) is the headland that marks the shoreline boundary between Keahuolū and Kealakehe.

The traditional accounts published in *Ka Hoku o Hawaii* by John Wise and J. W. H. Issac Kihe reveal the importance that the hill of Kaloa and the plain of Kanoenoe held for the farmers who cultivated this stretch of the Kona coast. Puʻu o Kaloa appears to have received its name from a historic event that took place in its vicinity. The Hawaiian historian Samuel Manaiakalani Kamakau states that, upon his death, ʻUmi a Līloa, the 17th century chief who ruled over the island of Hawaiʻi, divided his kingdom between his two sons Ke-liʻi-o-kaloa-a-ʻUmi and his younger brother Keawe-nui-a-ʻUmi. Ke-liʻi-o-kaloa made his residence in Kona, while Keawe-nui ruled in Hilo. Animosity between the two brothers led to warfare and Keawe-nui-a-ʻUmi's forces marched across the mountains to do battle on the lava plains of Kona. As Kamakau describes it;

> When the armies of Hilo reached the shore of Kona the war canoes arrived from Ka-ʻu and from Hilo. The battle was [both] from the upland and from the sea. Ke-liʻi-o-kaloa fled and was killed on a lava bed. The spot where he was killed was called Puʻu-o-Kaloa (Kaloa's hill), situated between Kailua and Honokohau (Kamakau 1961:36).

John Papa ʻĪʻī, writing in the Hawaiian language newspaper *Kuokoa Ka Nupepa Kuokoa* (his series of articles was later collected into the book *Fragments of Hawaiian History*), noted that Puʻu o Kaloa was located along the trail that led from Kamakahonu, the royal residence in Kailua in the *ahupuaʻa* of Lanihau, north "to Puu o Kaloa and on as far as Kiholo [in the *ahupuaʻa* of Puʻu Waʻawaʻa], where it joins the road from the upland that is called Kealaehu" (ʻĪʻī 1959:120). The exact route of this traditional trail is uncertain. ʻĪʻī appears to be referring to either a coastal

trail or one located slightly inland of the coast, rather than the later Māmalahoa Trail (old government road), whose alignment runs close to that of the present Queen Kaʻahumanu Highway.

Testimony given before the Board of Commissioners for Boundaries, which formalized the boundaries of the various *ahupuaʻa* in the years following the Māhele indicates that Puʻu o Kaloa rested on the boundary between the *ahupuaʻa* of Keahuolū and Kealakehe. An examination of place names situated along this boundary suggests that Puʻu o Kaloa was located *makai* (seaward) of Puʻu Nahaha, a hill that historic maps show as being located just *mauka* of the Old Government Road (roughly the alignment of the present Queen Kaʻahumanu Highway).

In his article in *Ka Hoku o Hawaii*, J. W. H. Issac Kihe places the hill, "not far from the shore of Kaiwi and Hiiakanoholae" (Kihe in *Ka Hoku o Hawaii* March 19, 1914; transcribed and translated in Maly 1994:A-5). It appears likely that the hill at which Ke-liʻi-o-kaloa was killed is located somewhat close to the coast, inland of Lae o Kaiwi and *makai* of the Māmalahoa Highway. An upthrust of *pāhoehoe* lava, consisting of a series of ridges and low hills, runs just south of the present *ahupuaʻa* boundary from the near the shoreline at Lae o Kaiwi to the Queen Kaʻahumanu Highway. This ridge may have originally marked the line of the *ahupuaʻa* boundary. It seems likely that the hill of Puʻu o Kaloa is located somewhere along this ridge.

Place names often appear in *moʻolelo* (traditional stories) as the names individuals involved in the narrative. The names of the *ahupuaʻa* of Keahuolū and Lanihau are woven into *He Kaao no Hiku a me Kawelu*, the "Legend of Hiku and Kawelu," included among the *Fornander Collection of Hawaiian Antiquities*, a collection of traditional stories and historic accounts compiled and translated by Judge Abraham Fornander and published after his death. The *kaʻao* begins by stating that:

> O Keahuolu ka makuakane, o Lanihau ka makuahine, o Hiku ke keiki, o Kaumalumalu ka aina, o Kona ka moku, o Hawaii ka mokupuni.
>
> Keahuolu was the father and Lanihau the mother of Hiku a boy. These people once lived in Kaumalumalu in the district of Kona, island of Hawaii (Fornander 1916-1920:V, 182-183).

Kaumalumalu is an *ahupuaʻa* located south of Keahuolū and Lanihau, between Holualoa and Keauhou.

3.3 Traditional Place Names

A number of traditional place names have been identified within the *ahupuaʻa* of Keahuolū. The majority of those place names that have survived are located either along the shoreline or along the boundaries of the *ahupuaʻa*. The reason for this is that much of the historic documentation of place names within Keahuolū was associated with the determination of land boundaries. The names of those places located along the *ahupuaʻa* boundaries were recorded in testimony presented before the Board of Commissioners for Boundaries at the time that the boundaries of

Keahuolū and its adjoining *ahupuaʻa* were formalized. Other place names, not being written down, gradually went out of use and were forgotten as the *kamaʻāina* (native born) population of Keahuolū dwindled or left the land.

Only one known traditional place name (Namahana) is located within the present project area. This name appears on a map produced by Hawaiʻi Government surveyor Joseph S. Emerson in the 1880s. Emerson, the son of a missionary family, was fluent in the Hawaiian language and often spoke with local residents of the areas he surveyed in order to obtain the traditional names and other information regarding the places included on his maps. His map locates the place name Namahana in the northeastern corner of the project area just *makai* of the Queen Kaʻahumanu Highway, in the spot presently occupied by the International Marketplace (Figure 13). Two additional place names appear on Emerson's map just *makai* of and adjacent to the project area boundary, in the area presently occupied by the Old Kona Airport State Recreation Area.

Namahana (survey point)

The place name Namahana first appears on a survey map prepared by Hawaiʻi Government surveyor Joseph S. Emerson (Figure 22, Emerson 1880s map). This map, drafted sometime in the 1880s, shows a survey point labeled "Namahana" located adjacent to the now destroyed section of the Māmalahoa Trail just *makai* of the Queen Kaʻahumanu Highway in the present industrial area, down slope of the Makalapua Shopping Center. Its location roughly corresponds to the *mauka* parking lot of the International Marketplace property (Figure 13). This place name also appears in roughly the same location on the 1924 U. S. Geological Survey topographic map of the Kailua Quadrangle (Figure 23, United States Geological Survey 1924a map). It is unclear whether the traditional place name referred to a physical feature, a land area or a point along the trail.

The place name Namahana, if broken down to its root words, *na* and *mahana* can have multiple meanings depending upon its pronunciation. Nāmāhana can be translated as "the twins," with *nā* pluralizing the following noun, and *māhana* meaning "twins" (Pukui et al 1974:161). Namāhana can be translated as "belonging to twins," *na* meaning "belonging to" (Pukui and Elbert 1971:237), and *māhana* meaning "twins" (Pukui and Elbert 1971:202). If pronounced Nāmahana, the name can be translated as "the heat," *nā* which pluralizes the following noun (Pukui and Elbert 1971:237), and *mahana* meaning heat or warmth (Pukui and Elbert 1971:202).

This place name could also be a reference to the Maui chiefess Nāmāhānaʻi Kaleleokalani who was the widow and half sister of Kamehameha Nui, *aliʻi nui* (high chief) of Maui and later the wife of the prominent Kona chief Keʻeaumoku Pāpaʻiahiahi. Keʻeaumoku was an advisor to Kamehameha I and served as Royal Governor of Maui. Nāmāhana was the mother of several important *aliʻi*. Her daughters were Kaʻahumanu, the favorite wife of Kamehameha I and after his death the *Kuhina Nui* (Queen Regent) of the kingdom; Kalākua Kaheiheimālie (later known as Hoapili Wahine) another of Kamehameha's wives and mother of Queen Kamāmalu and Kīnaʻu (who served as Kuhina Nui after Kaʻahumanu); and Lydia Nāmāhana o Piʻia, another of Kamehameha's

wives and for a time the Royal Governor of Oʻahu. Her sons were John Adams Kiʻiapalaoku Kuakini, who served as the Royal Governor of Hawaiʻi Island and who supervised the construction of the Kuakini Wall; and George Cox Kahekili Keʻeaumoku who served as the Royal Governor of Maui. The place name could also refer to Nāmāhana's daughter Lydia Nāmāhana o Piʻia.

Kaholeakane (boundary point)

The place name "Kaholeakane" appears on Joseph Emerson's 1880s map of Kona (Figure 22, Emerson 1880s map) at a point along the boundary between Keahuolū and Lanihaunui near to the coast, northwest along the *ahupuaʻa* boundary from "Puu o palena." It is located *makai* of the present intersection between Loloku Street and the Kuakini Highway in one of the playing fields of the Old Kona Airport State Recreation Area (Figure 13).

The name "Kaholeakane" can possibly be broken down into the words *ka* ("the", Pukui and Elbert 1971:99), *hole* ("to skin, peel, file, rasp, make a groove; to strip" Pukui and Elbert 1971:72), *a* ("of", Pukui and Elbert 1971:1), and *kāne* ("male, husband, male sweetheart, man", Pukui and Elbert 1971:119).

Puuopalena/Puu o palena (hill)

The place name Puuopalena (Puu o palena) appears to belong to a hill located somewhat north of the Keahuolū/Lanihaunui boundary near to the coast.

Boundary Commission testimony provided by Kealakai indicates that, "The boundary at seashore between Lanihaunui and this land [Keahuolū] is at Pohakuloa thence towards Kailua; the sand on Lanihau and the pahoehoe on Keahuolu, thence mauka along raised lava; (flat lava being on Lanihau), passing some distance on the North side of Puuopalena, thence mauka to Hoenui, a good ways makai of Governor Adams wall" (Boundary Commission Vol. A, No. 1:356).

The place name "Puu o palena" appears on Joseph Emerson's 1880s map of Kona (Figure 22, Emerson 1880s map) at a point along the boundary between Keahuolū and Lanihaunui where the northwest to southeast running boundary line (which parallels the coast) angles inland. It is situated between "Kaholeakane" (to the northwest) and the Māmalahoa Trail (to the northeast). Presently this location roughly corresponds to the area somewhat *makai* of the intersection between Kaiwi Street and the Kuakini Highway at the southern edge of the Old Kona Airport State Recreation Area.

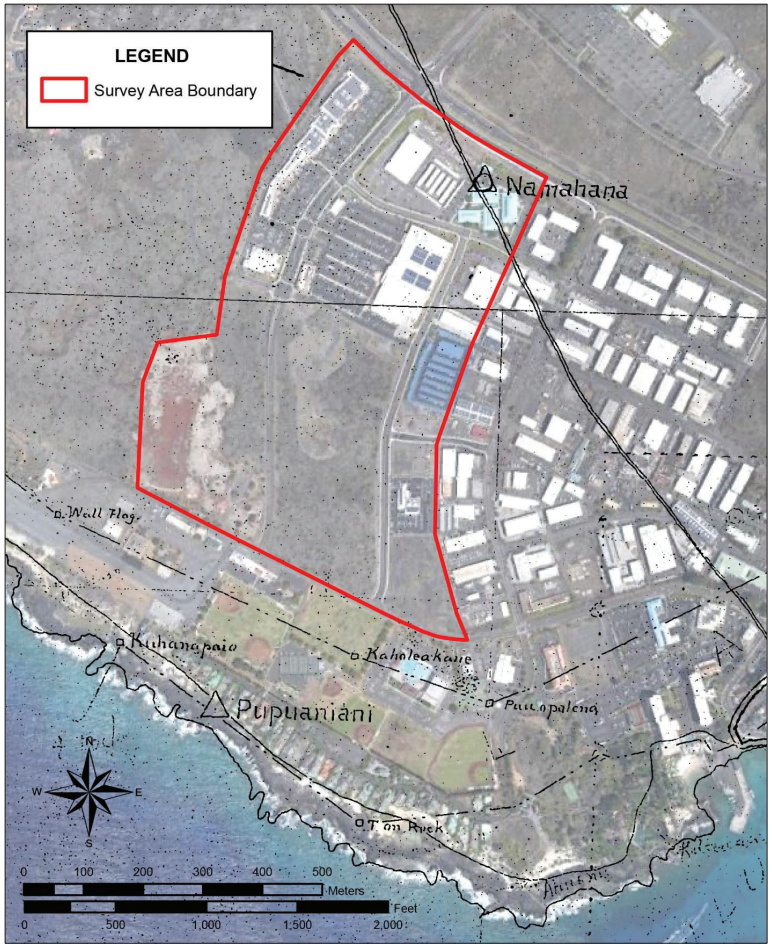


Figure 13. Known traditional place names in the vicinity of the Kona Commons project area (background aerial from Google Earth accessed 2014).

The place name may be broken down into the words *pu'u* ("hill, peak, mound", Pukui and Elbert 1971:330), *o* ("of", Pukui and Elbert 1971:252), and *palena* ("boundary, limit, border", Pukui and Elbert 1971:287), and could be translated as "hill of the boundary." It is interesting to note that the boundary between the *ahupua'a* of Keahuolū and Lanihaunui angles sharply inland at this point, suggesting that the hill served as an easily recognizable boundary marker.

3.4 The Traditional Period

The *ahupua'a* of Keahuolū is located just north of Kailua Bay, which was a major focus of settlement during the pre-Contact period. Kailua was also a traditional political and religious center, being one of the residence areas of the *ali'i nui* (high chiefs) of Hawai'i Island.

Relatively little is known of the early history of Keahuolū. It does not figure prominently in many legendary or traditional accounts. The "Ka'ao Ho'oniua Pu'uwai no Ka-Miki," (The Heart Stirring Story of Kamiki), which is set in the time of Pili-a-Ka'aiea (Pili), sovereign chief of Kona around the 13th century, mentions that at that time the district of Keahuolū and the divisions of Lanihau (1 and 2) were under the rule of Kapohoku'imaile (*kāne*, male) and Papalula (*wahine*, female) (*Ka Hōkū o Hawai'i* 5/21/1917, as translated by Maly ms.).

Archaeological investigations have revealed that the coastline of Keahuolū was well populated during the pre-Contact period. House sites were scattered along the shoreline with concentrated settlement at the bays of Halepa'o and Pawai where there were groves of coconut trees. Early investigations by John F. G. Stokes indicate that this coastal area was the location of at least several *heiau* (temples) and *ko'a* (fishing shrine) (Stokes 1991:40-42, see Section 4.1).

3.4.1 Environmental Zones

The pre-Contact residents of North Kona recognized and gave names to the various environmental zones that existed within their leeward lands. An ethno-historical study of land use within the Kona region undertaken by anthropologist Marion Kelly identified four of these traditionally recognized vegetation and cultivation zones extending inland from the coast (Kelly 1983). These zones are elevational in nature, beginning just back from the shoreline and extending up into the forest. They include the *kula* zone, which in Kona encompassed the dry coastal plain stretching inland from the shoreline; the *kaluulu* zone, an area of luxuriant growth including groves of *'ulu* (breadfruit, *Artocarpus altilis*) trees; the *'āpa'a* zone, an area of dryland cultivation that formed the major component of the Kona Field System; and the *'ama'u* zone (sometimes referred to as the *wao kanaka*), the area of upland rain forest dominated by the *'ama'u* fern where some human activity took place (Kelly 1983:47-50, Pukui and Elbert 1971:353). Further up slope from the *'ama'u* zone was the *wao nahele* (the inland forest, also referred to as the *wao la'au* or *wao eiwa*) and beyond it the *wao akua*, the wilderness of the gods (Malo 1951:17, Pukui and Elbert 1971:353).

Archaeologist Rose Schilt attempted to map out some of these traditional land use zones and to place each within its relative elevational context (Schilt 1984:5, Figure 1.3). She suggested that the *kula* or coastal area extended from sea level to c. 500 feet in elevation, the *kaluulu* or seaward

slope from c. 500 to 1,000 feet, the *ʻāpaʻa* or upland slope from c. 1,000 to 2,500 feet, and the *ʻamaʻu* or upland forest from c. 2,500 to 4,000 (Schilt 1984:6). While these elevation ranges are likely to have varied depending upon location, terrain, and rainfall, the general pattern of vegetation, both cultivated and natural, remained relatively consistent, providing a good indicator of traditional land use within North Kona. A somewhat similar description of traditional land use at various elevations is provided by Craighill and Elizabeth Handy in their *Native Planters in Old Hawaii*. Though they refer to land use and cultivation practices in the district of South Kona, and their elevation estimates differ somewhat from those proposed by Schilt, their observations can help to flesh out the picture of land use in North Kona.

> In the time of intensive native cultivation, South Kona was planted in zones determined by rainfall and moisture. Near the dry seacoast potatoes were grown in quantity, and coconuts where sand or soil among the lava near the shore favored their growth. Up to 1,000 feet grew small bananas which rarely fruited and poor cane; from 1,000 to 3,000 feet, they prospered increasingly. From approximately 1,000 to 2,000 feet, breadfruit flourished. Taro was planted dry from an altitude of 1,000 feet to approximately 3,000 feet (Handy and Handy 1972:525).

Based upon these estimations, the present Kona Commons project area, which ranges from approximately 20 and 80 feet in elevation, falls within the traditional *kula* zone. While the relative scarcity of soil throughout much of the project area would have limited the opportunities for dryland cultivation, the former presence of Punaluu Series soils in the northeastern corner of the project area would have allowed for the cultivation of *ʻuala* (sweet potato, *Ipomoea batatas*).

3.4.2 Traditional Settlement

The primary centers of population within the *ahupuaʻa* of Keahuolū during the pre-Contact period appear to have been along the coast and in the well watered uplands. Although coastal residences were strung along the shoreline, situated near small bays and canoe landings, the main areas of coastal settlement seem to have been located at the small crescent bays of Halepaʻo and Pawai, as well as along the sandy beach immediately south of Pawai in the area known as Makaʻeo. The fishing village of Makaʻeo appears to have been the closest settlement to the Kona Commons project area.

Evidence suggests that the coconut grove that fringed Pawai Bay stretched further south along the shoreline to shade the fishing settlement known as Makaʻeo. Boundary Commission testimony, collected in the latter half of the 19th century, indicates that there was "an old village, on Lanihau, called Makaeo" (Boundary Commission Vol. A, No. 1:354). Makaʻeo was located along the shoreline to the south and east of the prominent outcropping of lava known as Pōhakuloa, which rises from the sea near the northern end of the Old Kona Airport runway and marks the boundary point along the shore between the *ahupuaʻa* of Keahuolū and Lanihau. The 1952 Territorial Government sectional map of Kona (Figure 11, Awana 1952 map) refer to this stretch of shoreline as "Makaeo Bay".

The settlement of Makaʻeo may have been in existence from at least the time of ʻUmi a Līloa, who was the *aliʻi nui* (high chief) of the island of Hawaiʻi in the 15th century (estimated reign A.D. 1600 to 1620, Cordy 1994:7). Reference to Makaʻeo can be found in two of the traditions

associated with ʻUmi's reign. These traditions suggest that the bay and settlement of Makaʻeo served as a landing point for individuals wishing to visit the chiefly compound of Kamakahonu in Kailua without being observed. Makaʻeo is mentioned twice in the traditions associated with ʻUmi, once in his dealings with Kiha a Piʻilani of Maui, and again in regards his death and burial.

ʻUmi had taken as a wife the *aliʻi wahine* (chiefess) Piʻikea, daughter of Piʻilani the *aliʻi nui* of the island of Maui. Following Piʻilani's death, rivalry developed between his eldest son Lono a Piʻilani and his younger son Kiha a Piʻilani. Kiha sailed from Maui to Kona, to the court of ʻUmi, to ask his sister for aid (Cordy 2000:207). In his description of these events, the Hawaiian historian Samuel Manaiakalani Kamakau recorded that Kiha;

> …decided to go to Hawaii, to consult his brother-in-law, ʻUmi-a-Liloa, ʻUmi-a-Liloa had married his sister Piʻi-kea-a-Piʻi-lani…. When the canoe was ready, Kiha-a Piʻi-lani, his wife Kumaka, and the canoe paddlers set sail for Hawaii and landed at Kohala. From Kohala they sailed to Makaʻeo in Kailua, and when evening fell Kiha ordered the canoemen and the chiefess Kumaka to remain where they were. He said, "Stay here and if someone should come for you, then you'll know that I am alive. But if no one comes, then trouble has befallen me. Put the ocean's space between us, for yonder lies Maui, and you may go home." Kiha-a-Piʻi-lani went up to see his sister Piʻi-kea. Night had fallen, and the candles in the chief's house and the many houses of the chiefesses were lighted. According to the number of chiefly wives ʻUmi-a-Liloa had, so was the number of their houses. Piʻi-kea and Kapu-kini had the largest houses, and they were near the enclosure of ʻUmi's house.
>
> On the way up Kiha-a-Piʻi-lani met a man at Kamakahonu coming home from the chief's residence and asked him about the rows of lights. The man guessed that he was from the back country or perhaps a stranger and pointed out first the home of one chiefess and then the home of another. When Kiha knew which one was Piʻi-kea's, he went on and entered (Kamakau 1961:27-28).

Kamakau's account seems to suggest that Kiha a Piʻilani put ashore at Makaʻeo, where he left his canoe and his companions. It is likely that he then followed the coastal trail to ʻUmi's residence at Kamakahonu.

Following the death of ʻUmi a Līloa, one of his adopted sons, Koʻi, assumed the task of concealing his father's bones. Koʻi was living on Kauaʻi when he heard that his father had died. Samuel Kamakau mentions that Koʻi and his companion embarked by canoe for Maui and then made their way to Hawaiʻi Island:

> They sailed from Kipahulu and landed at Kohala, and there he heard more of ʻUmi-a-Liloa's death. From there they continued to Kekaha, and there darkness fell. There was a man there who strongly resembled ʻUmi-a-Liloa, and Koʻi went to kill him and laid him in the canoe. Koʻi and his companions set sail from Kekaha and beached their canoe at the lava bed below Makaʻeo. It was then late at night. He went up and found the guards of the cave [where his father's body was being kept] asleep except Piʻi-mai-waʻa who guarded the inside. Koʻi entered with the substitute. Piʻi-mai-waʻa knew that the body had long been promised to Koʻi. Koʻi laid the man down and took ʻUmi-a-Liloa's body by way of the lava bed to the sea of Makaʻeo and boarded the canoe (Kamakau 1961:32).

Again, in this second account, we see that Makaʻeo was used as a back entrance to the chiefly compound when the visitor did not wish his presence to be widely known.

A good description of Makaʻeo, as it existed in the later historic period, was provided by John Clark in his book *Beaches of Hawaii*. Clark described Makaʻeo as, "a small Hawaiian community of ʻŌpelu fishermen lived in a cluster of homes in a large coconut grove. Behind the homes were several large brackish-water ponds from which the fishermen gathered tiny red shrimp [*ʻōpae ʻula* (*Crangon ventrosus*)] to mix in the *palu*, or chum, used for catching ʻōpelu. Several springs and one well provided water for drinking and for other domestic needs. The fishermen kept their canoes and boats at Kamakahonu in Kailua, where a protected, sandy cove offered a safe site for landing, unloading catches, and beaching their crafts" (Clark 1985:110). The fishing settlement of Makaʻeo survived until the 1940s when the village and its attendant coconut grove was destroyed to make way for the Kona Airport.

In addition to the coastal settlements of Halepaʻo, Pawai and Makaʻeo, there appears to have been another population center located further inland within the upland agricultural areas bordering the traditional upland trail from Waimea to Kona, which became the Upper Government Road and eventually the Māmalahoa Highway. Boundary Commission testimony indicates that a settlement was situated within the *ʻili ʻāina* (small land division) of Maili along the border with the neighboring *ahupuaʻa* of Lanihaunui. Local informants stated that, "Maili is an old village at Puu o Kaliu a palipali ahua [precipitous mound or hillock], where houses used to stand" (Boundary Commission Testimony 1:355). Land Commission Award testimonies for several *kuleana* parcels claimed in this inland area indicate that *kalo* (taro, *Colocasia esculenta*) and *ʻuala* (sweet potato, *Ipomoea batatas*) were cultivated in *kīhāpai* (small gardens or fields).

3.4.3 Trails

The movement of goods and people overland between coastal settlements as well as between the coast and the uplands was undertaken along an established system of walking trails (*ala hele*). These were narrow paths that followed the contours of the natural terrain. *Ala hele* extended both laterally along the shoreline and from *mauka* to *makai*. The trails that ran inland were referred to as *ala piʻi* (*ala* meaning "path, road, trail", Pukui and Elbert 1971:14, and *piʻi* meaning "to go inland", Pukui and Elbert 1971:301). Also known as "*ala piʻi uka*" or "*ala piʻi mauna*" (*uka* meaning "inland, upland, towards the mountain" Pukui and Elbert 1971:337, and *mauna* meaning "mountain" Pukui and Elbert 1971:223), they connected areas of coastal habitation with the more inland settlements and planting areas, and eventually with the upper forest zones. The coastal trails were referred to as *ala kahakai* (*ala* meaning "path, road, trail", Pukui and Elbert 1971:14, and *kahakai* meaning "beach, seashore", Pukui and Elbert 1971:103), and served to link the various settlements strung along the shoreline.

The *ala loa* were the "long trails," trails of regional significance that covered extensive distances and connected major settlements. Two major *ala loa* appear to have passed through the *ahupuaʻa* of Keahuolū. One of these was the *ala kahakai* that ran along or close to the shoreline. This may have been the trail mentioned by John Papa ʻĪʻī that led from Kamakahonu, the royal residence in Kailua north "as far as Kiholo, where it joins the road from the upland that is called Kealaehu" (ʻĪʻī 1959:120). This *ala loa* connected the coastal settlements. The exact alignment of this trail is uncertain. It may correspond to the route shown on Joseph Emerson's historic map

of North Kona that was drafted from surveys conducted in the 1880s (Figure 21, Emerson 1880s map). However, John Papa ʻĪʻī's account suggests that the trail, or a branch of it, crosses by or over Puʻu o Kaloa, which is slightly inland of the coast (see Section 3.2). This branch may be the one whose beginning is shown on Joseph Emerson's map separating of the main trail just inland of Pawai Bay. Emerson's map, however, does not show the full extent of this trail.

Another *ala loa* appears to have run through the more *mauka* portion of the *ahupuaʻa*, linking the inland settlements located in the agricultural zone and allowing for more direct travel between South Kona and Waimea. This trail may roughly correspond to the alignment of the present upper Māmalahoa Highway.

These traditional trails would have been simple footpaths, wide enough for individuals to walk single file. The construction styles of these *ala hele* varied greatly depending upon the topography and terrain through which they passed. On soil and smooth *pāhoehoe* lava they were often simply paths worn smooth by the passage of many feet. In rough areas, where the trails passed over jagged *ʻaʻā* lava, waterworn boulders or smooth *pāhoehoe* slabs would at times be laid down as stepping stones. In certain cases, trails across *ʻaʻā* would consist simply of a bed of crushed lava clinkers and cinders (occasionally edged with low curbstones). Today, stepping stone trails and crushed clinker trails are relatively easy to recognize and follow. Along stretches of smoother *pāhoehoe*, however, the trails remained generally unmodified, and as a result, it is much more difficult to trace their course.

3.5 Early Historic Period

Additional information on the traditional pattern of settlement and land use within the *ahupuaʻa* of Keahuolū can be gained from the accounts of missionaries and other Westerners who visited the Kona area during the early historic period.

3.5.1 Early Western Visitors

One of these early visitors was Reverend William Ellis, an English missionary who, in 1823, accompanied a group of American Protestant missionaries making a two months circuit of the island of Hawaiʻi, beginning in Kailua, Kona and traveling counter-clockwise around the coast. The published journal of Ellis' journey provides information on both coastal and inland settlement as they existed at that time. Ellis describes the coastal area of Kona, which he refers to as the "Suburbs of Kailua," by saying;

> The houses, which are neat, are generally built on the sea-shore, shaded with cocanut and kou trees, which greatly enliven the scene.
>
> The environs were cultivated to a considerable extent in every direction. Small gardens were seen among the barren rocks on which the houses are built, wherever soil could be found sufficient to nourish the sweet potato, the water melon, or even a few plants of tobacco, which in many places seemed to be growing literally in the fragments of lava, collected in small heaps around their roots (Ellis 1917:47-48).

Ellis' account reveals that, while most of the settlement took place along the seashore, even the barren *pāhoehoe* flows that fringe the coastline of Keahuolū were traditionally cultivated. His description provides a picture of settlement and cultivation in coastal Kona that probably differed little from that of the traditional period.

3.5.2 Population Decline

While there was much continuity between the pre-Contact period and the early years of the historic era, there were also many changes. As early as 1823, Ellis noted that, "traces of deserted villages, and numerous enclosures formerly cultivated, but now abandoned, are every where to be met with" (Ellis 1963:16). Ellis attributed, "The rapid depopulation which has most certainly taken place within the last fifty years" to "the frequent and desolating wars which marked the early part of Tamehameha's [Kamehameha I] reign," as well as the ravages of introduced diseases (Ellis 1963:16). The missionary Asa Thurston estimated a population of not less than 20,000 people along a thirty mile stretch of the North Kona Coast, most living close to the shore, but some families also dwelling in a habitation belt that stretched two miles inland (Kelly 1983:14). A formal census, conducted in 1832, recorded 12,432 people within the district of Kona. By 1835, this number had declined to 5,957 (a 52% decline), and by 1853 it had dropped to 2,210 (an 82% decline). This suggests that there was an 82% decline in the population of Kona in the twenty-one year period from 1832 to 1853 (Schmitt 1968:21, 29, 31).

3.5.3 Māmalahoa Trail

In 1847, a program of road construction was initiated by King Kamehameha III. This program involved the modification of many old trail alignments (particularly the *ala loa*) to create a system of *Ala Aupuni* (Government Roads, also known as *Alanui Aupuni* or "Main Government Roads"). Construction of these roads was funded by government appropriations and the financial contributions of local residents. Work on the roads was often carried out using convict labor. Existing routes were widened, leveled (often by the construction of stone causeways), and in some cases lined with curbstones. These *Ala Aupuni* became the main routes of travel between major population centers, such as Waimea and Kona. They often appear marked on government survey maps. The smaller *ala piʻi* continued to be used, particularly by residents of the minor settlements scattered along the coast or in the uplands.

One result of this trail improvement program may have been the construction of the Māmalahoa Trail, though it is equally possible that this trail was built somewhat earlier, during the tenure of Governor John Adams Kiʻiapalaoku Kuakini, who served as the second Royal Governor of Hawaiʻi Island from 1820 to his death in 1844. The Māmalahoa Trail (Site 50-10-27-00002) is a stone curbed roadbed built during the early years of the 19th century to allow horse and wagon traffic to travel between Kailua-Kona and the coastal areas of North Kona. Referred to on later maps as the Lower Government Road, it appears to have been constructed between 1836 and 1855 (Cordy et al. 1991:403, 405).

The trail's name, Māmalahoa, appears to be a variation of *māmala hoe* (literally paddle fragment) (Pukui and Elbert 1971:235). The Māmalahoe Kanawai (the "law of the splintered paddle") was promulgated by Kamehameha I, and guaranteed the safety of all people traveling the highways of the kingdom. Linguist Mary Kawena Pukui has suggested that the word *hoe* (paddle) came

to be replaced by *hoa* (friendship), and that this variant version was used as the name of the trail (Pukui et al. 1974:144).

A relatively straight, curb-lined path wide enough for horses and carts, the Māmalahoa Trail provided a more direct route of travel between historic era communities. In the classification of Hawaiian trail types developed by historian Russell Apple, the Māmalahoa Trail might be considered a Type C trail: a curbed road bed wide enough for two horse to ride abreast and built in a relatively straight line between major points, cutting off the small coastal settlements (Apple 1965:43-59, 68). Such trails were commonly built by labor forces conscripted by the island governors (Apple 1965:45-50).

The construction of such historic horse/mule trails and cart paths usually involved the straightening and/or realigning, as well as the widening and smoothing over of older walking trails. Some sections of old trail were simply abandoned for newer more direct routes. While the traditional *ala kahakai* often followed the winding of the shoreline linking the region's coastal settlements, the new historic trails were frequently moved far enough inland so as to ensure a straight alignment. It is unclear how closely the historic Māmalahoa Trail corresponds to the traditional *ala kahakai* in this stretch of North Kona. It may run straighter and be located somewhat more inland.

At the time of its construction, the Māmalahoa Trail served as the major thoroughfare for this section of Kona. By 1888, however, its use had substantially declined (Cordy et al. 1991:403, 405). During the late historic and modern periods the Māmalahoa Trail was utilized only sporadically. Some stretches of the trail show evidence of vehicular use, suggesting that they may have served as jeep tracks (Walsh and Hammatt 1995:37). In recent years the trail has been breached at numerous points along its length and now survives as a series of discontinuous segments in varying states of preservation.

The original alignment of the Māmalahoa Trail can be reconstructed based upon these surviving remnants and its course as shown on early historic maps. While the 1952 sectional map of Kailua shows the trail running north only as far as the boundary of the two *ahupuaʻa* of Honokahaunui and Honokahauiki (Figure 11), more recent USGS maps show it extending up to the runway of the Keāhole-Kona Airport. Remnants of the surviving trail are visible on aerial photographs stretching from the outskirts of Kailua town to the *ahupuaʻa* of Kohanaiki. From Kohanaiki, the trail extends south on the *makai* side of the Queen Kaʻahumanu Highway. The trail crosses from the *makai* to the *mauka* side of the Highway in the area of the Kaloko-Honokōhau National Historic Park entrance road. It can then be clearly seen running roughly parallel to the highway just inland of its *mauka* shoulder. The trail enters the *ahupuaʻa* of Keahuolū along the *makai* boundary of the Urban Phase II and portions of the Urban Phase I parcels. Not long after it enters the Phase I property, just north of the Makala Boulevard intersection, its route re-crosses the highway. All traces of the trail from this point south have been obliterated by highway, commercial and urban construction activities. A 1992 archaeological inventory survey identified a segment of the trail which at that time extended through the northeastern corner of the Kona Commons project area (O'Hare and Rosendahl 1993, Figure 30). This segment has since been destroyed.

3.5.4 The Māhele ʻĀina

Among the other governmental reforms that took place around this time was the Māhele ʻĀina (land division, also known as the Great Māhele or simply the Māhele) of the 1840s, which put an end to the traditional system of land tenure and ushered in private ownership of property. At the time of the Māhele the lands of the Hawaiian kingdom were "…divided into three parts – one to the Chiefs, one for the support of the Government, and a third for the King's personal use. These we know by the names of "Konohiki," "Government" and "Crown Lands"" (*Indices Of Awards* 1929:vii). It was principally from within the chief's "…one-third of the Great Mahele that the common people, who were their tenants, received title to the small holdings which are known as "Kuleanas". These Kuleanas were areas which these tenants had improved and used for their own purposes" (*Indices Of Awards* 1929:vii). In order to be granted a *kuleana* holding, a member of the *makaʻāinana* (common people) had to present his claim before the Land Board and give testimony in support of it.

In December of 1845, a Board of Commissioners to Quiet Land Titles (often referred to as the Land Board or Land Commission) was established to investigate land claims and make awards based upon these claims and their supporting testimony. If a claim was approved by the Board, a Land Commission Award (L.C.A.) was granted to the claimant. These L.C.A. properties were known as *kuleana* lands. Often a single *kuleana* claim consisted of several *ʻāpana* (land sections).

After nine years the Land Commission was dissolved in March, 1855. "The Land Commission worked with most commendable energy, going to every part of the Islands to meet the people and prepare for awarding their claims, involving the hearing and taking of testimony in connection with nearly 12,000 individual claims. These awards are of record in ten immense volumes, and the testimony on which they are based is recorded in some fifty odd lesser volumes …" (*Indices Of Awards* 1929:vii-viii). The claims and supporting testimony presented before the Land Commission are preserved in the Land Commission Records presently housed at the Hawaii State Archives. Among the documents that make up these records are the *Buke Kakau Paa no ka mahele aina i Hooholoia i waena o Kamehameha III a me Na Lii a me na Konohiki ana*, commonly referred to as the Māhele Book, which records the division of lands between Kamehameha III, the chiefs, and the konohiki (Māhele Book 1848); the Land Commission Awards of *kuleana* claims (Land Commission Awards 1836-55); the Native Register of claims (Native Register 1846-48); the Foreign Register of claims (Foreign Register n.d.); the *Buke Hoike*, commonly referred to as Native Testimony, which includes testimony on land claims, chiefly in Hawaiian, of both native and foreign-born residents made during the Māhele ʻĀina (Native Testimony 1844-54), and Foreign Testimony, which includes testimony on land claims, chiefly in English, of both native and foreign-born residents (Foreign Testimony 1846-62).

The concept of land ownership was foreign to the traditional Hawaiian way of thought. As a result, not all Hawaiians occupying lands submitted claims to the Land Commission. In addition, not all claimants were awarded land, and even those claims that were granted did not always included the fallow fields and scattered agricultural plots that had traditionally been part of a *kuleana*. Though they are occasionally difficult to decipher, Land Commission Award records can provide a wealth of information concerning what was happening on the land at the time of the claim. Claimants often supported their claims by testifying as to the presence of house sites, fields, gardens and other features on their land. This documentation can in turn be

used to infer possible traditional settlement patterns and land uses. The details of land use within such *kuleana* parcels can be gleaned from Land Commission claims presented in the Land Commission Award Books and Native Testimony provided in support of those claims.

At the time of the Māhele ʻĀina, the entire *ahupuaʻa* of Keahuolū was awarded to the *aliʻi wahine* (chiefess) Analea (Ane) Keohokālole under Land Commission Award 8452: Apana 12 (Royal Patient 6851) (Wong Smith 1990:B3). Chiefess Ane Keohokālole was born in Kailua Kona in 1816, the daughter of *aliʻi kāne* ʻAikanaka and the *aliʻi wahine* Kamaʻeokalani (Figure 14). She was named Keohokālole, which means straight hair, by Kaʻahumanu because of her father's straight hair. Her fraternal great grandfathers were Kameʻeiamoku and Keawe-a-Heulu, two of the five major war chiefs who assisted Kamehameha I in conquering and uniting the islands (Kelly 1983:31). Ane Keohokālole served as a member of the House of Nobles from 1841 to 1847, and on the King's Privy Council 1846 to 1847.

In 1833, Ane Keohokālole married her first cousin, Caesar Kaluaiku Kamakaʻehukai Kahana Keola Kapaʻakea. Just as her *kūpuna* (ancestors) had played an important role in helping Kamehameha I establish the kingdom of Hawaiʻi, Ane Keohokālole's offspring were to play a significant role in its continuation. Among the many children born to Ane Keohokālole and her husband Kapaʻakea were David Laʻamea Kamanakapuʻu Mahinulani Nalaiaehuokalani Lumialani Kalākaua, who became the 7th king of Hawaiʻi, and Lydia Liliʻu Loloku Walania Wewehi Kamakaʻehā (more commonly known by her royal name of Liliʻuokalani) who succeeded her brother as its 8th and final ruler (Figure 14). Ane Keohokālole's youngest daughter, Miriam Kapili Kekāuluohi Likelike, was herself the mother of Princess Victoria Kaʻiulani Kalaninuiahilapalapa Kawekiu i Lunalilo Cleghorn, who was proclaimed heir apparent to the throne in 1891 and would have become the 9th ruler if the kingdom had not been overthrown in 1893.

Chiefess Keohokālole inherited extensive tracts of land from her paternal grandmother Keohohiwa and great uncle Naihe. Land court documents indicate that the chiefess held two walled houselots "from very ancient times" along the shore of Keahuolū. At her death, the lands of Keahuolū passed on to her heir, Liliʻuokalani.

Although Ane Keohokālole was given title to the entire *ahupuaʻa*, there were existing tenants who resided and cultivated land within Keahuolū. Some of these filed claims with The Board of Commissioners to Quiet Land Titles and were awarded *kuleana* lands (Wong Smith 1990: B-4, Native Register). A total of six smaller Land Commission Award claims were granted within the *ahupuaʻa* of Keahuolū:

L.C.A. 7351: to Kahuanui
L.C.A. 8012: to Apiki
L.C.A. 10198: to Hailewalewa
L.C.A. 10303: to Maa
L.C.A. 10345: to Naalualu
L.C.A. 11071: to Aki

Figure 14. Genealogy of Queen Lili'uokalani (courtesy of the Queen Lili'uokalani Trust).

Five of these *kuleana* appear on County Tax Maps as being located *mauka* of the Upper Government Road (now the Māmalahoa Highway) along the boundary with the *ahupua'a* of Lanihau (Figure 15). This area appears to correspond to the '*ili* '*āina* of Maili, which is described in Boundary Commission testimony as, "an old village at Puu o Kaliu a palipali ahua [precipitous mound or hillock], where houses used to stand" (Boundary Commission Testimony 1:355). Testimony accompanying these land claims (Native Testimony) indicates that all of the parcels contained one or more cultivated *kīhāpai* (small gardens or fields, Pukui and Elbert: 1971:136). The crops mentioned in testimonies related to these claims include both *kalo* (taro) and '*uala* (sweet potatoes), suggesting that all of them were located in the fertile lands near the upper Government Road (Wong Smith 1990: B-4).

Land Commission Award (LCA) 7351 to Kahuanui for 2.90 acres

Papaula, sworn says I know the claim of Kahuanui. It is in the ahupuaa of Keahuolu, Kona. It consists of one piece of kalo land, five patches—all lying together. One of these patches is planted with coffee. It is bounded mauka by the land of Kahookohukaneole, Kau by Lanihau, makai by the land Nahaalualu, Kohala by the konohiki. Claimant received this land from his brother in 1846, and his title has never been disputed (Foreign Testimony Vol. 8:682, translation from Wong Smith 2007:12)

Land Commission Award (LCA) 8012 to Apiki for 1.10 acres

Mahu, sworn, says he knows the kuleana of Claimant in Kailua, Kona. It consists of five patches of Kalo and a lot of patches of potatoes. The kalo patches form one piece, bounded on Kau side by Lanihau, makai by Papaula's land, Kohala side the same, mauka by Hai's land. The potato land is bounded mauka by Haino's land, Kau side by Lanihau, makai by Kahili's land, Kohala side the same. Claimant derived the land from the Konohiki, before the death of Kuakini, and has held it ever since without disputes (Foreign Testimony Vol. 8:676, translation from Wong Smith 2007:12)

Land Commission Award (LCA) 10198 to Hailewalewa (Kailewalewa) for 1.30 acres

Mahu sworn, He has seen the place on which Hailewalewa had cultivated with his own hands, it is in Ulelele ili of Keahuolu ahupuaa. Section 1 taro. Section 2, Kaluulu. Land has been cultivated, one land section. On land from Hailewalewa's parents to him. Uncertainty for one section (Native Testimony Vol. 4:525, translation from Wong Smith 2007:12).

Land Commission Award (LCA) 10303 to Maa for 2.25 acres

Mahu sworn, He had seen a whole section of land, however, it is just as he has indicated in his claim that there are eleven taro kihapais, and ten potato kihapais in the ili land of Maili of Keahuolu ahupuaa. That land is not cultivated completely, but, Maa had planted seven palm trees. The fruit is for Samuela, both Maa and Samuela have joint interest in the seven fan palm trees. There is also a coconut grove which had been planted by Maa's grandparents for the Chings who owned the land, they were the caretakers. The same had applied to Maa's parents and to him at the present time. The coconuts went to Keohokalole upon the death of Keoua and it has been that way to the present time. One whole section is salt land and it is still yielding salt. [while testimony regarding Maa's claim mentions a section of land "yielding salt," his *kuleana* in the '*ili* of Maili is located in the uplands]...Land passed down to Maa's parents, these to him now. Maa's grandparents received the ili land Maili of Keahuolu during the time of Kamehameha I. Kamauoha had given to Maa the land section of Lanihau ahupuaa in

1848, no one had object to him (Native Testimony Vol. 4:526, translation from Wong Smith 2007:12)

Land Commission Award (LCA) 10345 to Nahaalualu (Naalualu) for 2 acres

Kuia sworn, He had seen Naalualu place that he had cultivated himself in the ili land of Puuokaliu of Keahuolu ahupuaa in Hawaii. Section 1 (boundaries given) one section cultivated. Section 2, four cultivated kihapai, Section 3, one cultivated kihapai, Section 4, four cultivated kihapais...(Native Testimony Vol. 4:527, translation from Wong Smith 2007:12).

Land Commission Award (LCA) 11071 to Aki for 0.60 acres

Kuia sworn, He has seen Aki's land that which he had cultivated himself, it is in the ili land of Pauaaiki of Keohuolu [sic] ahupuaa in Hawaii. Section 1, five cultivated kihapais. Section 2, one kihapai not cultivated. Section 6, four cultivated kihapai. Section 7, one cultivated kihapai. These interests have been made from Kaea, Nahaalualu and Kalekahi at the time of Kamehameha I (Native Testimony Vol. 4:527, translation from Wong Smith 2007:12)

No *kuleana* claims were awarded within the coastal portions of Keahuolū. This appears to reflect the general decline in the local population and the gradual abandonment of the coastal settlements. That is not to say that the coastal regions of Keahuolū were completely deserted by the late 1840s. Not all Hawaiian families made *kuleana* claims (in fact, the percentage that did so was relatively small), and it is likely that many of the surviving coastal residents continued to dwell in their ancestral homesteads. It is also probable that many families living along the more barren stretches of the coast shifted their place of residence to more fertile areas, such as the coconut grove at Pawai Bay, where a small community survived well into the historic period. Given the relatively barren and inhospitable nature of the more interior areas of the *kula* zone, it is not surprising that there were no *kuleana* claims made for lands located within this area.

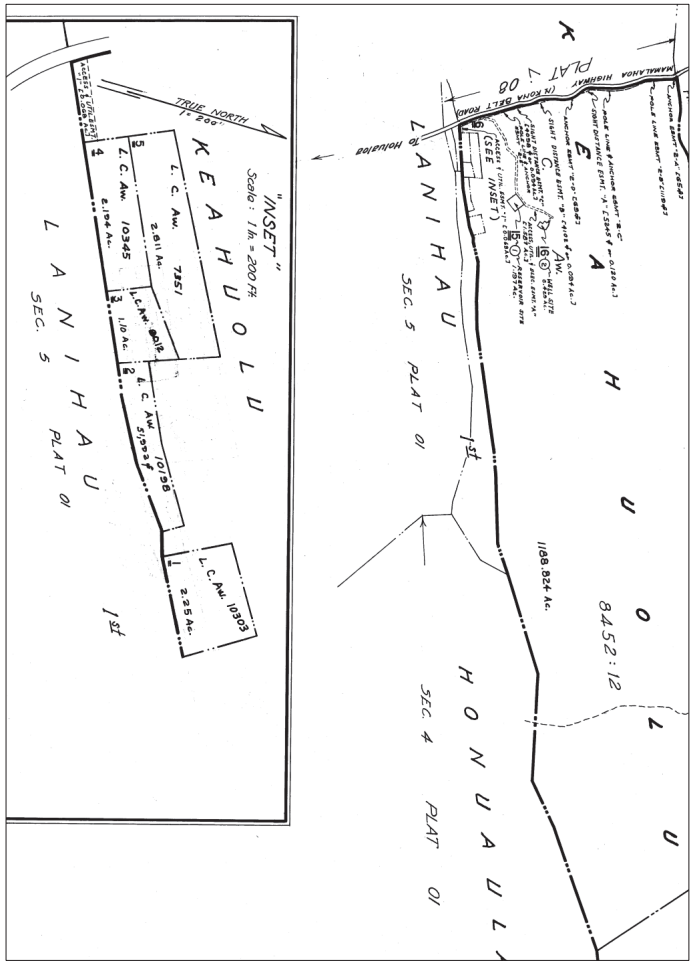


Figure 15. Section of Hawai'i County Tax Map Zone 7, Section 4, Plat. 2 showing Land Commission Award parcels in *mauka* Keahuolū.

3.6 THE LATER HISTORIC PERIOD

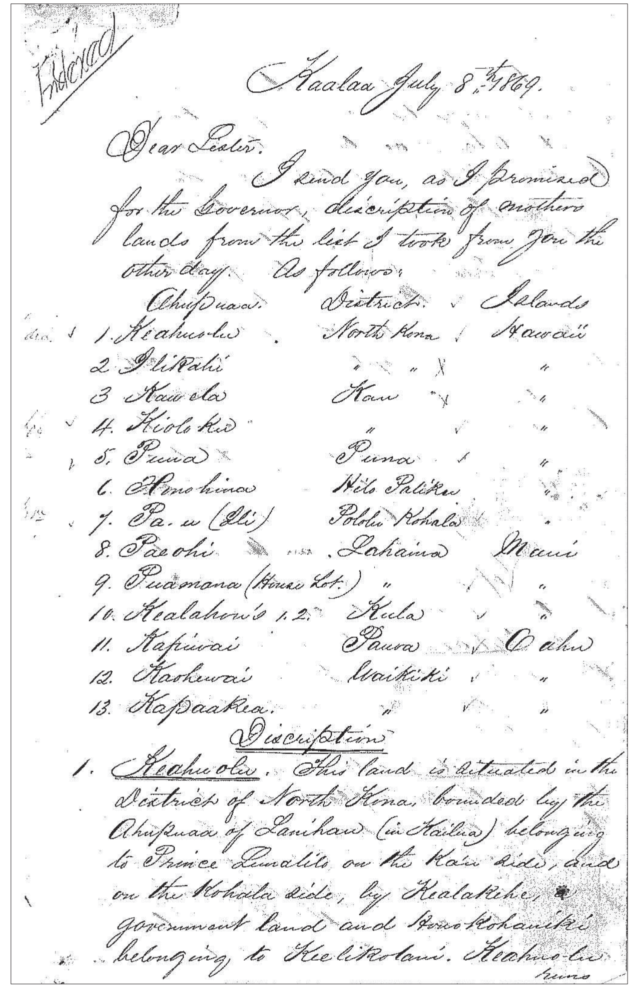
Following the Māhele ʻĀina, even greater changes took place within the *ahupua*ʻ*a* of Keahuolū as its resident population continued to decline and much of the land was given over to cattle ranching.

3.6.1 David Kalākaua's Letter

Ane Keohokālole died in April of 1869. A few months after her death, her son David Kalākaua sent a letter addressed to his sister Liliʻuokalani describing the various lands belonging to their mother. In this letter, dated July 8, 1869 (housed in the Hawaiʻi State Archives, a copy is included below, Figure 16 and Figure 17), Kalākaua provides a description of the *ahupua*ʻ*a* of Keahuolū.

> This land is situated in the District of North Kona, bounded by the Ahupuaa of Lanihau (in Kailua) belonging to Prince Lunalilo on the Kaʻu side, and on the Kohala side, by Kealakehe, a government land and Honokohauiki belonging to Keelikolani. Keahuolu runs clear up to the mountains and includes a portion of nearly one half of Hualalai mountains. On the mountains the koa, kukui and ohia abound in vast quantities. The upper land or inland is arable, and suitable for growing coffee, oranges, taro, potatoes, bananas &c. Breadfruit trees grow wild as well as the Koli oil seed. The lower land is adopted for grazing cattle, sheep, goat, &c. The fishery is very extensive and a fine grove of cocoanut trees of about 200 to 300 grows on the beach. The flat land near the sea beach is composed chiefly of lava, but herbs and shrubbery grows on it, an [sic] herbs suitable for feed of sheep and goats. It is estimated at 15,000 to 20,000 acres or more (Kalakaua 1869).

The "fine grove of cocoanut trees" referred to in the letter is most likely the grove shown on early maps as being located at Pawai Bay and Makaʻeo. Kalākaua's comment that the "flat land near the sea beach" is suitable for the grazing of "sheep and goats" provides another indication that many of the house sites in this coastal area had already been abandoned.



Endorsed

Kaalaa July 8th 1869.

Dear Lealii:
I send you, as I promised for the Governor, discription of mothers lands from the list I took from you the other day. As follows:

Ahupuaa.	District.	Islands
1. Keahuolu	North Kona	Hawaii
2. Ilikahi	"	"
3. Kaauela	Kau	"
4. Kiolokia	"	"
5. Puna	Puna	"
6. Honohina	Hilo Paliku	"
7. Pa.u (Ili)	Pololu Kohala	"
8. Paeohi	Lahaina	Maui
9. Puamana (House Lot.)	"	"
10. Kealahou's 1.2.	Kula	"
11. Kapuwai	Pauoa	Oahu
12. Kaohuwai	Waikiki	"
13. Kapaakea.	"	"

Discription

1. Keahuolu. This land is situated in the District of North Kona, bounded by the Ahupuaa of Lanihau (in Kailua) belonging to Prince Lunalilo on the Kau side, and on the Kohala side, by Kealakehe, government land and Honokohauiki belonging to Keelikolani. Keahuolu runs

Figure 16. Portion of Kalākaua's 1869 letter concerning Keahuolū (page 1).

runs clear up to the mountains and includes a portion of nearly one half of Hualalai Mountains. On the mountains the Koa, Kukui and Ohia abounds in vast quantities. The upper land or inland is arable, and suitable for growing Coffee, oranges, taro, potatoes, bananas &c. Bread fruit trees grow wild as well as the Koli oil seed. The lower land is adopted for grazing Cattle sheep, goats &c. The fishery is very extensive and a fine grove of cocoanut trees of about 200 to 300 grows on the beach. The flat land near the sea beach is composed chiefly of lava, but herbs and shrubbery grows on it, and herbs suitable for feed for sheeps and goats. It is estimated at 15,000 to 20,000 acres or more.

2. Ulukaki. This land I dont know much about. I have always thought it was sold or given at the division of lands to the government.

3. Kawelo. This is a large land. I should think it about 6000 to 7000 thousand acres or more. This land is adopted for grazing. (I think a large portion of Keelikolani's cattle runs on the land.) A portion of this land is lava and on the lava, the wiliwili timber grows.

Figure 17. Portion of Kalākaua's 1869 letter concerning Keahuolū (page 2).

3.6.2 Keahuolū in 1875

A glimpse of life as it was lived in North Kona during the late 19th century is provided by J. P. Pu'uokapu, a *kama'āina* of the Kekaha region, who in 1875 wrote a letter to the editor of the Hawaiian language newspaper *Kuokoa*. Pu'uokapu's letter was composed in response to a previous letter from a visitor to Kona who suggested that there was drought and famine in Kekaha. J. P. Pu'uokupa's description not only gives evidence of the traditional foods ("sweet potatoes and taro") still being grown on these lands, but also the introduction of new commercial enterprises such as the cultivation of coffee and raising of livestock. This description can be applied to life in the *ahupua'a* of Keahuolū at that time.

> The people who live in the area around Kailua are not bothered by the famine. They all have food. There are sweet potatoes and taro. These are the foods of these lands. There are at this time, breadfruit bearing fruit at Honokohau on the side of Kailua, and at Kaloko, Kohanaiki, Ooma and the Kalaoas where lives J.P. [the author]. All of these lands are cultivated. There is land on which coffee is cultivated, where taro and sweet potatoes are cultivated, and land livestock is raised. All of us living from Kailua to Kalaoa are not in a famine, there is nothing we lack for the well being of our bodies.
>
> …As was said earlier, coffee is the plant of value on this land, and so is the raising of livestock. From the payments for those products, the people are well off and they have built wooden houses. If you come here you shall see that it is true. Fish are also something which benefits the people. The people who make the *pai ai* [cakes of hard, pounded but undiluted *poi*, the common form in which *poi* was carried over long distances or exchanged for other foods] on Maui bring it to Kona and trade it. Some people also trade their *poi* for the coffee of the natives here… (*Kuokoa*, November 27, 1875, as translated by Maly 2000).

3.6.3 Boundary Commission

In 1862, the Board of Commissioners for Boundaries was established by the legislature of the kingdom to formalize the boundaries of large land divisions, such as *ahupua'a*, which had not been accurately surveyed at the time of the Māhele. As part of this process, the Board collected detailed testimonies from older native residents called on to relate what they knew of the boundaries of the various *ahupua'a*. These testimonies contain not only information on the boundaries and traditional place names, but also details of some of the traditional activities which took place on these lands. The native witnesses usually spoke in Hawaiian, and their testimony was translated into English and then transcribed. As a result, the Boundary Commission testimonies often contain inconsistencies in the spelling of traditional place names. The collected testimonies of local witnesses and the resulting Boundary Certificates are preserved in the Boundary Commission Records and are accessible on microfilm at the Hawai'i State Archives (Boundary Commission).

Application for the judication of the boundaries of the *ahupua'a* of Keahuolū was made by John Owen Dominis, the husband of Queen Lili'uokalani. Testimony regarding the boundaries of the *ahupua'a* of Keahuolū was heard by the Commission on August 12, 1873 at the Court House in Kailua Kona (an annotation on the Boundary Certificate for Keahuolū indicates that the accompanying testimony was included in Folio 354 Book A). Information gleaned from the Boundary Commission Records has been useful in locating and identifying many of the traditional place names within the *ahupua'a* of Keahuolū.

3.6.4 1875 Map of Keahuolū

In 1875, a map was drafted of the "Ahupuaa Keahuolu in N. Kona Hawaii" based upon work undertaken by Hawai'i Government Surveyor J. F. Brown (Brown 1875 map). These surveys appear to have been conducted by Brown as part of the certification of the boundaries of Keahuolū by the Boundary Commission that had taken place the previous year. The Boundary Certificate for the *ahupua'a* notes that the boundary points recorded are "As surveyed by J. F. Brown" (Boundary Commission Vol. 1, No. 3:47).

Brown's map provides an overview of the *ahupua'a* as it existed in the late 19th century, including its rough topography and vegetation zones (the complete map is shown in Figure 18, while its coastal section is shown in Figure 19).

The lower portion of the 1875 map shows the coastal area of Keahuolū, from the shoreline *mauka* (inland) to the "Lower Road to Kailua." This lower road is most probably the historic Māmalahoa Trail (State Site 50-10-27-00002), which ran from Kailua town to the settlements further north. The lands situated *makai* of "Lower Road to Kailua" are labeled "Barren Pahoehoe." The only areas of vegetation noted in this coastal area are two small groves of coconut palms along the shore. The larger and more southerly of these palm groves, located near the lava headland of Pōhakuloa, is most probably the one mentioned in David Kalākaua's 1866 letter to his sister which speaks of "a fine grove of cocoanut trees of about 200 to 300." This coconut grove edges Pawai Bay and marks the site of the fishing settlement of Maka'eo, "a small Hawaiian community of 'Ōpelu fishermen…in a cluster of homes in a large coconut grove" (Clark 1985:110). The small circle marked on the map as being located slightly north along the shore from the coconut grove may represent the water hole of Keanawai (*ke ana wai*, literally translated as "the water cave," Pukui and Elbert 1971:130, 22, and 349) which is described in Boundary Commission testimony as "a water hole, where there used to be a great many houses" (Boundary Commission Testimony 1:355). A second, smaller grove of coconut palms is shown further north at Halepa'o Bay, where another circle appears to mark the location of the anchialine ponds there.

The coastal area of the *ahupua'a*, within which rests the present project area, is marked in the 1875 map as "Barren Pahoehoe." This lava land is shown to stretches inland to a point half way between the "Lower Road to Kailua" and the "Mauka Govt Road," which roughly corresponds to the route of the present Māmalahoa Highway.

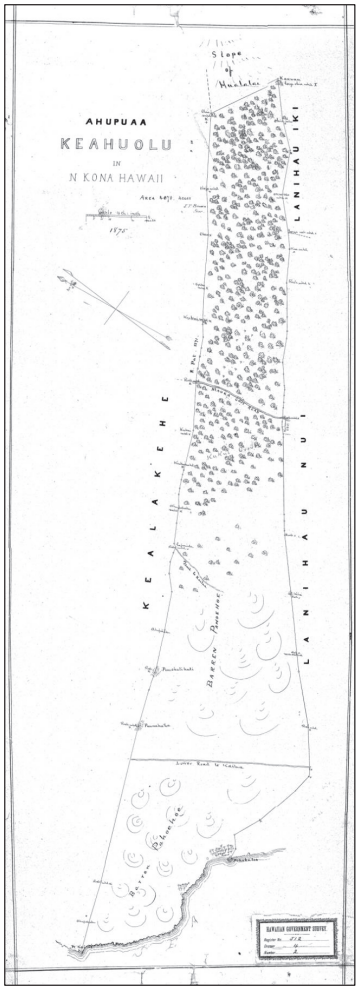


Figure 18. 1875 survey map of the *ahupua'a* of Keahuolū (Brown 1875 map).

Figure 19. Coastal section of the 1875 map of Keahuolū *ahupua'a* (from Brown 1875 map).

3.6.5 Joseph S. Emerson 1880s Map

Another historic map which sheds light on the coastal area of Keahuolū is a map of the North Kona District based upon surveys conducted by Hawai'i Government surveyor Joseph Swift Emerson in the 1880s (Figure 20, Emerson 1880s map).

Born at Lāhaināluna, Maui in 1843, Emerson was the sixth son of missionaries Reverend John and Ursula Emerson. He was employed by the Hawaiian Kingdom as a surveyor from 1877 onwards, working on Hawai'i Island. Greatly interested in Hawaiian beliefs, traditions, and customs, Emerson, who was a fluent speaker of *'ōlelo Hawai'i* (the Hawaiian language), sought out knowledgeable native residents of the lands he surveyed to act as his guides. He made meticulous notes of place names and of the traditions associated with various features of the cultural and natural landscape. As Emerson noted in a letter to W. D. Alexander, the government Surveyor General, he documented, "every visible hill, cape, bay, or point of interest in the district, recording its local name, and the name of the Ahupuaa in which it is situated. Every item of local historical, mythological or geological interest has been carefully sought & noted" (Emerson 1882). Emerson's field notebooks, which are presently held at the Hawai'i State Survey Office, provide a wealth of information about the places he surveyed.

The portion of Emerson's map which includes the more coastal section of the *ahupua'a* of Keahuolū shows several roads and/or trails (Figure 21). There is what appears to be a coastal trail running north from Kailua and ending just north of the Keahuolū/Kealakehe *ahupua'a* boundary. Also shown is the route of the Māmalahoa Trail and the upper Government Road (Brown's "Mauka Govt Road," now the Māmalahoa Highway). The "Trail to Kailua" as shown on Brown's map, is traced out more fully, extending from the upper road into Kailua town and crossing through the *ahupua'a* of Keahuolū in the process. Its alignment approximates that of the present Palani Road (Figure 22).

In the vicinity of the Kona Common project area, the Emerson map shows three place names (Figure 22). Only one of these is located within the project area itself. This is the survey point labeled "Namahana," which is located along a now destroyed section of the Māmalahoa Trail just *makai* of the Queen Ka'ahumanu Highway in the present industrial area, down slope of the Makalapua Shopping Center. Its location roughly corresponds to the *mauka* portion of the International Marketplace property (Figure 22).

Two other place names are located somewhat *makai* of the project area, in the present Old Kona Airport State Recreation Area. The first of these is the place name "Kaholeakane" which appears at a point along the boundary between Keahuolū and Lanihaunui near to the coast, northwest along the *ahupua'a* boundary from "Puu o palena" (Figure 22). This boundary point is located *makai* of the present intersection between Loloku Street and the Kuakini Highway in the area of the Old Kona Airport State Recreation Area.

A second boundary point, labeled "Puu o palena," appears along the *ahupua'a* boundary between Keahuolū and Lanihaunui where the northwest to southeast running boundary line (which parallels the coast) angles inland. It is situated between "Kaholeakane" (to the northwest) and the Māmalahoa Trail (to the northeast), which at that point runs somewhat south of the present Queen Ka'ahumanu Highway as it began to enter Kailua town.

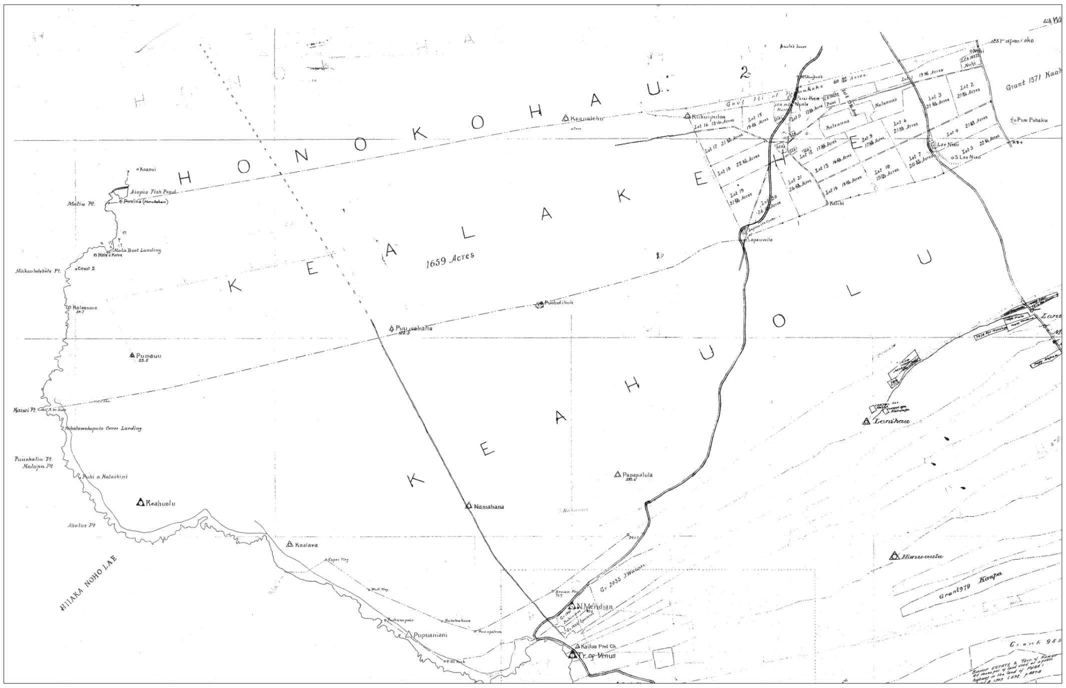


Figure 21. Portion of Joseph S. Emerson's 1880s map showing the *ahupua*'*a* of Keahuolū (from Emerson 1880s map).

Figure 20. Joseph S. Emerson's 1880s map of the Kona region (Emerson 1880s map).

Figure 22. Portion of Joseph S. Emerson's 1880s map overlaid atop USGS topographic map (base USGS Keāhole Point quad. overlay from Emerson 1880s map).

Presently this location corresponds to the area somewhat *makai* of the intersection between Kaiwi Street and the Kuakini Highway in the Old Kona Airport State Recreation Area. The place name appears to refer to a small hill (*pu'u*) formerly located in that area.

3.7 1900S TO PRESENT

By the early 1900s, much of coastal Keahuolū had been given over to the raising of cattle. The relative absence of people from the land was noted by John Reinecke who was contracted by the Bernice Pauahi Bishop Museum in 1929 and 1930 to conduct a survey of archaeological sites in West Hawai'i. A portion of Reinecke's survey area extended from Kailua to Kalāhuipua'a, and he observed that,

> This coast formerly was the seat of a large population. Only a few years ago Keawaiki, now the permanent residence of one couple, was inhabited by about thirty-five Hawaiians. Kawaihae and Puako were the seat of several thousands, and smaller places numbered their inhabitants by the hundreds. Now there are perhaps fifty permanent inhabitants between Kailua and Kawaihae–certainly not over seventy-five. When the economy of Hawaii was based on fishing and horticulture this was a fairly desirable coast; the fishing is good; there is a fairly abundant water supply of brackish water, some of it nearly fresh and very pleasant to the taste; and while there was no opportunity for agriculture on the beach, the more energetic Hawaiians could do some cultivation at a considerable distance mauka (Reinecke 1930:1-2).

From the late 1890s until 1924 a sisal (*Agave sisilana*) mill was in operation at Keahuolū. The 1924 U.S. Geological Survey topographic map of the Kailua Quadrangle shows the mill as being located at an elevation of approximately 428 feet along inland trail that now corresponds with Palani Road (United State Geological Survey 1924b map). The mill was surrounded by sisal fields that covered an area of up to 1000 acres in Keahuolū and Kealakehe *ahupua'a* (Jensen 1995).

In the early years of the 20th century, Henry Walsworth Kinney walked the shoreline of Kona from Kailua north through Keahuolū. He described what he saw in a book published in 1913. In that book, Kinney mentions encountering several *heiau* and fishing shrines in the large coconut grove near Pōhakuloa at the Keahuolū/Lanihau boundary. He also makes mention of the *heiau* of Pauai, which appears to be located among the coconut trees at Pawai Bay.

> From the point where the Honokohau Trail leaves Kailua a poor trail leads makai over the lava to the lighthouse. Hence it continues along the beach for a couple of miles. After passing several old stone mausoleums [shown on the 1883 map], the trail passes an abandoned grass house where is a stone wall, the remnants of the heiau Keohuulu. Still further north is a cocoanut grove, where there were several heiau, notably that of Palihiole. There were several kuula [fishing shrine, usually dedicated to the fishing god Ku'ula Kai] here, one particularly powerful one, the idol of which is still remembered as having been in a fair state of preservation, only one arm missing, when a Christian priest took it from the cave where it was kept. Since then, say the inhabitants, the fishing has been comparatively poor. In the grove are two cocoanut stumps which served as gallows for the first execution conducted by hanging in Hawaii. A chief, Kekuakahaku, was the

victim. Beyond the main grove are a few isolated trees near the edge of the flow. Here was the heiau of Pauai [Pawai?], and here the trail ends (Kinney 1913:59).

It has sometimes been assumed that the chief mentioned by Kinney was Kamanawa, paternal grandfather of David Kalākaua, who was hanged for murdering his ex-wife Kamokuʻiki by giving her a poisoned cup of *ʻawa* (Wong Smith 2007:19). The hanging of Kamanawa was the first public execution under the 1840 laws, but historic evidence suggests that the execution took place at the Fort in Honolulu.

3.7.1 1924 United States Geological Survey Map

The 1924 United State Geological Survey (USGS) topographic map of the Keāhole Point Quadrangle shows three distinct trails running through or adjacent to the Kona Commons project area (Figure 23, United State Geological Survey 1924a map). These three trails appear as dashed lines on the map. One of these trails runs along the coast from Kailua Bay and extends as far as Pawai Bay, located at the northern end of the present Old Kona Airport Park. This appears to represent the course of the traditional coastal trail, the "poor trail" described by Kinney that "leads makai over the lava to the lighthouse" and ends at the heiau of Pauai (Kinney 1913:59). A second trail, which runs northwest from Kailua town and somewhat inland of the coast, represents the alignment of the historic Māmalahoa Trail. A third trail branches off of the Māmalahoa Trail within the vicinity of the present Kona industrial development located just east of the present survey area (as can be seen when the 1924 map is overlaid atop a contemporary USGS topographic map, Figure 24 and runs southwest, connecting to the coastal trail near the survey point of Mahiahale, just inland of the settlement of Mākāʻeo (Figure 24). As can be seen when the route of these trails is overlaid atop a contemporary USGS topographic map (Figure 24), the third trail crosses through the *makai* half of the Kona Commons project area.

Although both the coastal trail and Māmalahoa Trail are shown on other early maps, this is the first documentary evidence for the existence of the connecting trail. This trail does not appear on Joseph Emerson's 1880s map (Figure 20, Emerson 1880s map) or other known early historic maps.

3.7.2 Liliʻuokalani Trust

In December of 1909, Queen Liliʻuokalani executed a deed of trust establishing a private foundation dedicated to the welfare of orphan children. Two years later she amended that deed to include destitute children among her beneficiaries. It was the Queen's wish that, "all the property of the trust estate, both principal and income, . . . shall be used by the Trustees for the benefit of orphan and other destitute children in the Hawaiian Islands, the preference to be given to Hawaiian children of pure or part aboriginal blood." The childless Queen had inherited ancestral lands through her mother, Analea Keohokālole, and it was with these lands that she established the Trust. As a result of her bequest, upon Liliʻuokalani's death the *ahupuaʻa* of Keahuolū passed into the care of the Queen Liliʻuokalani Trust.

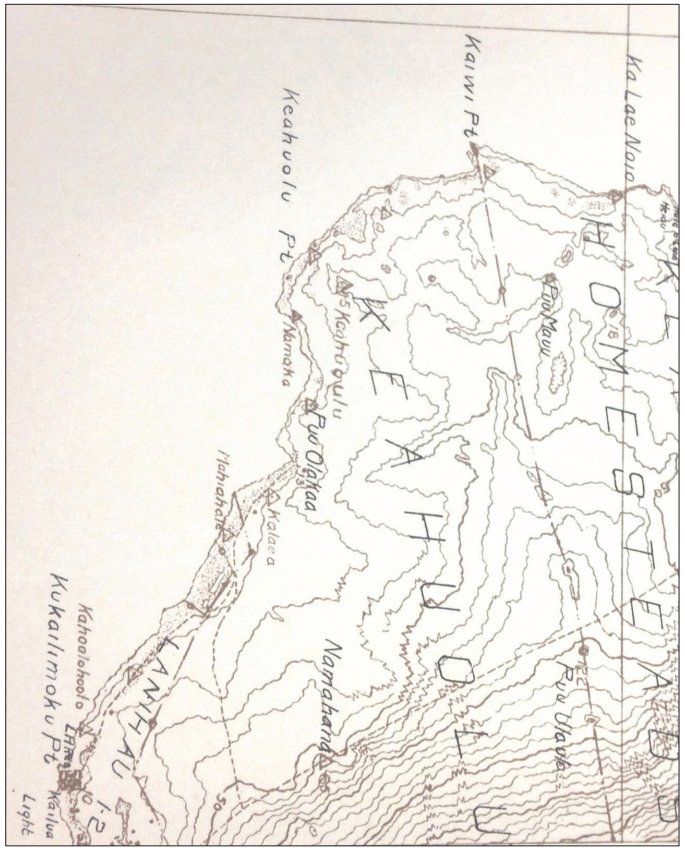


Figure 23. Portion of the 1924 U.S. Geological Survey map, Keāhole Point Quadrangle (United State Geological Survey 1924a).

Figure 24. Routes of the trails shown on the 1924 USGS map plotted onto a current USGS topographic map (USGS 1924a, base map USGS Keāhole Point quadrangle).

4.0 PREVIOUS ARCHAEOLOGY

4.1 Early Archaeological Research

The *ahupua'a* of Keahuolū has been the subject of several archaeological investigations beginning in the first decade of the 20th century. The earliest of these formed part of larger regional or island wide surveys and as a result were not as detailed as later studies. These initial surveys were concentrated for the most part along the coast, which was the main area of settlement during the pre-Contact period.

The first archaeological documentation of sites within the *ahupua'a* of Keahuolū was undertaken between 1906 and 1907 by John F. G. Stokes, an archaeologist with the Bernice Pauahi Bishop Museum, who conducted a survey of traditional Hawaiian religious sites on the island of Hawai'i (Stokes 1991). Stokes recorded the presence of a *ko'a* (the fishing shrine of Mākā'eo) within the coastal portion of the *ahupua'a* of Lanihau near the Keahuolū and Lanihau boundary. He also documented a *ko'a* (the fishing shrine of Halepa'u) and two *heiau* (the temples of Kawaluna and Palihiolo) within the coastal portion of the *ahupua'a* of Keahuolū, as well as a *heiau* (the temple of Luapawila) located further inland along the boundary between Keahuolū and Kealakehe in the vicinity of the present Palani Road.

In his manuscript on Hawaiian *heiau*, Stokes indicates that much of the traditional information gathered concerning these coastal sites was provided to him by, "a very old native living in the coconut palm grove" (Stokes 1991:42). This "coconut palm grove" is most likely the grove of palms that shaded the fishing settlement of Mākā'eo, which was destroyed during the construction of the Old Kona Airport (Clark 1985:110).

The closest of Stokes' sites to the present survey area is the *ko'a* of Mākā'eo (Bishop Museum Catalogue site number 50-Ha-D9-3, State Inventory of Historic Places site number 50-10-27-2137). This fishing shrine was located along the coast approximately 280 meters west of the Kona Commons project area. Stokes describes the site as, "a small pen, 200 feet from the sea and about half a mile to the southeast of Palihiolo Heiau" (Stokes 1991:42). The shrine was likely situated along the southeastern fringe of the coastal settlement of Mākā'eo. It appears to have been destroyed during the construction of the Old Kona Airport.

In 1929, 23 years after Stokes completed his *heiau* survey, the Bernice Pauahi Bishop Museum commissioned John E. Reinecke, a teacher at Kona Waena High School, to undertake a more intensive survey of the archaeological remains present within coastal areas of West Hawai'i (Reinecke 1930). Reinecke conducted a survey of coastal North Kona and South Kohala in July of 1930, walking from Ahuena Fort in Kailua to Kalahuipua'a in South Kohala.

Traveling the shoreline, Reinecke made a descriptive list of the sites he encountered, plotting the approximate location of these sites on a contemporary (1928) United States Geologic Survey topographic map (Figure 25). The unpublished typescript of Reinecke's "Survey of Hawaiian

Sites: From Kailua, Kona, to Kalahuipuaa, Kohala" is on file at the Department of Anthropology, B.P. Bishop Museum (Reinecke 1930).

In the report of his survey, Reinecke noted that, "The remains on this strip of coast have some special characteristics differentiating them from the rest in Kona. First, there is an unusual number of petroglyphs and papamu, especially about Kailua and at Kapalaoa. Second, probably because of the strong winds, there are many walled sites, both of houses and especially of temporary shelters" (Reinecke 1930:2). The type of walled temporary shelters mentioned by Reinecke may correspond to the windbreak shelters encountered within the current survey area.

Although none of the sites described by Reinecke rest within the present Kona Commons project area, all of them being located closer to the shoreline, a number are situated directly *makai* of the project area boundary (Figure 25). All of these sites rest within the adjacent coastal areas of the *ahupua'a* of Lanihaunui and Lanihauiki. Reinecke's descriptions of them are included below.

> Site 4. A group of masonry platform graves on the sand beach. [This may be the "Burial Ground" shown on George Jackson's 1883 map of Kailua Bay (Jackson 1883 map) and referred to in Jackson's 1883 Field Notes, p.32 as "graves of chiefs" (Neller 1980).]
>
> Site 5. Remains of a platform of large stones. Near this is a notable group of petroglyphs, all those which are not mere scratches being drawn on pages 22-23, and the best photographed. There is also a hole with a ring around it, a form of carving which I have found elsewhere, but what it represented is hard to say --- perhaps a kohe [vagina]. There are also papamu: a clear one 16 x 13; a very fine one with evenly arranged holes 1-1½" in diameter (photographed); and a third too dim to make out the rows, but there must have been about 12 each way.
>
> Site 6. A large masonry tomb or powder magazine, with very massive walls. [This may be the structure marked "Grave" located just inland of Kukailimoku Point on George Jackson's 1883 map of Kailua Bay (Jackson 1883 map) and referred to as "Kamehameha's Tomb" in George Jackson's 1883 Field Notes, p.30 (Neller 1980).] About it are eight papamu, two platforms probably puoa [Reinecke appears to use the term "puoa" to refer to a stone tomb, usually a well built and nicely faced stone mound that is roughly rectangular in plan and which may represent a burial monument], and a number of rough basin-like stones.
>
> These basin-stones are a feature of this waterless coast; several are found about a single house site, in several instances; their use is uncertain. [The "basin-stones" described by Reinecke appears to be similar to sizeable waterworn boulders partially hollowed out by natural erosion that were encountered during the 2009 archaeological inventory survey of the 628 acre Keahuolū conservation zoned coastal parcel. These stones were often found built into the walls of or set up near archaeological features. It appears that the traditional inhabitant of coastal Lanihau and Keahuolū collected these naturally hollowed out boulders and set them up near their places of residence, possibly as rainfall catchment features (Reeve et al. 2009a:54)].

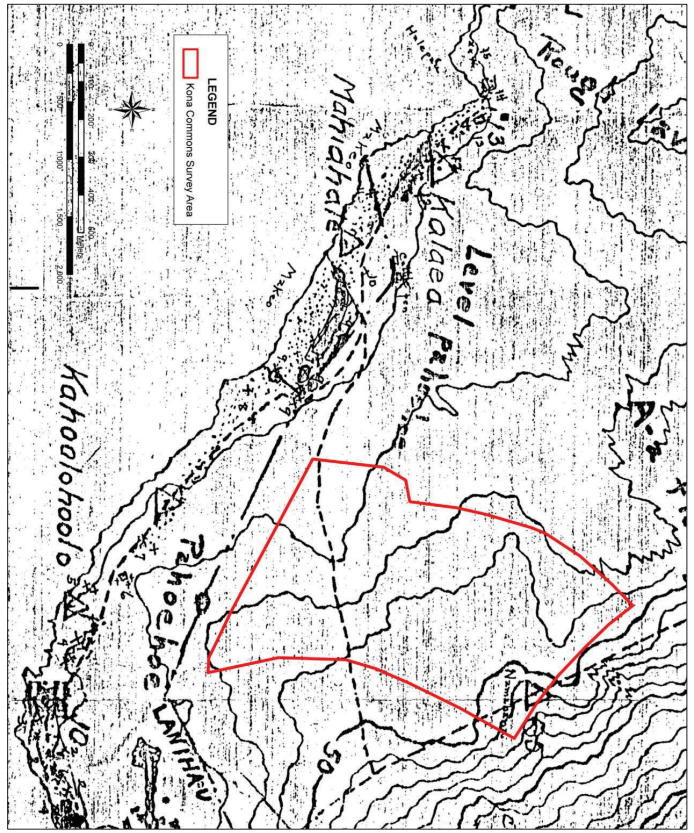


Figure 25. Section of Reinecke's site map showing the boundaries of the Kona Commons project area (Reinecke 1930:44).

The papamu are as follows:

a. 13x13, remarkable for four rows being very close together in one corner.
b. 11x9, dim, with the same grouping of rows – doubtless made by same man.
c. (?) 6x5, doubtless incomplete.
d. (?) 15x13, dim and chipped in places.
e. 8x7, dim and wide spaced.
f. 11x9, small and chipped.
g. 10x10, dim.
h. 15x?, cracked and dim.

Site 7. On the beach, ruins of a platform and pen of boulders; on the pahoehoe back of this, a small house platform of pahoehoe fragments. [This may be the *koʻa* (fishing shrine) of Mākāʻeo, described by Stokes as "a small pen, 200 feet from the sea" (Stokes 1991:42), however the *koʻa* of Mākāʻeo could also possibly be Site 8, whose location better matches Stokes' description].

As can be seen from Reinecke's descriptions, a number of the sites in this area appear to be possible burials, both historic and traditional. There are also numerous petroglyphs and *papamū* (gaming boards). Only one possible house site is noted, at Site 7. Further north and west along the coast (at Site 9, Figure 25), Reinecke encountered a number of residential structure around an old fishpond. This was the former fishing village of Mākāʻeo, which is the closest major settlement to the Kona Commons project area.

4.2 More Recent Surveys of Coastal Keahuolū

Since Reinecke's work in the 1930s, numerous survey have been conducted within coastal Keahuolū (Figure 26). Kenneth P. Emory, also from the Bishop Museum, undertook a generalized inventory of archaeological sites within the districts of Kona, Kaʻū and parts of South Kohala in 1970. He noted but was unable to relocate either the *heiau* of Palihiolu or Kawaluna recorded by Stokes (Emory 1970). The report of Emory's survey includes descriptions of three sites located along the coast *makai* and to the west of the present project area.

3841 (D9-4) Lanihau, Kailua-Kona, SW of old airport. Petroglyphs, located in three clusters, totaling 75 units, includes dots, circles, diagrams, and triangular and linear figures. [This site is likely to be Reinecke's Site 5].

3842 (D10-1) Waikilohi beach at Keahuolu. Palihiolu Heiau, and enclosure 25 by 29 feet with a coral pavement, not located.

3843 (D10-2) Pawai beach at Keahuolu. Kawaluna Heiau, an enclosure used until recently by fishermen as a koʻa or fishing shrine, not located (Emory 1970).

The next survey to be conducted within Keahuolū was undertaken in 1972 by Robert F. Bevacqua from the Bishop Museum. This reconnaissance survey focused on the immediate coastal zone of the *ahupuaʻa*. The survey identified a total of nine sites (Bevacqua 1972).

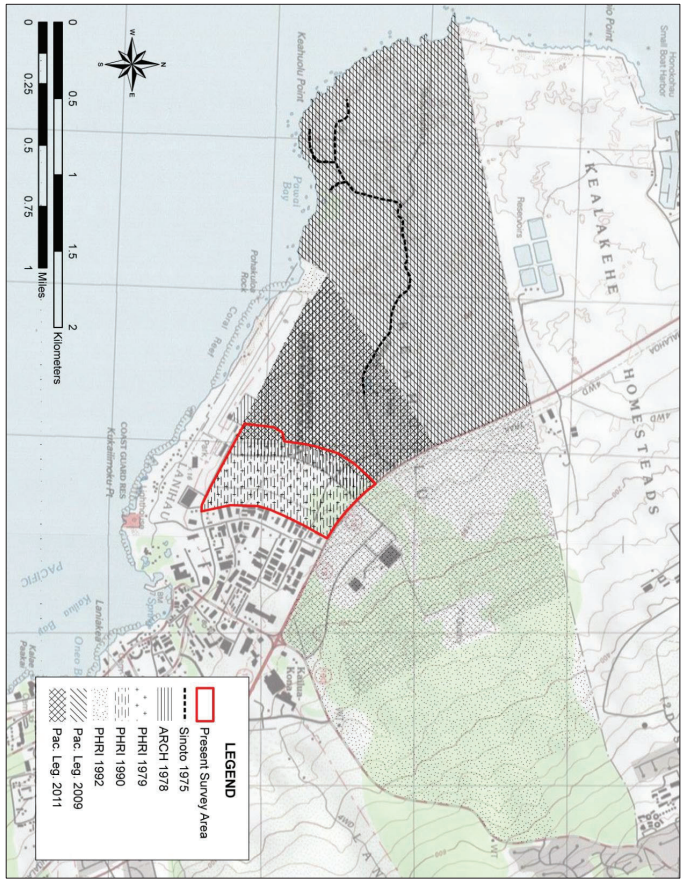


Figure 26. Extent of archaeological surveys conducted within and adjacent to the Kona Commons project area (base map USGS Keāhole Point quadrangle).

In 1975, Aki Sinoto from the Bishop Museum surveyed the corridor of a proposed coastal access road which now connects the three Queen Liliʻuokalani Trust campsite areas (Figure 26). He recorded a total of seven badly disturbed sites (Sinoto 1975:1). All of these sites were described as “small semi-permanent or temporary structures associated with coastal, probably marine, activities” (Sinoto 1975:3). The exact locations of these sites were not given in the resulting report (Folk 1980:7).

4.3 Surveys Within the Present Project Area

Portions of the Kona Commons project area have been the subject of four previous archaeological studies. Two of these projects have been reconnaissance surveys, while two were more detailed inventory level surveys. A 1978 reconnaissance survey undertaken by Archaeological Research Center Hawaiʻi, Inc. covered much of coastal Keahuolū, including a portion of the present project area. An initial reconnaissance survey (1979) and a later inventory survey (1992), both conducted by Paul H. Rosendahl Inc. (PHRI), concentrated specifically on 100 acres of the Kona Commons project area. An extensive 1990 archaeological inventory survey, also conducted by PHRI, covered the lands both to the north and west of the present Kona Commons survey area, but included the northwestern edge of the Swing Zone property.

4.3.1 1978 ARCH Reconnaissance Survey

In 1978, Francis Ching of Archaeological Research Center Hawaiʻi, Inc. (ARCH) conducted a reconnaissance survey of 987 acres within the *ahupuaʻa* of Keahuolū for the Queen Liliʻuokalani Trust. This survey covered much of the coastal portion of the *ahupuaʻa*, extending from the shoreline up to the Queen Kaʻahumanu Highway (Ching 1978:1). The southeastern edge of the ARCH survey area appears to overlap the present Kona Commons project area (Figure 27). The 1978 reconnaissance survey was undertaken over the course of two days and consisted of a pedestrian survey of the entire coastline, as well as transects of the inland area (Ching 1978:2). The survey resulted in the recording of a total of 59 archaeological sites containing 140 individual component features (Ching 1978:1) (Figure 27).

In the brief letter report documenting the results of his survey, Ching noted that most of the archaeological features were located along the coast, but that many of these had been damaged by high surf and tsunamis. Among the sites documented were cave shelters (25), pavings (21), *ahu* (21), boulder alignments (12), enclosures (10), platforms (8), C- or U-shaped structures (4), petroglyphs (3), wells (2), walls (1), planting or storage areas (1), basalt quarries (1), occupation areas (1), and 29+ stones he referred to as salt pans (Ching 1978:2). The survey found the inland portions of the survey area to be, “devoid of significant archaeological remains,” the few scattered inland features being in poor condition and difficult to interpret (Ching 1978:1). Ching recommended that prior to any development or major modification of the area, test excavations should be conducted at 16 cave shelter sites, whose numbers he listed (Ching 1978:1).

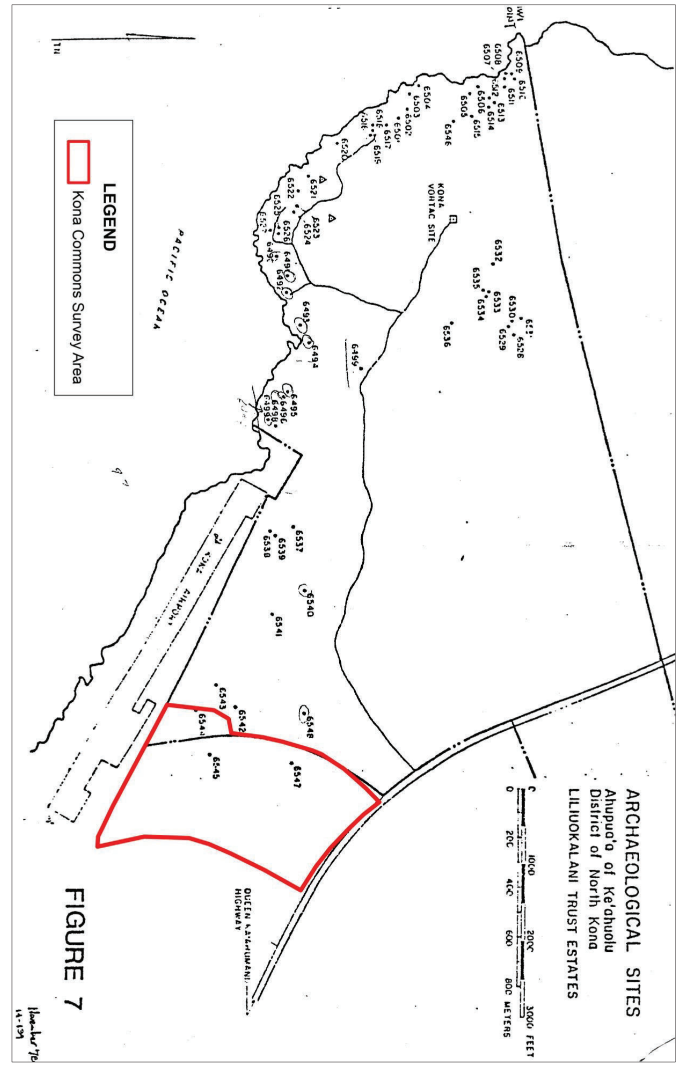


Figure 27. Site location map from the 1978 reconnaissance survey showing the Kona Commons project area (Ching 1978:9).

Only three of the sites recorded by Ching during the 1978 reconnaissance appear to be located within the present Kona Commons survey area (based upon the 1978 site map, Figure 27). These include Sites 50-10-27-6544, 50-10-27-6545 and 50-10-27-6547. Site 50-10-27-6544 is described in the reconnaissance survey report as a, "Cave shelter with wall fronting overhang: 6 meters long, 2 meters deep, 1 meter high" (Ching 1978:7). Site 50-10-27-6545 is referred to as an "Ahu, 1.5 meters in diameter, 50 centimeters high" (Ching 1978:7). The report describes Site 50-10-27-6547 as a, "Cave shelter, 3 by 2 meters, with wall fronting opening" (Ching 1978:7).

The relative location and description of the Site 50-10-27-6547 cave shelter do not match those of any site identified during subsequent surveys. It appears possible, however, that the Site 6547 shelter may correspond to a modified overhang identified during a subsequent 1992 archaeological inventory survey (see Section 4.3.4) as Site 50-10-27-18508, while the Site 50-10-27-6545 stone mound could possibly be the stone cairn (Feature A) documented during the PHRI 1979 reconnaissance survey (see Section 4.3.2) but not re-identified during the 1992 or current surveys. The Site 50-10-27-6544 cave shelter and wall could possibly correspond to the Site 13263 overhang identified during a 1990 PHRI survey (see Section 4.3.3), but neither the cave's dimensions nor its location (as shown on the 1978 site map) match the overhang recorded in 1990.

4.3.2 1979 PHRI Reconnaissance Survey

A one-day reconnaissance survey of lands located within Keahuolū was undertaken by Paul H. Rosendahl Inc. (PHRI) in 1979 (Rosendahl 1979). This survey covered three areas within the *ahupuaʻa*; a 100 acre parcel located *makai* of the Queen Kaʻahumanu Highway along the southern boundary of the *ahupuaʻa* that corresponds to the present Kona Commons project area, another 100 acres situated *mauka* of Queen Kaʻahumanu Highway and along the south side of Palani Road, and a 12 acre parcel along the north side of Palani Road (Figure 26). The survey identified 13 archaeological features or feature complexes (designated as A through M). These included four complexes, two modified sink holes, two wall sections, one cairn, one rock shelter, two petroglyph areas, and one walled enclosure (O'Hare and Rosendahl 1993:5).

Five of these features were found to be situated within the 100 acre Kona Commons project area. These features included:

Feature A: A stone cairn located in the extreme northwestern corner of the project area.
Feature B: A walled overhang located further inland of Feature A, along the northern boundary of the project area.
Feature C: A triangular human figure petroglyph pecked into the *pāhoehoe* bedrock along the northeastern border of the project area.
Feature I: A complex of low mounds and platforms located in the southeastern comer of the project area.
Feature J: An enclosure with barbed wire located just outside the extreme southeastern corner of the project area.

The report of the 1979 survey noted that the Feature A cairn and the Feature B walled overhang might correspond to the two sites (Sites 50-10-27-6545 and 50-10-27-6547) documented in the area during the 1978 survey, but that these features could not be positively identified as the same two features noted by Ching (O'Hare and Rosendahl 1993:14).

4.3.3 1990 PHRI Inventory Survey

In 1990, PHRI conducted an archaeological inventory survey of a 1,100 acre portion of the *ahupuaʻa* of Keahuolū located both *mauka* and *makai* of the Queen Kaʻahumanu Highway (Donham 1990). This survey, conducted from July 10, 1989, to January 29, 1990, was the most extensive archaeological investigation to be undertaken within the *ahupuaʻa* up to that time (Figure 26). The PHRI 1990 survey recorded 239 archaeological sites (comprised of 1,810+ component features) within its total project area (Figure 28).

Fifty-five of the sites identified were located within the 212 acre parcel situated *makai* (west) of the Queen Kaʻahumanu Highway (Figure 29). Among the numerous features documented within this portion of the 1,100 acre project area were, stone mounds, low rock walls, low stone edged enclosures, stone platforms and terraces, petroglyphs, and excavated areas within the *pāhoehoe*. The relatively low site count for this *makai* parcel is due in part to the fact that the survey did not include the shoreline areas which were the main center of coastal settlement during the traditional period.

An additional 184 sites (including 1,598+ features) were identified in that part of the survey area located *mauka* of the Queen Kaʻahumanu Highway. The archaeological sites recorded within this *mauka* area included a range of somewhat similar sites, stone mounds, rock walls, cave shelters containing marine shell midden, stone platforms and terraces, petroglyphs, and excavated areas within the *pāhoehoe* lava, that were identified as representing both agricultural and habitation features.

The greatest concentration of substantial archaeological features identified *mauka* of the Queen Kaʻahumanu Highway were found within the roughly delineated archaeological preserve area located toward the northern end of the Great Wall of Kuakini. The high density of sites within this area appears directly related to the presence of a deposit of relatively rich Punaluu Series soils situated atop an area of older lava flow. This soil provided an opportunity for intensive cultivation that was not available in most other areas of the *ahupuaʻa*.

Subsurface testing was conducted at 24 sites (33 individual features) within the 1,100 acre project area. Twenty-nine test units were excavated, with 4 additional subsurface samples collected. Fourteen of the 24 sites at which subsurface testing was conducted were located *makai* of the Highway, while an additional 11 sites (including 18 test trenches) were situated inland of the Highway.

Of the features tested, five were lava tubes or overhangs containing cultural deposits, while eight were structural features contained no soil. The deposits in the remaining features proved to be sterile. Seven charcoal samples recovered from test excavations were submitted for radiocarbon dating. Six of the seven radiocarbon samples were recovered from lava tube features (Site 50-10-27-13287, Feature A located *makai* of the Queen Kaʻahumanu Highway, Site 50-10-28-13350, Feature A located within what is now the Keahuolū Historic Preserve Area, and Site 50-10-27-13441, Feature P located upslope of the Ane Keohokālole Highway Corridor). The seventh sample was collected from the surface of a soil deposit in Site 50-10-27-13441, Feature O. The majority of the dates recovered ranged between the late 1300s and mid 1600s (Donham 1990:30-32).

Figure 29. PHRI 1990 inventory survey sites within and adjacent to the present project area (background aerial from Google Earth accessed 2015).

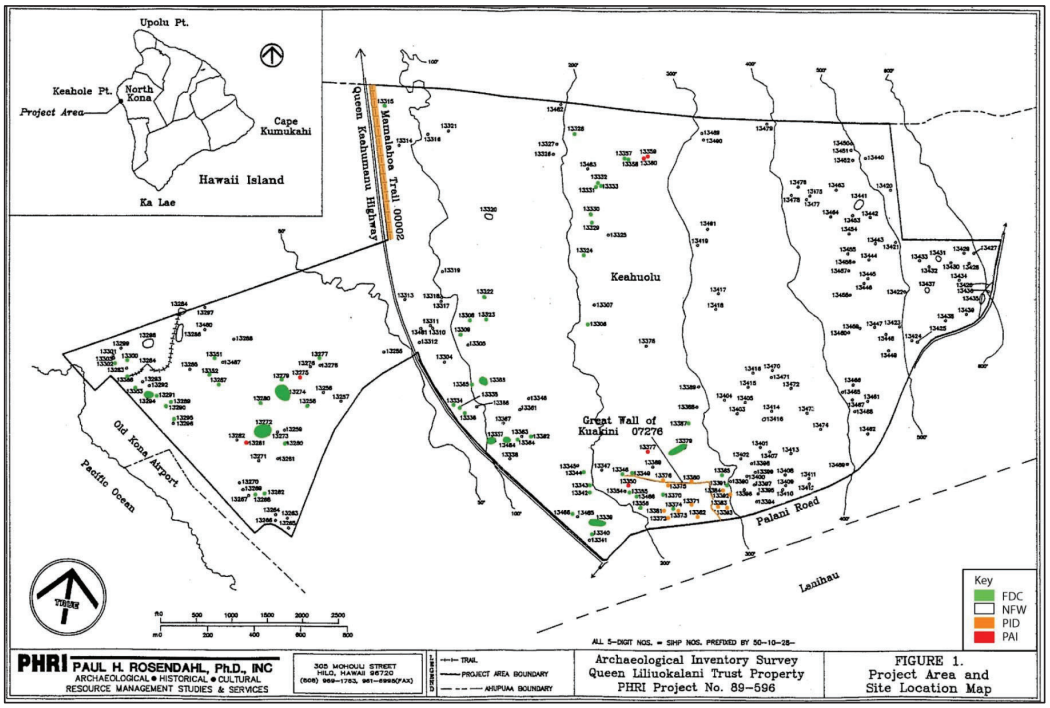


Figure 28. PHRI 1990 inventory survey site location map (Donham 1990:Figure 1).

The *makai* portion of the 1,100 acre 1990 project area, which consisted of a 212 acre parcel situated immediately north of the Kona Commons project area, was found to contain a greater density of sites than that found in the current survey area. Certain of these sites were also far larger and more complex than those documented within the 110 acre Kona Commons property. The reason for this may be due to the location of this *makai* area, directly inland of the traditional coastal settlements of Mākāʻeo and Pawai (Figure 29)

A small cluster of sites was encountered in the southeastern corner of this *makai* survey area (Figure 29). Four of these sites fall within or immediately adjacent to the boundaries of the present Kona Commons survey area. All are located within the area disturbed by the construction of the former Swing Zone driving range. These four sites include Site 50-10-27-13263, a modified overhang; Site 13264, a complex of five stone mounds and a *pāhoehoe* excavation; Site 13265, a stone mound; and Site 13266, a cave containing an internal wall and alignment, as well as a great deal of recent garbage near its entrance. Detailed descriptions of these sites, as documented during the 1990 survey, have been included in Section 6.1.1. This cluster of sites appears to have been destroyed during the construction of the Swing Zone driving range.

Mauka of the Queen Kaʻahumanu Highway, in the lands just inland of the present survey area, the 1990 PHRI survey encountered a number of sites (Figure 29) that included stone mounds, modified outcrops and rough stone platforms and terraces. As with the similar features located at the upper corner of the Kona Commons project area by the subsequent 1992 PHRI survey (see Section 4.3.4), many of these sites were interpreted by PHRI as being agricultural in nature and associated with the deposits of Punaluu Series soils that cover this area (see Section 2.2). Regretfully, the majority of sites situated in this portion of the 1990 PHRI survey area have since been destroyed by ground disturbing activities (Reeve et al. 2015:10 through 14, 94).

4.3.4 1992 PHRI Inventory Survey

In 1992, Paul H. Rosendahl Inc. conducted an archaeological inventory survey of the 100 acre Kona Commons property that they had initially formed part of its 1979 reconnaissance survey area (Figure 26). The boundaries of this survey area roughly correspond to the boundaries of the present Kona Commons survey area, but do not include the Swing Zone extension.

The fieldwork for this more intensive survey was undertaken by PHRI in October of 1992, though the report of the survey's findings was not completed until 1993 (O'Hare and Rosendahl 1993). At that time, the Kona Commons project area was referred to as the Kona Industrial Subdivision (KIS) Expansion Site. The 1992 survey identified a total of 18 archaeological sites containing 38 component features (Figure 30).

These sites included a segment of the historic Māmalahoa Trail, as well as lava excavations, modified outcrops, filled depressions, stone alignments, stone mounds, terraces, walls, hearths, walled overhangs, an enclosure, a modified depression, a cairn, a cave shelter, and a lava tube burial (O'Hare and Rosendahl 1993:ii). Detailed descriptions of all of these sites, as documented during the 1992 survey, have been included in Section 6.1.1.

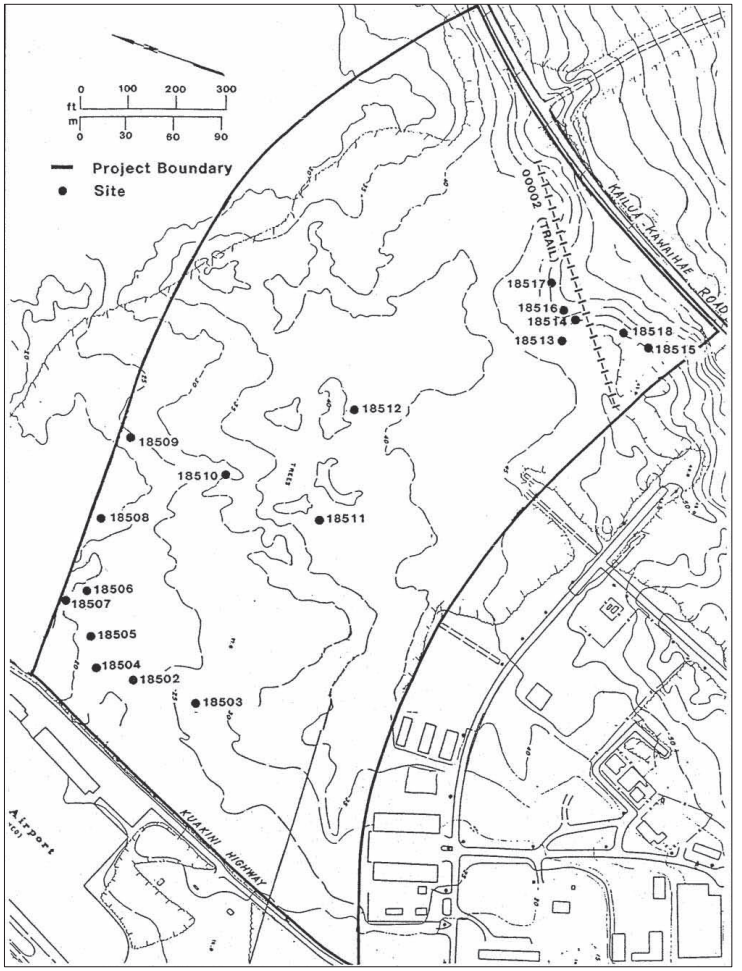


Figure 30. Relative locations of sites identified during the 1992 PHRI survey (O'Hare and Rosendahl 1992:Figure 2).

The 1992 PHRI survey attempted to relocate those archaeological features previously identified during both the 1978 and 1979 surveys. Although the survey report noted that, "A cairn (Feature A of Site 18505) and a walled overhang (Site 18508) were observed near the northern border of the project area during the current inventory survey" (O'Hare and Rosendahl 1993:14), there remained some question as to whether these features corresponded to the features identified by Ching in 1978 and PHRI in 1979. The AIS report observed that, "The description and location of the cairn observed by Rosendahl (Feature A) does not match very well with the location and description for Feature A of Site 18505. It is possible that the cairn observed by Rosendahl [and Ching] has been destroyed by recent bulldozing. The location and description of the walled overhang observed by Rosendahl (Feature B) and the walled overhang recorded during the current survey (Site 18508) are very similar; it is likely these two features are one and the same" (O'Hare and Rosendahl 1993:14).

The 1992 survey was unable to relocate the Feature C triangular bodied human figure petroglyph recorded by the 1979 survey as being located along the northeastern border of the project area. The AIS survey report observed that, "It was either obscured by vegetation or had been destroyed by bulldozing" (O'Hare and Rosendahl 1993:14). The survey report also noted that the concentration of low mounds and platforms (Feature I) identified during the 1979 reconnaissance as being located in the southeastern comer of the project area might represent portions of Sites 50-10-27-18513, 18515, 18516 or 18518 (O'Hare and Rosendahl 1993:14). The enclosure (Feature J) with barbed wire that was observed during the 1979 survey just outside the extreme southeastern corner of the project area was also not re-identified. It was noted that, "Since Rosendahl's survey, the area has been extensively bulldozed and there no trace of the features remain (O'Hare and Rosendahl 1993:14).

> In summary, only one (Feature B) of the five feature/feature clusters observed by Rosendahl [in 1979] was re-identified (Site 18508) during this survey. Feature I may be a portion of several sites recorded in the southeastern corner of the project area. Features A, C, and J have probably been destroyed by bulldozing, which is evident around the edges of the project area. The two features noted by Ching in the northwestern corner of the project area have probably also been destroyed by bulldozing (O'Hare and Rosendahl 1993:14).

As part of the 1992 inventory survey, subsurface excavations were conducted at three separate sites. One of these was the Site 50-10-27-18506 lava tube shelter. This cave shelter was found to possess "many interior features, a dense midden of ecofacts, and scattered indigenous artifacts— including a bone fishhook and a cowry octopus lure. The bone fishhook was collected from the surface but the cowry lure was left in place" (O'Hare and Rosendahl 1993:15). One of the two possible fire hearths located within the lava tube was bisected and excavated. The interior of the hearth consisted of a single layer of ashy soil (black, 10YR 2/1 when wet, to very dark grayish brown, 10YR 3/2 when dry, silt) 2 to 6 centimeters thick extending down to bedrock. When screened, the soil yielded marine gastropods (*Nerita picea* and *Cypraea caputserpentis*), echinoid remains, and *kukui* (candlenut, *Aleurites moluccana*) nut shell fragments. No charcoal was obtained for dating. The AIS survey report recommended that further work, including more detailed recording and excavation, was needed at the site, with more charcoal collected for dating purposes (O'Hare and Rosendahl 1993:15).

Another lava tube, Site 50-10-27-18511, was found to contain a scatter of human bone consisting primarily of phalanges (finger and toe bones) resting on the cave floor and among the loose stones covering it. An area of piled stones was also observed near the entrance of the tube, and a filled depression in the central area of the cave. The PHRI field crew moved some of the rocks in these two areas in order to determine if an articulated burial might rest the rocks. Only a few more scattered bones were found. It was suggested that a complete burial was once placed within the lava tube, but was later removed. A single waterworn cap to a conus shell with a hole through its center (described by the survey report as a "puka shell") was observed in the piled stones near the entrance. A clear glass patent medicine bottle found inside the cave was collected.

During the survey, a 1 by 1 meter test unit was excavated into a small, low stone mound built atop a fractured *pāhoehoe* outcrop (Site 50-10-27-18516, Feature A). The mound, which measured approximately 1.50 meters in length by c. 1.20 meters in width, and was c. 0.35 meters high, formed part of a complex located in the northeastern corner of the survey area. The northern and western faces of the mound were outlined with large boulders. Given the unusual care that appeared to have been taken to construct this mound, it was thought it might contain a human burial. For this reason, the center of the mound was dismantled and the thin (0.5 to 1 centimeter deep) layer of silt beneath it was excavated and screened. The excavation was taken down to bedrock, but no human remains or other cultural materials were encountered (O'Hare and Rosendahl 1993:15). A sample of the underlying soil was collected for possible pollen analysis, but this analysis appears never to have been undertaken.

A 50 by 50 centimeter test unit was also excavated into the floor of the Site 50-10-27-18502 modified depression, which was filled with modern trash. The excavation was undertaken to determine whether pre-Contact cultural material might be present beneath the trash. The unit was excavated down through three natural layers. Modern rubbish, consisting of fragments of aluminum foil, window pane glass, bottle glass, dog bones and crustacean remains, was recovered from the upper two layers, while the final layer, which terminated on *pāhoehoe* bedrock, proved to be culturally sterile. No distinctly traditional cultural material was encountered during the excavation, suggesting that the modifications to the depression may have taken place during the modern period (O'Hare and Rosendahl 1993:15).

The 1992 Archaeological Inventory Survey provided substantial evidence of human activity within the Kona Commons project area during the pre-Contact period. These activities, however, appear to have been primarily short term, undertaken by individuals visiting or passing through the area rather than residing in it.

4.4 Surveys Within the Surrounding Area

Numerous archaeological investigations have been conducted within the *ahupua'a* of Keahuolū since 1992, including several associated with the construction of the Ane Keohokālole Highway (for detailed descriptions of these highway projects, see Reeve et al. 2011). The following section details those archaeological surveys conducted in areas located immediately adjacent to the present project area (Figure 26)

4.4.1 2009 Pacific Legacy Inventory Survey

Since 2009, Pacific Legacy, Inc. has undertaken several archaeological inventory surveys within the *ahupuaʻa* of Keahuolū. These have included parcels located immediately north of the Kona Commons project area, as well as inland of it. In 2009, an archaeological inventory survey was undertaken of the 628 acre Conservation zoned parcel located at the northern boundary of the *ahupuaʻa*, *makai* of the Queen Kaʻahumanu Highway (Reeve et al. 2012). This survey resulted in the recording of 325 archaeological sites with 469 component features (Figure 31). The survey also identified and recorded the locations of 139 lava excavations. These sites ranged from shrines and residential complexes, most of which were situated close to the coast, to stone mounds and small windbreak shelters located in the more inland areas.

A program of archaeological testing was also carried out with controlled test excavations being conducted at four habitation features situated along the coast. These excavations yielded an abundance of cultural material including traditional artifacts and food remains. The presence of fishhooks and other fishing gear within the artifact assemblage at these sites, as well as the abundance of shell fish and fish remains recovered from them, indicated the close relationship between the residents of coastal Keahuolū and the sea. Radiocarbon samples recovered from these excavations were submitted for age determination, and the results suggest that settlement of this portion of the *ahupuaʻa* may have begun as early as the mid 13th century.

4.4.2 2011 Pacific Legacy Inventory Surveys

More recently, archaeological inventory surveys have been conducted within the 487 acre Urban Phase I and Urban Phase II parcels located *mauka* of the Queen Kaʻahumanu Highway, (Reeve et al. 2015) and the 213 acre Urban Phase III parcel located immediately north of the Kona commons project area.

The archaeological inventory survey of the Urban Phase I and II parcels, undertaken in 2011, resulted in the recording of 82 archaeological sites containing 126 component features (Figure 32). These sites ranged from sizeable habitation complexes to solitary stone mounds and included stone faced terraces and platforms, walled enclosures, stone mounds, C-shaped walls, stone alignments, modified depressions, overhangs and lava blisters, stacked stone boundary walls, trail segments, petroglyphs, and lava tubes containing both occupation debris and human remains (Reeve et al. 2015:i). The survey also identified and recorded the locations of 256 lava excavations. Excavations of this type were found to be scattered throughout the project area. The various features documented during this survey date from both the pre-Contact and early historic periods, and appear to have served a range of functions, including habitation, ceremony, art, processing, recreation, burial, travel, boundary marking, water catchment, storage, animal husbandry, and crop cultivation.

During the Pacific Legacy survey, extensive portions of the Urban Phase I survey area were found to be disturbed by recent development activities. A substantial amount of bulldozing was noted in the area *makai* of the Makalapua Shopping Center, between it and the Queen Kaʻahumanu Highway. The 1990 PHRI survey had identified a sizeable number of sites in this area, which is located just *mauka* of the Kona Commons project area. Many of these archaeological features were interpreted in the 1990 report as being agricultural in nature, as

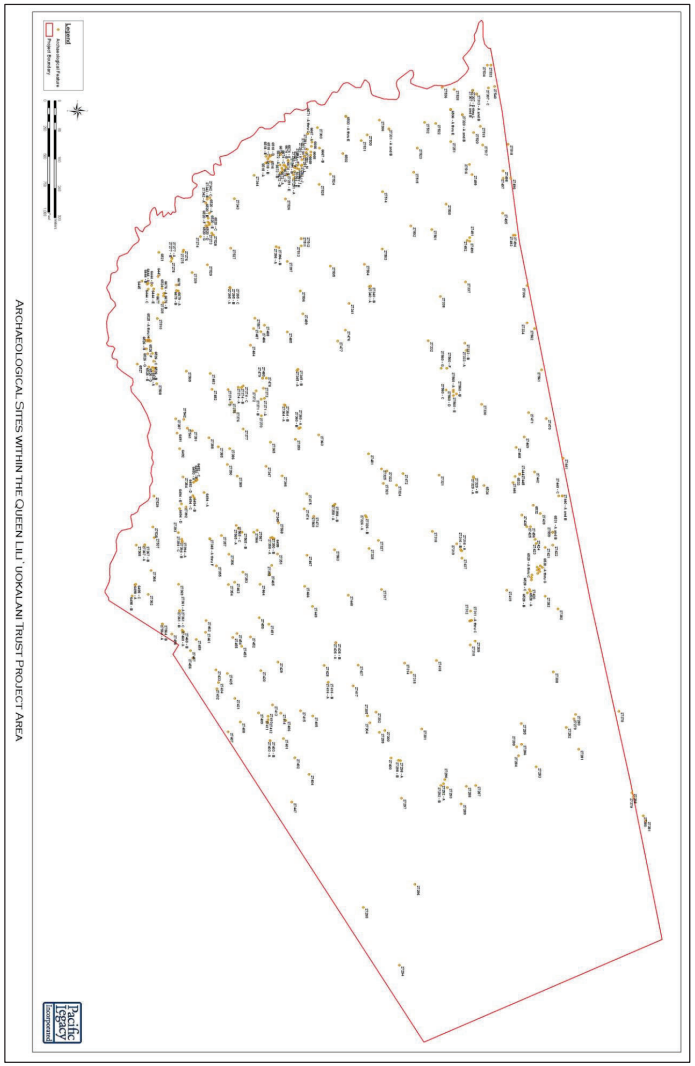


Figure 31. Relative location of archaeological sites within the 628 acre Conservation project area (Reeve et al. 2012:Figure 15).

they rested within a pocket of older lava flow covered by Punaluu Series soils (Figure 5). Only a small number of these features survived to be relocated during the Pacific Legacy survey.

A program of archaeological testing was also carried out as part of this archaeological inventory survey (Reeve et al. 2015:161-167). Controlled test excavations were conducted at two lava tube sites. These excavations yielded only a small amount of cultural material, which consisted primarily of shellfish remains, but also included fish, bird, and mammal bone. The only artifacts recovered were a pencil urchin spine abrader and a pencil urchin spine abrader fragment. Two charcoal samples (one from each excavation unit) provided similar age ranges of between approximately AD 1670 and AD post 1950. Given the date ranges provided by the charcoal samples, and the fact that all of the cultural materials recovered from test excavations were traditional in nature, it seems probable that occupation of the lava tubes may have taken place sometime between approximately AD 1670 and the very early post-Contact period (before circa 1800) (Reeve et al. 2015:184-185).

The results of the Urban Phase I and II survey indicated that while some permanent pre-Contact settlement appears to have taken place within the southwestern corner of the Urban Phase I parcel, most of the sites located within the survey areas were associated with more short term activities.

The survey of the Urban Phase III parcel resulted in the recording of 120 archaeological sites containing 212 component features. The report of this survey is still in preparation (Reeve et al. in prep). The 213 acre project area was found to contain a denser concentration of sites than the Kona Commons survey area. The same range of smaller sites such as stone mounds, windbreak shelters and modified natural features was encountered. In addition, there were sites of more permanent habitations, ceremonial structures and large petroglyph clusters. This greater density and complexity of sites may be due to the area's location directly inland of the coastal settlements of Mākāʻeo and Pawai.

4.5 Anticipated Survey Findings

Previous archaeological surveys undertaken both within and adjacent to the Kona Commons project area provide a good indication of what might be expected to be encountered during the present Supplemental Archaeological Inventory Survey. Within those portions of the 100 acre survey area that have not been impacted by ground disturbing activities, one might not only expect to find those sites recorded during the 1992 PHRI survey, but possibly also additional sites that were not recognized at that time. These sites would likely consist of small features such as stone mounds, windbreak shelters, modified natural features, and lava excavations.

It is difficult to determine exactly which of the archaeological sites identified during the 1992 PHRI survey have survived. The extent of commercial development within the project area would suggest that the eight archaeological sites documented during the 1992 survey as being located within the *mauka* half of the property no longer exist (Figure 33). Others sites located in those areas impacted by the development of the Swing Zone driving range, which were identified during both the 1990 and 1992 PHRI surveys, are also likely to have been demolished. That would leave somewhere between five and eight previously identified sites (depending on

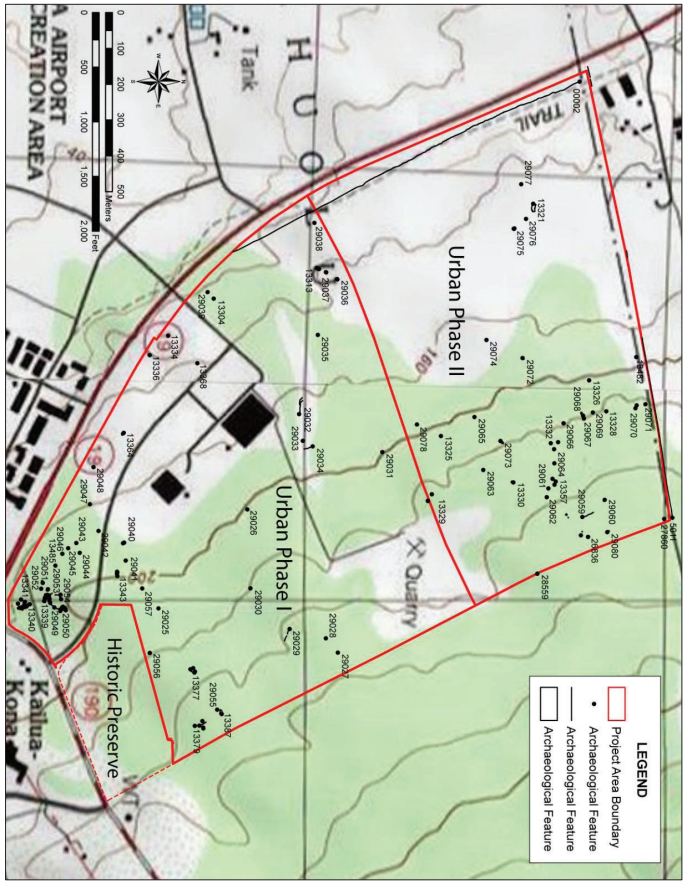


Figure 32. Relative location of archaeological sites within the Urban Phase I and Phase II project area (Reeve 2015:Figure 49).

the accuracy of the PHRI map locations) that may still survive within the remaining relatively undisturbed 41 acres (Figure 33). One of these sites is the Site 50-10-27-18511 lava tube burial, which was recommended for preservation and is presently encircled by orange construction fencing. Among the others may be the Site 50-10-27-18506 cave shelter complex, which was initially recommended for data recovery, and the Site 50-10-27-18504 a stone walled enclosure with its two internal walls that was interpreted as a possible ceremonial site and also originally slated for data recovery.

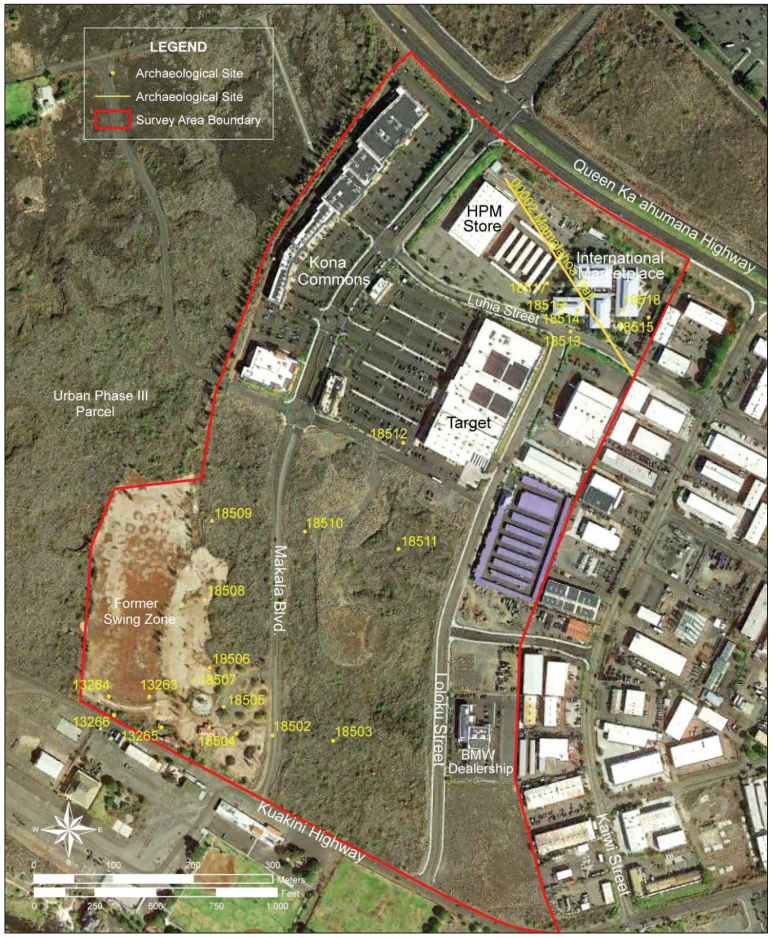


Figure 33. Approximate locations of sites identified during the 1990 and 1992 PHRI surveys in relation to recent development (from O'Hare and Rosendahl 1992:Figure 2, aerial base from Google Earth accessed 2015).

5.0 METHODS

The Supplemental Archaeological Inventory Survey of the 100 acre Kona Commons parcel was undertaken over a period of one week between 23 June and 27 June of 2014. The survey was under the overall supervision of Principal Investigator Paul Cleghorn, Ph.D. Field operations were supervised by James McIntosh, B.A. The Pacific Legacy field crew included Mr. Caleb Fechner, B.A. and Ms. Uʻilani Macabio, B.A. All surviving archaeological sites and features located within the project area were identified and fully documented.

5.1 Survey

To ensure that all of the archaeological features present within the project area were located and identified, pedestrian sweeps were undertaken of those portions of the survey area not covered by existing structures or paved roads and parking areas. These pedestrian transects were conducted by the three members of the archaeological field crew spaced between 10 and 15 meters apart, depending upon the density of the vegetation.

When an archaeological feature was encountered, its relative location and appearance were then compared with the site location maps and brief descriptions provided in the PHRI 1990 and 1992 inventory survey reports (Donham 1990 and O'Hare and Rosendahl 1993). This was done in order to determine whether the site had previously been identified. If the archaeological feature had been documented during one of the previous surveys (as was the case with 4 sites, two of which were site complexes containing three features each), the existing site description was supplemented with any additional relevant information and the current condition of the feature.

In all cases, an effort was made to retain the site number and site boundaries assigned by the previous surveys. This was done despite the fact that some previously recorded sites consisted of widely dispersed features that might not be directly associated. The Site 50-10-27-18511, Feature A modified overhang is an example of this, being located some 24 meters away from the other relatively tightly custered features of the site. In two cases (Sites 50-10-27-18509 and 50-10-27-18511) newly discovered features were added to existing sites. All three of these features were lava excavations located in relatively close proximity to the other components of the site complex.

If a feature was determined not to have been previously documented, it was examined to determine whether it constituted an isolated element deserving its own site number or whether it formed part of a larger site complex (due to its close proximity to nearby features and the apparent association of those features). The site or site complex was then assigned a temporary field number to facilitate identification. This field designation consisted of a T (for temporary) followed by a consecutive number (i.e., T-001). Individual structural features within a specific site complex (only one such site complex, Site 50-10-27-30210, was identified) were assigned consecutive letter designations to aid in recording and mapping.

When a site was recognized as having been documented during a previous survey, it was identified by the Hawai'i State Inventory of Historic Properties (SIHP) site number assigned to it at that time. Additional SIHP numbers were requested and received from the State Historic Preservation Office for all newly identified sites within the project area. The SIHP numbering system employs a four part numeric code. The first element designates the state. The second specifies the island. The third indicates the U. S. Geological Survey topographic quadrangle within which the site is located. The fourth is a site specific number designation (e.g., Site 50-10-28-18503).

Once identified, each site and its component features were fully documented. Vegetation clearance was undertaken as needed. The relative location of each site was mapped using a hand held Trimble GeoExplorer XT global positioning system (GPS). Its coordinates were recorded in Universal Transverse Mercator, North American Datum for 1983, Zone 5 (UTM NAD 83 Z5) projection. An individual point was taken for each site (site datum) and for each individual feature (feature datum). A listing of these coordinates is provided in Appendix B. When possible, the shape of a structure or feature (either as a line or area) was also recorded using the GPS.

Detailed site and feature descriptions were recorded for all identified archaeological remains (see Section 6.0). Documentation also included digital photographs of each site. Plan view maps were prepared of the more complex sites using tape and compass. In some cases, modifications were made to existing site maps drafted during previous surveys. A metal site tag was filled out and left at each site for relocation purposes. Since, at the time of the survey, SIHP number had not been assigned to the newly identified sites, the metal site tags left were marked with either the SIHP number assigned by a previous survey or the temporary field number, as well as the date of recording. A list of all sites documented, giving both their SIHP and temporary identification numbers, can be found in Appendix A.

5.2 Test Excavation

Test excavations were conducted as part of the 1992 PHRI Archaeological Inventory Survey at the Site 50-10-27-18502 modified depression, the Site 50-10-27-18516, Feature A stone mound, and the Site 50-10-27-18506 lava tube shelter. The results of these excavations are described in Section 4.0. None of the other previously recorded sites relocated during the current survey were found to possess soil deposits that had the potential to contain cultural deposits, and would thus warrant subsurface testing. The same proved true for the newly identified sites documented during the survey. For this reason, no additional test excavations were undertaken during the present supplemental inventory survey.

A different type of subsurface testing, in the form of core drilling to determine the presence or absence of lava tubes, was undertaken in the more *makai* portion of the survey area. This investigation was conducted in association with Geolab, Inc., and was intended to assist Queen Liliʻuokalani Trust and the County of Hawai'i in planning a new alignment for the northern portion of the present Kuakini Highway. Testing involved drilling to obtain subsurface core samples at five locations along the route. Following consultation with the Hawai'i State

Historic Preservation Division, it was agreed that this subsurface boring would be considered part of the testing phase of the present supplemental archaeological survey and its procedures and results would be included in this report (see Section 7.0).

5.3 CURATION

All field records (descriptions, notes, and photographs) resulting from the inventory survey have been temporarily housed in the Pacific Legacy office in Kailua, Oʻahu. These will be provided to the Queen Liliʻuokalani Trust once all analyses and write up have been completed.

Only one artifact, a basalt hammerstone found at the Site 50-10-27-18511, Feature D lava excavation, was encountered during the current supplemental archaeological survey. Given that the Kona Commons parcel may be impacted by future development, this artifact was recorded and collected. After full documentation, the artifact was given into the care of the Queen Liliʻuokalani Trust, which, as the active steward of the land, has agreed to permanently curate it.

5.4 CONSULTATION

Hawaiʻi Administrative Rules §13-276-5(g) states at an Archaeological Inventory Survey report, "shall contain information on the consultation process with individuals knowledgeable about the project area's history, if discussions with the SHPD, background research or public input indicate a need to consult with knowledgeable individuals." No consultation appears to have been undertaken as part of the original 1992 inventory survey. For this reason, recognized cultural descendants associated with the *ahupuaʻa* of Keahuolū were consulted during the present survey to determine whether they were familiar with any cultural history or cultural use of the Kona Commons project area. The consultation was conducted through Ms. Nicole Lui, a recognized cultural descendant of the Keahuolū *ahupuaʻa*. Ms. Lui discussed the area with the other recognized descendants of the *ahupuaʻa, n*one of whom were able to provide any specific cultural information regarding the project area.

Additional information regarding the *ahupuaʻa* as a whole, which has been gathered through consultations with the cultural descendants of the area, is presently being compiled as part of a cultural overview of the *ahupuaʻa* of Keahuolū being prepared for the Queen Liliʻuokalani Trust by Pacific Legacy. Much of this information has been incorporated within the Historic Background section (Section 3.0) of the present report. Additional consultation with cultural descendants and others specifically regarding the Site 50-10-27-18511 lava tube burial will be included in the Burial Treatment Plan for this site. This Burial Treatment Plan will be prepared following the review and approval of the present Archaeological Inventory Survey report.

6.0 FIELD INVESTIGATIONS

The present supplemental archaeological inventory survey resulted in the recording of eleven archaeological sites containing 21 component features (Table 1, Figure 34 and Figure 35). Of the eleven sites identified, four had been previously recorded, either during the 1978 reconnaissance survey or the 1992 inventory survey. A total of seven sites were newly discovered.

Table 1. List of Archaeological Sites and Features Recorded During the Present Survey

Site Number	Feature Designation	Site or Feature Type	Possible Age	Possible Function
50-10-27-18502		Modified Depression	Modern	Habitation/Dump
50-10-27-18508		Modified Overhang	Pre-Contact	Habitation
50-10-27-18509		Complex	Pre-Contact	Agriculture
	A	Stone Mound	Pre-Contact	Agriculture
	B	Filled Depression	Natural	None
	C	Stone Mound	Pre-Contact	Agriculture
	D*	Lava Excavation	Pre-Contact	Agriculture
50-10-27-18511		Complex	Pre-Contact	Habitation/Burial/Quarry/Agriculture
	A	Modified Overhang	Pre-Contact	Habitation
	B	Lava Excavation	Pre-Contact	Agriculture
	C	Modified Lava Tube	Pre-Contact	Burial
	D*	Lava Excavation	Pre-Contact	Quarry
	E*	Lava Excavation	Pre-Contact	Quarry
50-10-27-30207		Lava Excavation	Pre-Contact	Uncertain
50-10-27-30208		Stone Mound	Pre-Contact	Marker
50-10-27-30209		Enclosure	Pre-Contact	Habitation
50-10-27-30210		Complex	Pre-Contact	Habitation/Storage/Uncertain
	A	Modified Overhang	Pre-Contact	Storage
	B	Lava Excavation	Pre-Contact	Uncertain
	C	C-shaped Wall	Pre-Contact	Habitation
	D	Enclosure	Pre-Contact	Habitation
50-10-27-30211		Petroglyph	Historic	Communication
50-10-27-30212		C-shaped Alignment	Pre-Contact	Habitation
50-10-27-30287		Trail	Historic	Travel

*Indicates a newly identified feature of an existing site.

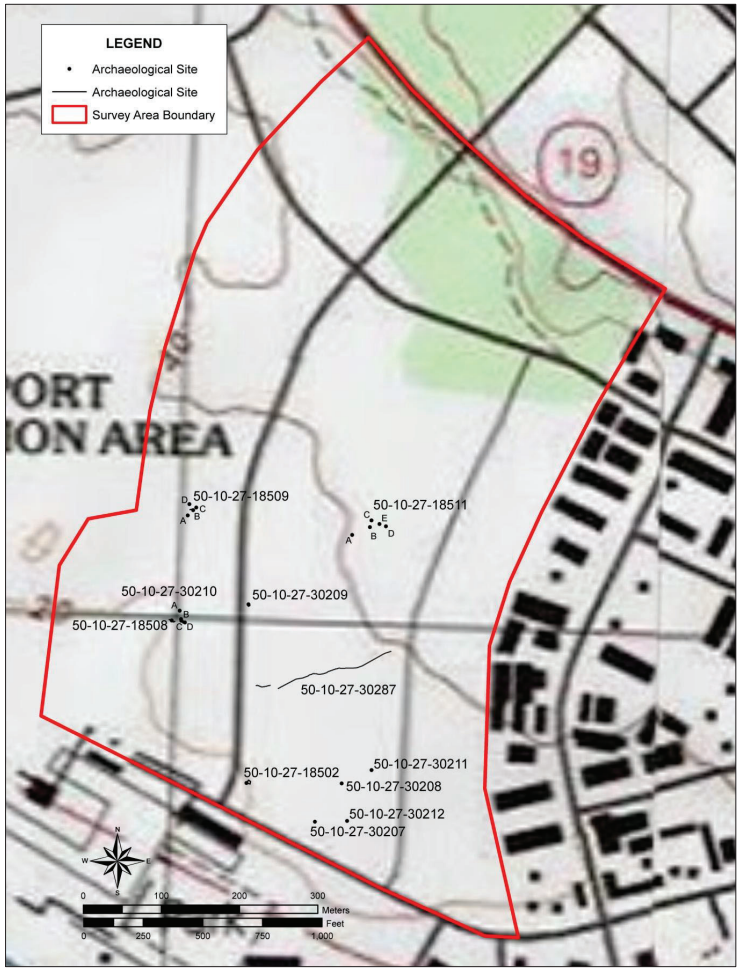


Figure 34. Relative locations of sites identified during the present survey (base map USGS Kailua and Keāhole Point quadrangles).

Figure 35. Relative locations of sites identified during the present survey (aerial base from Google Earth, accessed 2015).

6.1 Previously Recorded Sites

The present survey found that approximately 51 acres of the Kona Commons property remains undeveloped, though portions of this undeveloped area have been disturbed by bulldozing and by landscaping associated with the former Swing Zone driving range (Figure 8). Of the 18 archaeological sites originally recorded during the 1992 survey, only four were relocated (Table 2). These were all situated within the southern half of the project area, *makai* of the major existing development (Figure 36). The remaining sites appear have been destroyed, either by the commercial development of portions of the property, or by bulldozing associated with that development. Of the four sites within the survey area documented during the 1990 PHRI survey, all appear to have been destroyed during the construction of the Swing Zone. The current survey identified three previously unrecognized features within the four surviving archaeological sites documented during the 1992 survey.

Table 2. List of Previously Recorded Sites and Their Present Condition

SIHP Number	Site Type (from 1990 or 1993 report)	Status	Present Condition
50-10-27-00002	Māmalahoa Trail	Not Relocated	Destroyed
50-10-27-13263	Overhang	Not Relocated	Destroyed
50-10-27-13264	Complex (Mounds/Lava Excavation)	Not Relocated	Destroyed
50-10-27-13265	Mound	Not Relocated	Destroyed
50-10-27-13266	Complex (Cave/Wall/Alignment)	Not Relocated	Destroyed
50-10-27-18502	Modified Depression/Historic Dump	Relocated	Fair
50-10-27-18503	Filled Depression	Not Relocated	Probable Natural Feature
50-10-27-18504	Enclosure Complex	Not Relocated	Destroyed
50-10-27-18505	Complex (Mound/Modified Outcrop/ Filled Depression/Lava Excavation)	Not Relocated	Destroyed
50-10-27-18506	Lava Tube Complex	Not Relocated	Possibly Destroyed (also possible that entrance is buried with tube intact)
50-10-27-18507	Lava Excavation	Not Relocated	Destroyed
50-10-27-18508	Walled Overhang	Relocated	Fair
50-10-27-18509	Complex (Mounds/Filled Depression)	Relocated	Fair
50-10-27-18510	Lava Excavation	Not Relocated	Destroyed
50-10-27-18511	Complex (Modified Overhang/Modified Lava Tube/Lava Excavations)	Relocated	Fair
50-10-27-18512	Alignment	Not Relocated	Destroyed
50-10-27-18513	Agricultural Terrace Complex	Not Relocated	Destroyed
50-10-27-18514	Wall	Not Relocated	Destroyed
50-10-27-18515	Complex (Modified Outcrop/Alignment)	Not Relocated	Destroyed
50-10-27-18516	Complex (Mound/Modified Outcrop)	Not Relocated	Destroyed
50-10-27-18517	Filled Depression	Not Relocated	Destroyed
50-10-27-18518	Complex (Mound/Filled Depression)	Not Relocated	Destroyed

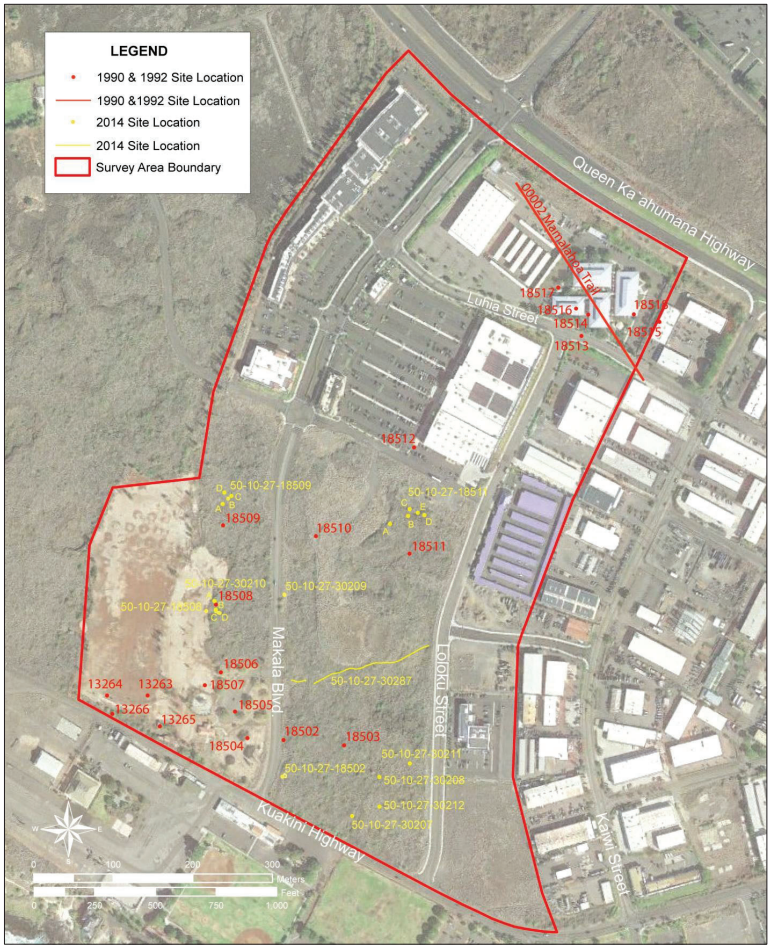


Figure 36. Comparative locations of archaeological sites identified during the 1990 and 1992 PHRI surveys and the current survey (background aerial from Google Earth accessed 2015).

6.1.1 Site Descriptions of Previously Recorded Sites

The following are detailed descriptions of the sites identified during the 1990 and 1992 PHRI surveys, along with assessments as to their present condition based upon the current field investigations. All previously identified sites have been included in this listing. If a site recorded in 1990 or 1992 was not relocated during the present survey, and is believed to have been destroyed, an explanation is provided as to why the site is believed to no longer exist.

SIHP Number: 50-10-27-00002
Site Type: Trail
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-00002 consists of a segment of the historic Māmalahoa Trail. The 1992 PHRI survey identified this site and described it as a "section of a kerbstone trail" that "is oriented at 150° to 330°" (O'Hare and Rosendahl 1993:A-1). During the 1992 PHRI survey, the trail was found to measure c. 290.0 meters in length by c. 3.8 meters in width, with a maximum height of 1.00 meters above the surrounding ground surface. The PHRI site description of Site 00002 also noted that:

> It has been destroyed on the north end by the construction of the Queen Kaahumanu Highway, and on the south end by construction of the industrial center. The trail continues north on the east side of Queen Kaahumanu Highway outside the project area [this portion of the trail currently remains intact]. The trail is identified as a section of the Mamalahoa Trail or King's Trail, a historic trail for horses that ran from the Kona District to the Kohala District. This trail is classified as a Type B trail (Donham 1986:18), which is a trail for horses built on top of a more ancient foot trail (Apple 1965:65). It is referred to as a "belt road" by Pukui, Elbert, and Mookini (1974:144), and as the "Old Beach Road" on a map of the Land Grant 3068 to Kapena, dated 1863.
>
> The trail runs through a variety of terrain, and the height and construction techniques used in the trail vary accordingly. In some areas, the trail is level with the surrounding ground surface and is defined only by an alignment of kerbstones. In other areas, the trail is elevated up to 1.00 m above the ground surface, the sides are faced with large cobbles and boulders, and the surface is paved with gravel. A large iron ring (wheel rim?) was observed on the trail at one point (O'Hare and Rosendahl 1993:A-1).

The Site 00002 trail was not relocated during the present survey. The PHRI site description indicates that the trail was located in the northeastern portion of the project area, *mauka* of Luhia Street and *makai* of the Queen Kaʻahumanu Highway. This area has been intensively developed and is now covered by the HPM Building Supply Store and the International Marketplace commercial properties and their associated parking areas (Figure 33). During the present survey, the area of Site 00002, as plotted by PHRI, was inspected by Pacific Legacy archaeologists and no trace of the trail was found. It is evident that the section of the Site 00002 Māmalahoa Trail located within the present survey area has been destroyed.

SIHP Number: 50-10-27-13263
Site Type: Overhang
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-13263 consists of a single modified natural overhang. The 1990 PHRI survey identified this site and described it as being located in a "Sinkhole within smooth pahoehoe" (Donham 1990:A-8). The 1990 report notes that, "Along the west side of a natural overhang opening, cobbles and slabs of pahoehoe appear to have been placed as a wind break. It is constructed perpendicular to the overhang opening, roughly bisecting the overhang area" (Donham 1990:A-8). The overhang measured approximately 2.76 meters in height, c. 2.16 meters in width, and c. 0.68 meters in maximum ceiling height. The report observed, however, that, "This windbreak is possibly natural collapse, and since no other modifications are evident this site is questionable" (Donham 1990:A-8).

The 1990 site distribution map locates Site 50-10-27-13263 within the limits of the former Swing Zone driving range (Figure 33). This area has been extensively disturbed. The vicinity was searched during the course of the present survey and no evidence of the overhang was found. It seems most probable that it was destroyed during the construction of the Swing Zone.

SIHP Number: 50-10-27-13264
Site Type: Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-13264 was recorded during the 1990 survey as a complex consisting of five mounds and a lava excavation. The 1990 PHRI survey report noted that, "The site is located in the southwest corner of the project area near the fence" (Donham 1990:A-8). The overall dimensions of the complex area were given as approximately 44.0 meters east to west by c. 20.0 meters north to south. "The site consists of five mounds (Features A, C through F), and a pahoehoe excavation (Feature B) (Donham 1990:A-8). The site was interpreted of being either pre-Contact or historic in age and having been used for agriculture.

Feature A
Site 50-10-27-13264, Feature A was described in the PHRI 1990 survey report as a stone mound measuring approximately 2.93 meters in length by c. 2.25 meters in width and c. 0.47 meters in maximum height. "Feature A is constructed with angular pahoehoe cobbles and clinkers, placed in a circular concentration on top of a smooth pahoehoe surface. It is generally circular shape in plan and is centrally raised in profile. A very roughly rectangular alignment exists on top of the mound, outlined by large angular pahoehoe blocks with small cobble and clinkers as paving" (Donham 1990:A-8). The feature was interpreted as being agricultural in function.

Feature B
Site 50-10-27-13264, Feature B was identified as a lava excavation measuring approximately 2.70 meters in lenth by c. 1.30 meters in width and c. 0.47 meters deep. The 1990 survey report noted that, "Feature B is located 6.5 m northeast from Feature A. It consists of a clearly excavated face

within the pahoehoe flow. Excavated basalt blocks are piled above and c. 0.5 m to 1.0 m to the northwest" (Donham 1990:A-8). It was said to have functioned as a probable quarry.

Feature C
Site 50-10-27-13264, Feature C was identified by the 1990 survey as a stone mound located 5.0 meters southeast of Feature B. The mound measured approximately 1.03 meters in length by c. 0.92 meters in width and c. 0.35 meters high. It was described as, "A random arrangement of excavated blocks of basalt on top of smooth pahoehoe" (Donham 1990:A-8). The function of the feature was given as quarry/agriculture.

Feature D
Site 50-10-27-13264, Feature D was also identified as a stone mound. Located 3.0 meters northeast of Feature E, it measured approximately 1.55 meters in length by c. 1.22 meters in width and was c. 0.30 meters high. The feature was described in the 1990 survey report as, "A low circular rock mound constructed on top of smooth pahoehoe. It is constructed with angular slabs and blocks of pahoehoe. Small cobbles are used as fill. Roughly circular shape in plan, it contains some facing along the north and northeast sides. Two uprights are visible, one north of the facing and the other south of the facing. The surface interior is of roughly level fill of pahoehoe slabs and cobbles" (Donham 1990:A-8). The Feature D mound was interpreted as being agricultural in function.

Feature E
Site 50-10-27-13264, Feature E was a stone mound located approximately 3.00 meters to the southwest of Feature D. It measured approximately 1.95 meters in length by c. 1.38 meters in width. The 1990 survey report noted that, "Feature E is a small low flat rock mound. Two rough alignments parallel to each other and oriented c. E-W are situated on the north and south sides of the mound. These alignments consists of medium to large angular pahoehoe blocks. Small cobbles are used in between. The mound is roughly circular shape in plan and centrally raised" (Donham 1990:A-8). It was interpreted as an agricultural feature.

Feature F
Site 50-10-27-13264, Feature F was referenced in the 1990 survey report as a stone mound located 3.40 meters east of Feature E. The mound measured approximately 2.13 meters in length by c. 1.36 meters in width. It was "roughly rectangular shape in plan, and constructed with small angular pahoehoe boulders and small to large angular cobbles. At the top of the centrally raised mound, there appears to be a partially faced circle of larger angular cobbles with smaller cobble interior fill" (Donham 1990:A-8 through A-10). As with the other mounds in Site 13264, Feature F was interpreted as an agricultural feature.

The Site 13264 complex of features was not relocated during the present survey. The 1990 PHRI site distribution map places the site near the southern edge of the former Swing Zone driving range Figure 30). This area has been heavily disturbed. During the present survey, the area was examined by Pacific Legacy archaeologists, but no evidence of the site was observed.

SIHP Number: 50-10-27-13265
Site Type: Mound
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-13265 consists of a single stone mound measuring approximately 1.77 meters in length, c. 1.47 meters in width and c. 0.42 meters in maximum height. The 1990 PHRI survey report noted that, "This relatively isolated rock mound is constructed with small to large pahoehoe blocks and slabs piled on top of smooth pahoehoe. It is roughly circular in plan and centrally raised. Perimeter stones on the north, east, and northwest sides are turned on edge, up to 0.20 meters in height. One piece of coral was observed on the surface near the mound" (Donham 1990:A-10). Test excavations were conducted at Site 13265.

> A 1.0 by 1.0 m square test unit was excavated into the center of the mound, in order to determine if a subsurface feature or deposit was present. Beneath the surface layer of pahoehoe slabs, a fill of small to medium size irregular cobbles and pebbles was encountered. This fill overlaid a thin layer of surface duff which varied from less than 0.01 m to 0.02 m in thickness. Pahoehoe bedrock was encountered beneath the duff layer. A single unidentifiable fragment of marine shell was encountered in the duff layer; no other portable remains or cultural features were observed (Donham 1990:A-10).

The Site 13265 mound, which was interpreted in the 1990 report as being pre-Contact in age and agricultural in function, is shown on the PHRI site distribution map as being located toward the southeastern corner of the former Swing Zone driving range (Figure 33). This area was thoroughly searched during the current survey and no trace of the site was found.

SIHP Number: 50-10-27-13266
Site Type: Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-13266 was identified during the 1990 survey as a complex consisting of a lava tube with two internal features. The 1990 PHRI survey report noted that, "The site consists of a cave (Feature C) that contain s a wall (Feature A) and an alignment (Feature B)" (Donham 1990:A-10). It was interpreted as a temporary habitation site utilized during possibly the historic or pre-Contact periods.

Feature A
Site 50-10-27-13266, Feature A was described in the PHRI 1990 survey report as, "A wall consisting of seven stacked slabs and blocks of pahoehoe, located immediately to the left of Feature C cave opening. It is constructed along the NNW side of the cave wall and built from the floor to the ceiling" (Donham 1990:A-10). The wall measured approximately 0.80 meters in length by c. 0.50 meters in width and was c. 0.60 meters in maximum height. During its examination by the 1990 survey crew, "Two slabs were removed from the wall in order to determine if any features were present behind it. Nothing was observed. One waterworn basalt is present c. 1.6 m east of Feature A" (Donham 1990:A-10). The function of the wall was not determined.

Feature B
Site 50-10-27-13266, Feature B was found to consist of, "Roughly piled slabs of roof fall constructed into a short alignment with a single upright slab on the SE end. Scattered skeletal remains of a dog are partially under the NW portion of the alignment," which measures approximately 0.90 meters in length by c. 0.40 meters in width and c. 0.35 meters in maximum height (Donham 1990:A-10). No function was determined for the alignment.

Feature C
Site 50-10-27-13266, Feature C was described by the 1990 PHRI survey report as, "A natural cave containing Feature A, Wall and Feature B, Alignment. A lot of recent garbage is concentrated at the cave opening. No soil deposits or portable remains other than recent refuse and dog remains were observed inside the cave" (Donham 1990:A-10). The Feature C lava tube was found to measure approximately 13.00 meters in length by c. 4.50 meters in width and was c. 0.70 meters in maximum ceiling height. It was interpreted as having been used for temporary habitation.

The 1990 survey site distribution map shows Site 13266 as being located at the southern edge of the former Swing Zone driving range, where it abuts the Kuakini Highway (Figure 33). As with the other sites located within the area occupied by the former Swing Zone, no evidence of Site 13266 was found during the present survey, and it is presumed to have been destroyed.

SIHP Number: 50-10-27-18502
Site Type: Modified Depression
Status: Relocated
Present Condition: Fair
Description: Site 50-10-27-18502 consists of a single modified depression. The 1992 PHRI survey identified this site and described it as a "modified depression, formed when a lava blister collapsed" and noted that it contained "a great deal of recent trash at the bottom of the depression" (O'Hare and Rosendahl 1993:A-1). A semicircular rock alignment was also recorded by PHRI, which appeared to be constructed around a portion (about one-fifth) of the lip of the depression. The modified depression was found to measure c. 5.00 meters in length by c. 4.25 meters in width, with a maximum depth of c. 1.50 meters. The PHRI site description of Site 18502 also noted that:

> The lip of the depression is rather triangular, with the corners at the north, southwest, and southeast oriented at 90°/270°. A semicircular alignment of pahoehoe cobbles and boulders was placed around the north corner for c. 1.25 m on the east side and 2.75 m on the west side. There is also an alignment of three pahoehoe boulders on the west side of the southwest corner. The rocks are c. 0.10-0.65 m in diameter. There are a couple of places where the rocks are stacked up to two courses high. These cobbles and boulders are not weathered, and some have scratched surfaces, similar to boulders in other areas with bulldozer disturbance. Therefore, this alignment may be the result of bulldozer push.
>
> The bottom of the depression is 0.90-1.60 m below the lip. It is filled with cobbles, some soil, and recent trash. This trash consists of large metal rusted cans, glass bottles, plastic, and pieces of aluminum foil. A 0.50 m by 0.50 m test unit (TU-2) was excavated into the bottom of the depression to see if any prehistoric material was below the recent historic trash. The unit was

> excavated to bedrock (0.24 m BS). Bottle glass, window glass, dog bones, crustacean remains, and small pieces of aluminum foil were recovered from the test unit. It seems likely that this depression was used as a dump in historic times. There is no evidence for prehistoric use.
>
> The feature may have been altered from a camp site to a dump site. It is in poor to fair condition. The portable remains consisted of recent historic trash only (O'Hare and Rosendahl 1993:A-1).

The Site 18502 modified depression was relocated during the current survey and the PHRI site map was modified to reflect its observed condition (Figure 37). The site is located in the *makai* portion of the survey area, in the undeveloped lands just south of the former Swing Zone, approximately 43 meters *mauka* of the Kuakini Highway and c. 18 meters southeast of Makala Boulevard (Figure 35). It is situated c. 99.8 meters northwest (298°) of the Site T-002 stone mound. The PHRI site description for Site 18502 (O'Hare and Rosendahl 1993:A-1) provides a relative accurate depiction of the site (Figure 38). The present survey noted some minor differences. The "semicircular alignment" of basalt boulders located along the lip of the depression appears to consist of stacked stones intentionally set in place in order to modify and formalize the collapsed lava sink (Figure 39). It does not appear to be simply bulldozer push, as described in the PHRI site description (O'Hare and Rosendahl 1993:A-1). The bulldozer scratching present on the stacked boulders may indicate that they were placed in position relatively recently (not too many years before the original 1992 survey), after some bulldozing had already taken place in the surrounding area. This provides an additional indication that the modifications to the sink are of recent age.

The current survey revealed no evidence of pre-Contact or historic cultural material at Site 18502. All of the debris observed within the collapsed lava sink appears to be modern trash, including some found behind the stacked stones. A concentration of approximately 20 pennies was found on top of a rock located along the interior southern edge of the collapse sink.

The Site 18502 modified depression is currently in fair condition. Based upon the lack of traditional and historic cultural material, both on the surface and recovered from the PHRI excavations, the modifications to Site 18502 appear to most likely be modern in age. The lava collapse sink seems to have been modified and utilized during the modern period, most likely either as a dump, a campsite occupied by homeless people, or both.

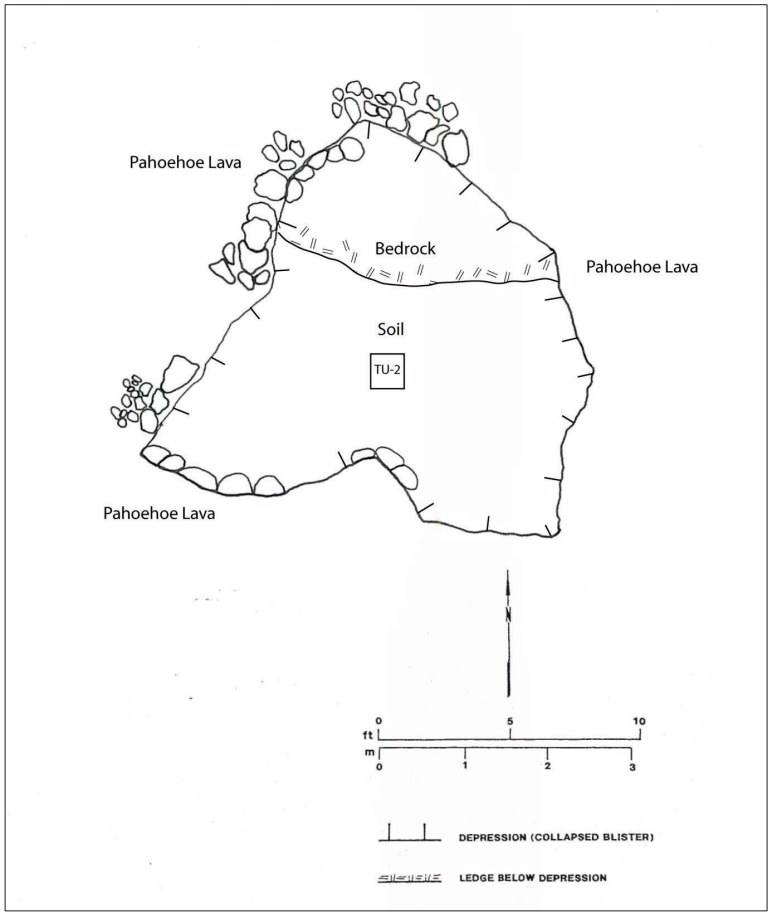


Figure 37. Plan view map of Site 50-10-27-18502 (base map O'Hare and Rosendahl 1993:Figure A-1, with modifications from the current survey).

Figure 38. Site 50-10-27-18502 modified depression (view southeast).

Figure 39. Site 50-10-27-18502 lava sink showing modifications (view west).

SIHP Number: 50-10-27-18503
Site Type: Filled Depression
Status: Not Relocated
Present Condition: Probable Natural Feature
Description: Site 50-10-27-18503 consists of a single filled depression. The 1992 PHRI survey identified this site and described it as a "Y-shaped crack in level pahoehoe bedrock, filled with pahoehoe gravel, cobbles, and small boulders to the level of the ground surface" (O'Hare and Rosendahl 1993:A-1, A-3). The filled depression was found to measure c. 6.10 meters in length by c. 1.25 meters in width, with a maximum depth of 0.05 meters. The PHRI site description of Site 18503 also noted that:

> The rocks are c. 0.05-0.30 m in diameter. The crack is c. 0.15-0.75 m wide in each branch of the Y-shape, but widens to 1.25 m at the junction of the three branches. Each branch is c. 2.00-3.00m long. The depth of the crack could not be determined, but it is probably fairly shallow (c. < 0.05 m deep). The crack may have been filled for planting purposes or to make a level surface for cattle. The feature is unaltered and in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993: A-1 and A-3).

The Site 18503 filled depression was not relocated during the present survey. According to the 1992 PHRI survey report, Site 18503 was encountered in the undeveloped *makai* section of the survey area, south of Site 18502 (Figure 33). During the current survey, the area occupied by Site 18503, as plotted on the 1992 PHRI site map, was walked and examined over on multiple occasions, but no evidence of a filled depression that corresponded to Site 18503 was found. There was also no evidence of construction activity or recent disturbance in the area. The existing vegetation did consist of a thick ground cover of fountain grass (*Pennisetum setaceum*), and *koa haole* (*Leucaena leucocephala*) that could potentially have obscured the visibility of the site. The description of Site 18303 in the PHRI report is similar to that given for the Site 18509, Feature B filled depression, which proved to be a natural feature. It is possible therefore that Site 18303 may also be a natural feature.

SIHP Number: 50-10-27-18504
Site Type: Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18504 is a complex consisting of two features; a large walled enclosure (Feature A) with two internal walls (Feature B) (Figure 40). The site was identified during the 1992 PHRI survey and found to measure approximately 18.00 meters in overall length (east to west) and c. 13.50 meters in overall width (north to south) (O'Hare and Rosendahl 1993:A-3-A-4).

Feature A
Site 50-10-27-18504, Feature A was described in the PHRI survey report as a "walled rectangular enclosure, with the longest wall oriented at 86°/266°" (O'Hare and Rosendahl 1993:A-3). The enclosure was found to measure c. 18.00 meters in length by c. 13.50 meters in width, with a maximum height of 0.60 meters. The PHRI feature description of Site 18504, Feature A also indicates that:

> The walls are constructed of subangular pahoehoe cobbles and boulders. The west, south, and north walls are constructed with small to medium sized cobbles that are c. 0.05-0.20 m in diameter. The east wall is constructed with small to medium boulders that are c. 0.20-0.60 m in diameter. A few smaller cobbles are also used in this side. The walls of the enclosure are c. 0.80-1.20 m wide for the east wall and c. 1.50-2.00 m wide for the other three walls. All four sides are composed of rocks stacked one to three courses high on top of bare, level pahoehoe bedrock. The walls range from 0.17-0.60 m high, with an average height of c. 0.30 m. The southeast corner has collapsed, but the other three comers form sharp right angles. The interior of the enclosure has been cleared of all rubble. There is a 1.60 m by 1.50 m semicircular alignment of cobbles and boulders constructed against the exterior of the west wall. The feature is unaltered and in excellent condition. No portable remains or cultural deposits were observed at the feature (O'Hare and Rosendahl 1993:A-3).

Feature B
Site 50-10-27-18504, Feature B was described in the PHRI report as consisting of "two parallel walls" that are situated "inside the east half an enclosure (Feature A)" (O'Hare and Rosendahl 1993:A-3). Feature B was found to measure approximately 3.20 meters in length by c. 3.00 meters in overall width, with a maximum height of c. 0.44 meters. The PHRI feature description of Site 18504, Feature B also notes that:

> These walls are oriented at 96°/276° and are at a slight angle (c. 10°) to the major axis of the enclosure walls. They are 0.25 m from the west wall of the enclosure and are about midway between the north and south walls. The walls are constructed of small pahoehoe cobbles to small boulders stacked three to six courses high on bare pahoehoe bedrock. The rocks are c. 0.075-0.30 m in diameter. The walls are 1.05 m apart towards the middle, 0.50 m apart at the east end, and only 0.20 m apart at the west end. The walls are c. 1.00 m wide, c. 0.44 m high, and are faced on the interior side. The exterior sides slope gradually down to ground level.
>
> The feature is unaltered and in excellent condition. One branch coral fragment (c. 0.20-0.30 m in diameter) was observed at the east end of the two walls. A second branch coral fragment (c. 0.10 m in diameter) was observed on the outside of the south parallel wall. These fragments may be evidence for a ceremonial function for the site. An opihi shell was found c. 3.00 m west of the south wall. No cultural deposits were present at this feature (O'Hare and Rosendahl 1993:A-3).

Figure 40. Plan view map of Site 50-10-27-18504 (O'Hare and Rosendahl 1993:Figure A-2).

The Site 18504 complex was not relocated during the present survey. According to the PHRI site distribution map, the site was situated in the southwestern corner of the survey area (Figure 33). During the present survey, the location of Site 18504, as plotted on the 1992 PHRI site map, was walked and examined by Pacific Legacy archaeologists, but no remnants of the site or evidence of cultural material was observed. The site's marked location appears to lie within the lands occupied by the former Swing Zone driving range. This area has been extensively modified and landscaped. There are four large basalt mounds (Figure 41), most likely associated with the surrounding mini golf-course, that are situated at the approximate location of Site 18304. It appears likely that the stones from the Site 18504 enclosure and internal walls were incorporated into one of the four large mounds during the grubbing and grading of the surrounding area.

Figure 41. Modern stone mounds associated with the former Swing Zone (view south).

SIHP Number: 50-10-27-18505
Site Type: Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18505 is a complex consisting of seven features; a cairn (Feature A), a lava excavation (Feature B), a filled depression (Feature E), and four modified outcrops (Features C, D, F and G). The site was identified and documented during the 1992 PHRI survey (Figure 42). It was found to measure approximately 28.00 meters in overall length (north to south) and c. 12.00 meters in overall width (east to west) (O'Hare and Rosendahl 1993:A-3, A-5 to A-6).

Feature A
The PHRI survey report described Site 50-10-27-18505, Feature A as "a circular cairn constructed of pahoehoe slabs on top of bare pahoehoe bedrock." It measured c. 1.60 meters by 1.60 meters, with a maximum height of 0.56 meters. The PHRI feature description for Site 18505, Feature A also indicates that:

> The slabs are 0.25-0.60 m in maximum diameter, and are 0.05-0.08 m thick. They are stacked four to six courses high in a ring-like formation, so that the edges of each slab overlap the next. The sides are faced, but a section on the east side consists of scattered cobbles and boulders.
>
> It appears that the cairn has not collapsed naturally, but that it has been recently dismantled. The feature is probably recently altered, but is still in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-3 and A-6).

Feature B
Site 50-10-27-18505, Feature B was described in the PHRI survey report as a lava excavation, measuring c. 2.50 meters in length by c. 1.30 meters in width, with a maximum depth of c. 0.33 meters (O'Hare and Rosendahl 1993:A-6). The report further describes Site 18505, Feature B by noting that:

> The broken fragments of the blister top consist of pahoehoe slabs 0.14-0.40 m in maximum diameter. Approximately 12 of these slabs are placed along the east edge of the excavated area. Some slabs are also piled two courses high near the north end of the hole. The hole could have been excavated to quarry material, but most of the material broken from the blister seems to still be around the hole, so the function remains indeterminate. The feature is unaltered and in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-6).

Feature C
During the 1992 PHRI survey, Site 50-10-27-18505, Feature C was identified as a "modified outcrop" and the survey report noted that "pahoehoe slabs are placed on top of bare pahoehoe bedrock to form a semicircle of rocks one course high" (O'Hare and Rosendahl 1993:A-6). The modified outcrop was found to measure approximately 3.10 meters by c. 2.70 meters, with a maximum height of c. 0.26 meters. The PHRI feature description for Site 18505, Feature C further notes that:

> The rocks are c. 0.05-0.25 m in maximum diameter. The feature has a c. 1.50 m circular bare interior space that may have functioned as a planting plot. The feature is unaltered and in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-6).

Feature D
Site 50-10-27-18505, Feature D was also a modified outcrop originally recorded during the 1992 PHRI survey. The modified outcrop is described as consisting "of c. 30 pahoehoe slabs placed to form a ring of stones on top of bare pahoehoe bedrock" (O'Hare and Rosendahl 1993:A-6). PHRI found Feature D to measure approximately 3.00 meters by c. 3.00 meters, with a maximum height of c. 0.15 meters. The PHRI feature description for Site 18505, Feature D also indicates that:

> The rocks are c. 0.05-0.20 m in diameter. An approximately 1.70 m by 1.40 m area in the center of the feature is bare, and probably functioned as a planting plot. The feature is unaltered and in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-6).

Feature E
The PHRI survey report indicates that Site 50-10-27-18505, Feature E consisted of a single filled depression. It was described it as "a filled F-shaped crack" (O'Hare and Rosendahl 1993:A-6). Feature E was found to measure approximately 1.50 meters by c. 1.50 meters, with a maximum depth of 0.10 meters. The feature description for Site 18505, Feature E provided by PHRI also notes that:

> The crack is fairly shallow (less than 0.10 m), and is c. 0.10-0.40 m wide. The filled portions of the crack are 1.40-2.00 m long. The crack is filled with small subangular pahoehoe gravel and cobbles piled one to two courses deep to the lip of the crack. The rocks are c. 0.03-0.10 m in diameter. The feature is unaltered and in poor condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-6).

Feature F
Site 50-10-27-18505, Feature F was originally recorded during the 1992 PHRI survey and described as a modified outcrop consisting "of c. 30 to 40 pahoehoe cobbles and small boulders placed one course high on top of bare pahoehoe bedrock, forming a ring (O'Hare and Rosendahl 1993:A-6). The PHRI survey found Feature F to measure approximately 1.70 meters by 1.60 meters, with a maximum height of 0.10 meters. The PHRI feature description for Site 18505, Feature F also indicates that:

> The rocks are c. 0.075-0.35 m in diameter. A 1.00 m by 0.60 m area in the middle of the feature is bare and probably functioned as a planting plot. The feature is unaltered and in poor condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-6).

Feature G
Site 50-10-27-18505, Feature G was also originally recorded by the PHRI survey as a modified outcrop. It was described in the survey report as consisting of "c. 35-40 pahoehoe cobbles and boulders placed one course high, forming a roughly oval rock ring on top of bare pahoehoe bedrock (O'Hare and Rosendahl 1993:A-6). The Feature G modified outcrop was found to measure c. 2.80 meters in length by c. 2.10 meters in width, with a maximum height of c. 0.10 meters. The PHRI feature description of Site 18504, Feature G also notes that:

> The rocks are c. 0.075-0.40 m in diameter. A circular area in the interior is bare, and probably functioned as a planting plot. The feature is unaltered and in poor condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-6).

The Site 18505 complex was not relocated during the present survey. According to the PHRI site distribution map, the site was situated in the southwestern corner of the survey area, just north of Site 18504 (Figure 33). During the present survey, the area of Site 18505, as plotted by PHRI, was walked and examined by Pacific Legacy archaeologists. This area appears to have since been modified by the landscaping of the former Swing Zone driving range. No remains of the site complex or evidence of cultural material was observed during the present survey. The entire Site 18505 is presumed destroyed by ground disturbing activities associated with the construction of the Swing Zone. The Feature C, D, F and G modified outcrops, as described in the survey report and shown on the site map (Figure 42), strongly resemble possible temporary windbreak shelters found elsewhere in the coastal Keahuolū area. It seems possible that this relatively common type of feature may have served as what the PHRI survey refers to as planting plots, but one would think that the cultivation of dryland crops such as *ʻuala* (sweet potato, *Ipomoea batatas*) would have been undertaken more successfully in natural or created depressions (such as lava excavations) rather than atop areas of level *pāhoehoe* lava surrounded by a low wall of stones.

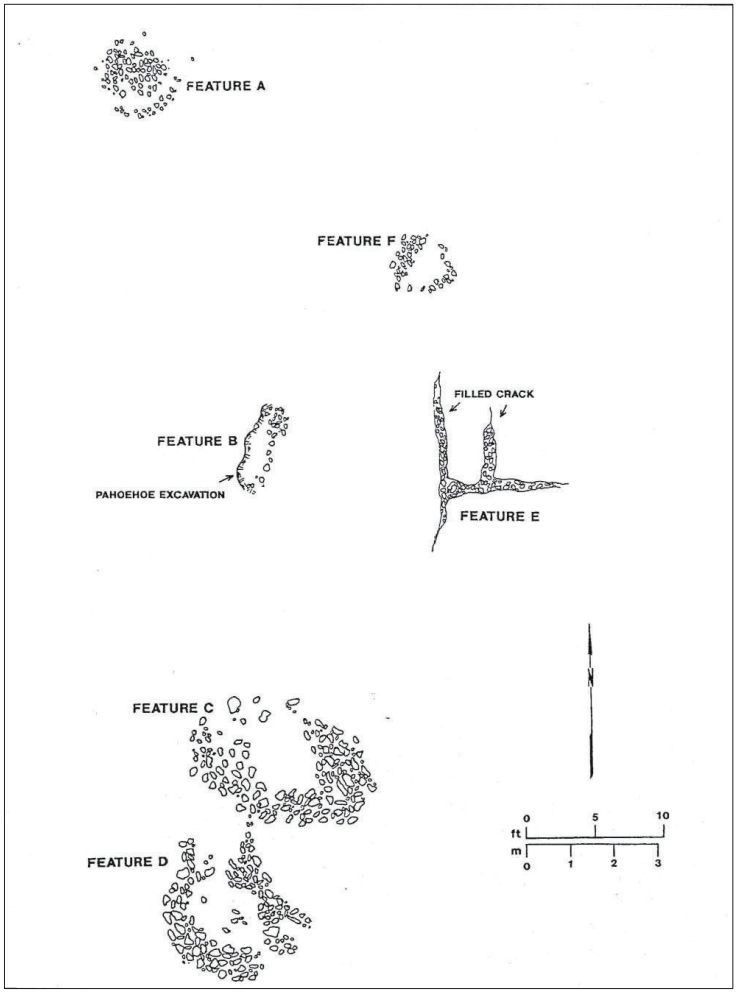


Figure 42. Plan view map of Site 50-10-27-18505 (O'Hare and Rosendahl 1993:Figure A-3).

SIHP Number: 50-10-27-18506
Site Type: Complex
Status: Not Relocated
Present Condition: Possibly Destroyed
Description: Site 50-10-27-18506 is complex comprised of four features; a lava tube (Feature A), two alignments located within the tube (Feature B and Feature C), and two fire hearths, also within the tube (Feature D). This site was initially identified during the 1992 PHRI survey. It was found to measure approximately 45.00 meters in overall length by c. 15.00 meters in overall width (O'Hare and Rosendahl 1993: A-6-A-9).

Feature A
The PHRI survey report describes Site 50-10-27-18506, Feature A as "a lava tube with three branching tubes." It measured approximately 45.00 meters in length by c. 15.00 meters, with a maximum ceiling height of c. 0.95 meters (O'Hare and Rosendahl 1993:A-8). The PHRI feature description of Site 18506, Feature A also notes that:

> The entrance to the cave shelter is reached from a section of collapsed ceiling c. 1.60 m by 1.30 m in diameter, and the cave floor is 0.60-0.90 m below the lip of the entrance. The entrance is above the area at which the three branches adjoin. This area has the highest ceiling (0.95 m) and the greatest density of cultural material.
>
> One tube runs east-southeast (110°) from the entrance. It is c. 20.00 m long and c. 5.00 m wide. The ceiling height of the tube at the west end (near the entrance) is 0.95 m, but becomes lower towards the east (0.32 m high). Most of the cultural material in this tube is at the west end (under the entrance and 5.00 m east), but one fragment of branch coral was observed c. 8.00 m from the entrance, and a sparse midden of burnt kukui nuts and some marine shell extends to the end of the tube. Near the entrance, several waterworn boulders, an octopus lure, a bone fishhook, a coconut husk, two hearths (Feature D), and a dense marine shell and kukui nut shell midden were observed in this tube. The fishhook was collected, and a 0.50 ml by 0.50 m test unit (TU-I) was excavated into one of the hearths to obtain charcoal for a radiocarbon date.
>
> A second tube extends south-southwest (220°) from the entrance. It is c. 20.60 m long and 0.70 m wide. The ceiling is 0.55-0.70 m high from the entrance to the southwest end. Most of the cultural material in this tube is concentrated near the entrance and 3.00 m southwest. A kukui nut midden extends past this point, however. A fragment of branch coral was observed c. 6.70 m from the entrance, and several waterworn cobbles were observed c. 9.80-10.80 m from the entrance. An alignment of boulders (Feature B) across the width of the tube at 3.00 m southwest of the entrance demarcates this area of dense cultural material. Kukui nuts, marine shell, waterworn cobbles, a coconut husk fragment, a bone awl, a polished basalt cobble, and a fragment of branch coral were all observed in this area.
>
> The third tube extends northwest (345°) from the entrance. It is c. 5.00 m wide with a ceiling height of c. 0.40-0.80 m for 21.50 m northwest of the entrance. At this point, the tube widens to c. 19.00 m, but the ceiling becomes so low that the tube cannot be followed further. Most of the cultural material in this tube is concentrated below the entrance and 1.50 m northwest. An alignment of boulders (Feature C) across the width of the tube demarcates this area. One fragment of branch coral was observed c. 5.00 m northwest of the entrance, and a sparse midden of burnt kukui nut extends past this feature. Near the entrance, kukui nuts, marine shell, some bone, and a coconut husk fragment were observed.
>
> The evidence for prehistoric temporary habitation at this feature includes ecofactual material and indigenous artifacts. The presence of waterworn boulders and fragments of branch coral may

> also be evidence for some ceremonial use. The cave is wet, with water dripping continually from the ceiling. The presence of coconut husk halves placed around the floor of the cave is probably evidence for water catchment. There is also evidence of temporary historic habitation outside the cave (two tin corrugated sheets). A historic camp might have been placed here to take advantage of this continual fresh water supply. The feature is unaltered and in good condition (O'Hare and Rosendahl 1993:A-8).

Feature B
Site 50-10-27-18506, Feature B is an alignment originally recorded during the 1992 PHRI survey. It is described by PHRI as "an alignment of boulders inside a cave shelter (Feature A)" and also noted as "approximately 20 large, subangular pahoehoe boulders are placed in a linear alignment running east-west" (O'Hare and Rosendahl 1993:A-8). During the PHRI survey, the alignment was found to measure c. 10.00 meters by c. 1.50 meters, with a maximum height of c. 1.00 meters. The PHRI feature description for Site 18506, Feature B also notes that:

> The boulders are c. 0.50-1.00 m in diameter. The east end of the alignment begins adjacent to two hearths in the east tube of the cave shelter, and the west end terminates along the southwest tube of the shelter. The alignment effectively demarcates the area of dense ecofactual and artifactual material on the cave floor of the southwest tube. These boulders probably represent roof fall that has been pushed back from the central area of the cave shelter to create a clear area for habitation. The feature is unaltered and in good condition (O'Hare and Rosendahl 1993: A-8).

Feature C
Site 50-10-27-18506, Feature C is also an alignment originally recorded during the 1992 PHRI survey and situated inside of the Feature A lava tube. According to PHRI, "approximately 20 large boulders are placed in a rough alignment oriented north-south" (O'Hare and Rosendahl 1993: A-8-9). During the 1992 PHRI survey, the alignment was found to measure c. 9.00 meters in length, c. 3.00 meters in width, and a maximum height of c. 0.80 meters. The PHRI feature description for Site 18506, Feature C also indicates that:

> The rocks are all a dark gray basalt, c. 0.35-1.00 m in diameter. The boulders are irregular in shape, although the majority are tabular in cross section. The alignment runs from the northwest tube to the southwest tube of the shelter, and demarcates an area of dense ecofactual and artifactual material on the cave floor near the entrance of the shelter. These boulders probably represent roof fall that has been pushed back from the central area of the cave shelter to create a clear area for habitation. The feature is unaltered and in good condition (O'Hare and Rosendahl 1993: A-8 to A-9).

Feature D
Site 50-10-27-18506, Feature D consists of two hearths, identified and originally recorded during the 1992 PHRI survey. The two fire hearths are situated inside of the Feature A cave shelter. Feature D is described by PHRI "as oval hearths" and located "c. 0.80-1.30 m east of the entrance to the cave in the east tube, in an area of dense ecofactual and artifactual material". (O'Hare and Rosendahl 1993: A-9). During the PHRI survey, the area comprised of the two fire hearths was found to measure c. 1.30 meters by 0.60 meters. The PHRI feature description for the Site 18506, Feature D fire hearths also notes that:

> The north hearth is c. 0.60 m by 0.30 m in diameter, and the south hearth is c. 0.70 m by 0.30 m in diameter. The features are unaltered and in good condition. A 0.50 m by 0.50 m test unit (TU-1)

was excavated into the south hearth to obtain charcoal for a radiocarbon date (O'Hare and Rosendahl 1993: A-9).

The entrance to the Site 18506 lava tube complex was not located during the present survey. According to the 1992 PHRI report, the site was encountered in the southwestern portion of the survey area in the vicinity of the former Swing Zone driving range (Figure 33). During the present survey, the area plotted on the PHRI site distribution map as the possible location of Site 18506 was surveyed and walked by Pacific Legacy archaeologists. Despite an intensive search of the area, no physical evidence of Site 18506 was observed. One lava tube, approximately 15 meters in length was investigated just north of the Swing Zone parking lot. This lava tube was found to contain no cultural material and determined to be a separate lava tube from the Site 18506 lava tube complex. It is probable that the Site 18506 lava tube was destroyed by construction activities associated with the development of the former Swing Zone.

SIHP Number: 50-10-27-18507
Site Type: Lava Excavation
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18507 is a single lava excavation. The 1992 PHRI survey identified this site and described as "an excavation in a naturally depressed area of undulating bare pahoehoe" (O'Hare and Rosendahl 1993: A-9). During the 1992 PHRI survey, the site was found to measure c. 2.80 meters in length by c. 1.80 meters in width, and a maximum height of c. 0.80 meters. The PHRI site description of Site 18507 also noted that:

> A section of the top of the bedrock has been broken, creating a hole c. 0.25 m deep. Pahoehoe cobbles and boulders are piled two to three courses high into this hole; filling it to the lip and above. Rocks have also been piled along the lip of the hole, obscuring the edges of the excavated area. The rocks are 0.20-0.30 m in diameter. Pahoehoe slabs (c. 0.20-0.35 m in diameter) are also piled with the cobbles and boulders. The feature is unaltered and in fair condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993: A-9).

The Site 18507 lava excavation was not relocated during the present survey. According to the 1992 PHRI survey, the site was encountered in the southwestern portion of the project area (Figure 33). During the current survey, the relative location of Site 18507, as plotted on the PHRI site distribution map, was walked by Pacific Legacy archaeologists. This area appears to have been extensively modified by the creation of the former Swing Zone driving range. The Site 18507 lava excavation, previously recorded by PHRI, is presumed to have been destroyed by construction activities associated with the Swing Zone.

SIHP Number: 50-10-27-18508
Site Type: Modified Overhang
Status: Relocated
Present Condition: Fair
Description: Site 50-10-27-18508 consists of a natural overhang with a wall fronting the entrance. The 1992 PHRI survey identified this site as a "walled overhang at the base of a

pahoehoe outcrop" (O'Hare and Rosendahl 1993: A-9). The PHRI site description for Site 18508 also noted that:

> It is oriented at 130°/310° and is c. 7.50 m by 0.90 m with a maximum ceiling height of 0.92 m. There was no soil or any kind of cultural deposit inside the shelter. The overhang floor is level, with a natural semicircular depressed area (c. 11.00 m by 3.50 m) in front of the drip line. This depressed area is bounded on most of the north side by pahoehoe outcrops. A gap between two outcrops is spanned by a wall 5.70 m by 3.10 m by 0.78 m, constructed of pahoehoe cobbles and boulders piled one to three courses high. The rocks are c. 0.10 m to 0.50 m in diameter. Some cobbles fill a smaller gap on the northwest end of the depressed area, but this material is probably natural roof fall. The feature is unaltered and in fair condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993: A-9).

Site 18508 was relocated during the current survey. It was found to be situated in the southwestern portion of the project area, approximately 74 meters west of Makala Boulevard and slightly east of the disturbed area associated with the former Swing Zone driving range (Figure 35). The site was located c. 228.8 meters northwest (334°) of the Site 18502 modified depression. The PHRI site description for Site 18508 (O'Hare and Rosendahl 1993:A-9) provides a relative accurate depiction of the site, though the present survey noted some minor differences in the measurement of the wall.

The Pacific Legacy archaeologists encountered the modified overhang within a large lava sink, measuring c. 11.0 meters by c. 6.0 meters. The overhang is situated on the south side of the lava sink, with its opening facing north (Figure 43). The highest point of the overhang ceiling is c. 0.90 meters above the floor of the sink. A rough and somewhat disturbed stone wall extends off of the southeastern end of the overhang, running in a northwesterly direction (Figure 44). This wall is constructed of loosely piled basalt boulders and cobbles, and measures c. 3.0 meters in length by c. 1.0 meters in width, with a maximum height of 0.70 meters. The area between the wall and overhang is relatively level with little or no soil, and measures c. 1.9 meters by c. 1.1 meters.

No cultural material was observed within or surrounding the site. The Site 18509 modified overhang is currently in fair condition. It is likely that this natural lava overhang was modified and utilized as a temporary habitation shelter during the pre-Contact period.

Figure 44. Site 50-10-27-18508, modified overhang (view southeast).

SIHP Number: 50-10-27-18509
Site Type: Complex
Status: Relocated
Present Condition: Fair
Description: Site 50-10-27-18509 is a complex comprised of four features; a stone mound (Feature A), a filled depression (Feature B), a stone mound (Feature C), and a lava excavation (Feature D). Features A through C were originally identified and recorded during the 1992 PHRI survey (O'Hare and Rosendahl 1993:A-9-A-10). The Feature D lava excavation was discovered during the present survey.

Site 18509 was relocated and documented by Pacific Legacy archaeologists during the present survey (Figure 45). The site complex is located toward the western edge of the project area, approximately 45 meters west of Makala Boulevard (Figure 35). It is situated c. 136.0 meters north (7°) from the Site 18508 walled overhang. The overall site complex measures c. 14.7 meters in length (north to south) by c. 11.6 meters in width (east to west). All of the features within the complex appear to be pre-Contact in age.

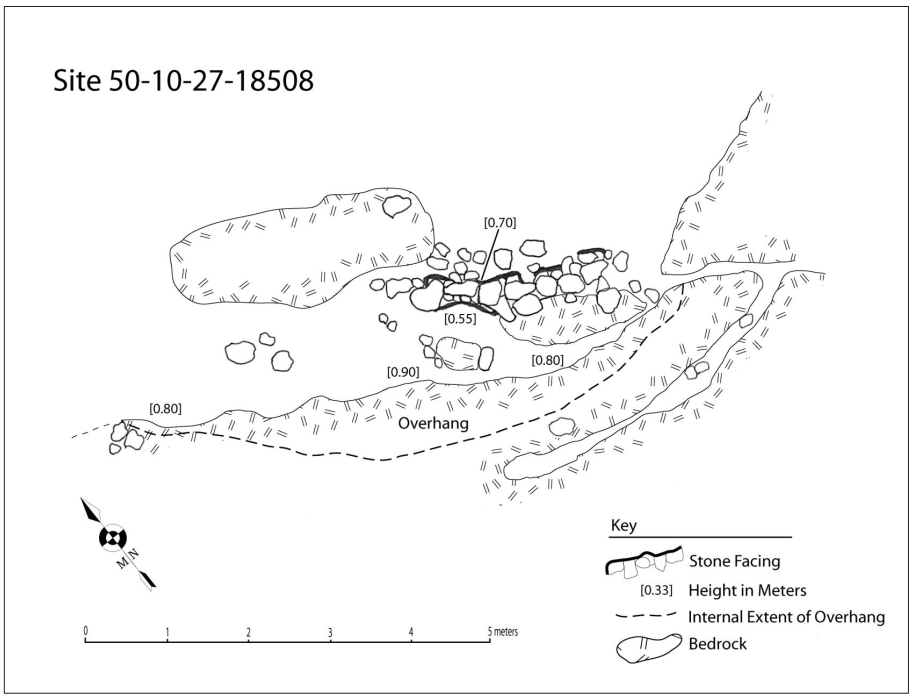


Figure 43. Plan view map of the Site 50-10-27-18508 modified overhang.

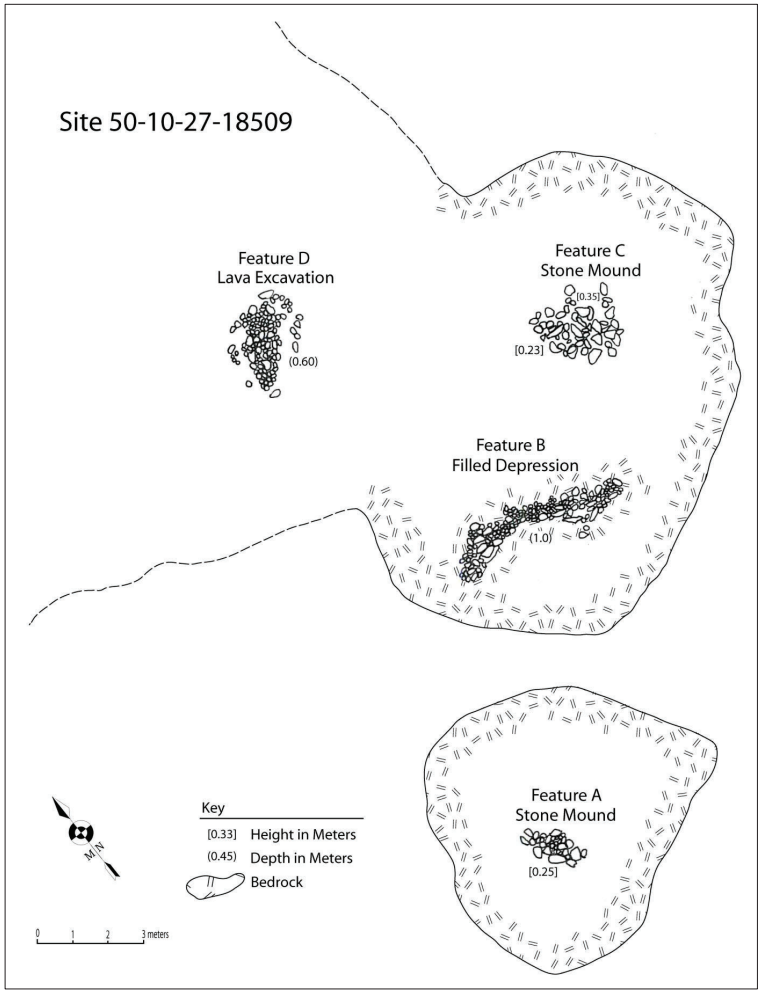


Figure 45. Plan view map of the Site 50-10-27-18509 site complex.

Feature A

Site 50-10-27-18509, Feature A is described by PHRI as an "irregularly shaped mound" measuring approximately 2.00 by 1.00 meters, with a maximum height of c. 0.29 meters (O'Hare and Rosendahl 1993:A-9-A-10). The PHRI feature description of Site 18509, Feature A also noted that:

> It is constructed of pahoehoe cobbles and boulders piled two to three courses high on top of bare pahoehoe bedrock. The rocks are 0.075-0.20 m in diameter. The west side abuts a pahoehoe outcrop. One upright cobble was noted on the northeast side of the mound. The feature is unaltered and in fair condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-9 to A-10).

The Feature A stone mound was relocated during the present survey (Figure 46). The Pacific Legacy archaeologists encountered the mound at the southwestern edge of the site complex, approximately 14.9 meters southwest (226°) from the Feature C stone mound. The structure appears somewhat collapsed and currently measures c. 1.2 meters (northwest to southwest) by c. 0.75 meters (northeast to southwest). The stone mound is comprised of *pāhoehoe* cobbles loosely piled 1to 3 courses high, with a maximum height of c. 0.25 meters. No cultural material was observed at this feature. Feature A, though partially collapsed, appears to be in fair condition. Although the PHRI survey report interpreted this feature to be an agricultural mound, it is build directly atop lava bedrock and seems more likely to have served as some form of marker constructed during the pre-Contact period.

Figure 46. Site 50-10-27-18509, Feature A, stone mound (view northeast).

Feature B
Site 50-10-27-18509, Feature B was originally recorded during the 1992 PHRI survey as a "filled depression", and found to measure c. 5.50 meters by c. 5.00 meters, with a maximum height of c. 0.09 meters (O'Hare and Rosendahl 1993: A-10). The PHRI feature description of Site 18509, Feature B mentions that:

> A serpentine crack, oriented at 85°/265°and on top of a pahoehoe bedrock dome, is filled with pahoehoe gravel and cobbles one to two courses deep. The rocks are piled to the lip of the crack and 0.04 m above the lip in some places. The feature is unaltered and in fair condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993: A-10).

During the present survey, the approximate location of Feature B, as plotted on the PHRI site distribution map (Figure 33), was surveyed by Pacific Legacy archaeologists. A serpentine crack similar to that described in the PHRI survey report was located. Upon examination, however, this crack appears to be a natural crevice in the lava that has become filled with slabs and fragments of fractured *pāhoehoe* from the surrounding surface (Figure 47). None of the material within the crack appears to be stacked or intentionally set into place. The settling of this surface material into the crack may have taken place naturally due to tectonic activity. Numerous other filled crevices of similar appearance were observed in the vicinity. All of these appear to be natural features. The Feature B "filled depression" was therefore determined to be a natural feature.

Feature C
During the 1992 PHRI survey, Site 50-10-27-18509, Feature C was described as a "roughly circular mound." It was found to measure c. 1.70 meters by 1.30 meters, with a maximum height of c. 0.45 meters (O'Hare and Rosendahl 1993: A-10). The PHRI feature description for Site 18590, Feature C notes that:

> It is constructed of subangular pahoehoe gravel and cobbles piled two to four courses high on top of bare pahoehoe bedrock. The interior is bare, so this feature was probably used as a planting plot. It is unaltered and in fair condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993: A-10).

The Site 18509, Feature C stone mound was relocated during the current survey. It is situated at the eastern edge of the site complex, approximately 14.9 meters northeast (46°) from the Feature A stone mound. Feature C appears to have been constructed on top of a small *pāhoehoe* dome (Figure 48). The mound, which shows evidence of collapse, currently measures c. 1.6 meters in length (northwest to southeast) by c. 1.3 meters in width (northeast to southwest). It stands 1 to 2 courses high, with a maximum height of c. 0.30 meters. No cultural material was observed within or around the feature. Feature C appears to be in fair condition, though somewhat tumbled. While the PHRI survey report identifies it as a probable "planting plot," the mound's location on the crest of a low dome of *pāhoehoe* lava might suggest that it served as some form of visual marker constructed during the pre-Contact period.

Figure 47. Site 50-10-27-18509, Feature B filled depression (view east-northeast).

Figure 48. Site 50-10-27-18509, Feature C stone mound (view southeast).

Feature D
Site 50-10-27-18509, Feature D is a lava excavation that was discovered and recorded during the present survey (Figure 49). This lava excavation is located at the northern end of the Site 18509 complex, approximately 9.9 meters northwest (295°) of the Feature C stone mound. Feature D is situated on top of a *pāhoehoe* lava ridge. It is roughly rectangular in shape and measures c. 2.3 meters in length (northeast to southwest) and c. 1.2 meters in width (northwest to southeast), with a maximum depth of 0.60 meters. No soil was visible within the lava excavation, and the interior was filled with broken cobble size rocks. No cultural material was observed inside or around of the lava excavation. Feature D appears to be in fair condition. It appears possible that the lava excavation may have been utilized as a planting area during the pre-Contact period.

Figure 49. Site 50-10-27-18509, Feature D lava excavation (view northeast).

SIHP Number: 50-10-27-18510
Site Type: Lava Excavation
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18510 was identified during the 1992 PHRI survey and described as "three pahoehoe excavations in a row (at 40°/2200) at the east base of a large elevated pahoehoe outcrop" (O'Hare and Rosendahl 1993:A-10). During the PHRI survey, the lava excavations were found to possess a maximum diameter of between c. 0.60 and 0.75 meters, and were excavated to a maximum depth of between c. 0.28 meters and 0.65 meters. The overall site was found to measure c. 6.40 meters by 3.10 meters, and to be c. 0.65 meters in maximum height. The PHRI site description of Site 18510 also noted that:

> A narrow, level strip at the [base of the outcrop consists of fractured bedrock in gravel and cobble size (c. 0.05-0.20 m in diameter).
>
> Some pahoehoe boulders that probably came from the excavations are scattered around. However, there are not enough of these rocks to account for the amount of material that must have been excavated from the outcrop. Therefore, some of the material must have been carried

> away. This is good evidence that the main function of the excavations was to quarry material. A discontinuous alignment of about nine boulders in front of the southernmost excavation may have been man-made or natural. These boulders are up to c. 0.35 m in diameter. The feature is unaltered and in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993: A-10).

The Site 18510 lava excavations were not relocated during the present survey. According to the PHRI site distribution map (Figure 30), the site was encountered in the central portion of the project area within or near a section of terrain that shows evidence of having been bulldozed, possibly during the construction of the Target parking lot (Figure 33). Pacific Legacy archaeologists walked over this area repeatedly but found no evidence of any of the lava excavations described in the PHRI report. It is presumed that the Site 18510 lava excavations have been destroyed.

SIHP Number: 50-10-27-18511
Site Type: Complex
Status: Relocated
Present Condition: Fair
Description: Site 50-10-27-18511 is a complex comprised of five features: a modified overhang (Feature A), a lava excavation (Feature B), a lava tube (Feature C), and two additional lava excavations (Feature D and Feature E). The Feature C lava tube contains human remains. Features A through C were originally identified and recorded during the 1992 PHRI survey (O'Hare and Rosendahl 1993:A-10 to A-12), while the Feature D and Feature E lava excavations were discovered during the present survey.

Site 18511 was relocated by Pacific Legacy archaeologists and found to be situated toward the center of the project area, approximately 170 meters east of Makala Boulevard and c. 85 meters west of Loloku Street (Figure 35). It is located c. 211 meters east (95°) of the Site 18509 complex. In overall extent, the site complex measures c. 44.4 meters in length (east to west) and c. 18.8 meters in width (north to south).

Site 18511 appears to be a multi-use complex whose component features served a range of functions. The Feature A overhang seems to have been modified for use as a temporary shelter, the Feature C lava tube served as a burial chamber, the Feature B lava excavation could have been utilized as either a planting area of a quarry, while the Feature D and E lava excavations seem most likely to represent areas where stone was quarried for use as building material.

Feature A
Site 50-10-27-18511, Feature A was originally recorded during the 1992 PHRI survey as a "walled overhang", measuring c. 9.00 meters by c. 6.00 meters, with a maximum ceiling height of c. 1.25 meters (O'Hare and Rosendahl 1993:A-10). The PHRI feature description for site 18511, Feature A further notes that:

> The overhang is oriented at 100°/280° and opens up at the base of a large pressure ridge. It is 7.00 m long and has an average depth of 5.00 m. An area in front of the overhang is fairly level and has been cleared of most rock. A short wall has been built across the west entrance to this

> depressed area. The wall is constructed of pahoehoe cobbles and boulders piled on top of bare bedrock. There are some goat bones against the back wall of the overhang. The overhang area gives access to a narrow, low-ceilinged cave. There is no evidence that the cave has been modified or utilized in any way. It is unaltered and in fair condition. No cultural deposits or soil deposits were observed at this feature (O'Hare and Rosendahl 1993:A-10).

Feature A was re-identified during the present survey and was found to be located at the southwestern edge of the Site 18511 complex, approximately 24.7 meters southwest (245°) of the Feature B lava excavation. Upon inspection, Feature A appears to be a modified overhang, rather than a walled overhang, as it had previously been described (Figure 50). No distinct wall was identified, instead, stone stacking was observed in a crevice to the east of the overhang that stands approximately 3 to 4 courses high and measures c. 1.2 meters by c. 0.70 meters (Figure 51). Stacking was also noted to the west of the overhang, standing approximately two courses high and measuring c. 0.60 meters by c. 0.50 meters. The overall dimensions of the overhang are c. 5.5 meters long, c. 1.6 meters wide, and c. 1.4 meters deep, making it much smaller than was originally recorded during the 1992 survey. Some modern trash was observed within the eastern crevice of the overhang, including an aluminum Coca-Cola can, a clear glass screw-top bottle, and what appears to be a can of acetone.

A lava tube is located to the south of the modified overhang (Figure 52). It measures c. 10.0 meters in length, c. 2.5 meters in width, with a maximum interior height of c. 1.25 meters. The main entrance is located on its western side, and contains tumbled rock that naturally slopes into the lava tube. There is also a skylight entrance on the eastern side of the lava tube. The interior of the lava tube is clear of debris and its floor relatively flat. No modifications to the lava tube were noted. Goat and dog bones are scattered throughout the north side of the lava tube. Recent trash, such as batteries and plastic debris are also present inside of the tube. No other cultural material was observed.

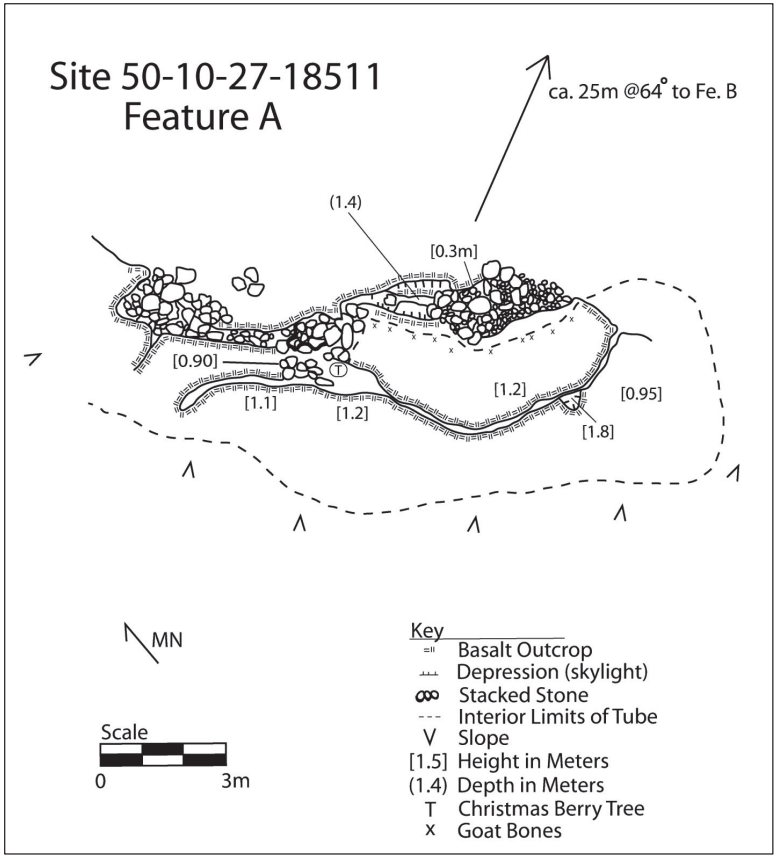


Figure 50. Plan view map of the Site 50-10-27-18511, Feature A.

Figure 51. Site 50-10-27-18511, Feature A, modified overhang (view northeast).

Figure 52. Site 50-10-27-18511, Feature A, lava tube entrance (view south).

The Feature A modified overhang appears to be in fair condition. The overhang and lava tube show evidence of having been occupied by homeless individuals. It is difficult to determine, however, if there have been recent alterations made to Feature A since the 1992 PHRI survey. The modified overhang most likely served as a temporary habitation shelter during the pre-Contact period.

Feature B

Site 50-10-27-18511, Feature B is a lava excavation that was originally recorded during the 1992 PHRI survey. At that time the lava excavation was recorded as measuring c. 3.0 meters by c. 1.50 meters, with a maximum depth of c. 1.60 meters (O'Hare and Rosendahl 1993:A-12). The PHRI feature description for Site 18511, Feature B also indicates that:

> Many naturally fractured bedrock fragments are at the bottom of a crevice at the crest of a pressure ridge. This crevice is oriented at 115°/295° and is c. 5.00 m long and 1.75 m wide. Some of the boulders (c. 0.40-0.50 m in diameter) in the west half of this crevice have been removed and are scattered outside on the south slope of the pressure ridge. This creates deep, bare pockets (up to 1.60 m deep) in the crevice. These pockets may have been used for growing purposes, for cache areas, or for quarrying of raw materials. Vegetation is growing in two of the pockets, although little soil was noted. Only a shallow (0.05-0.10 m deep) deposit of duff was observed. The feature is unaltered and in good condition. A waterworn boulder (c. 0.20 m by 0.25 m by 0.15 m) was observed in the crevice (O'Hare and Rosendahl 1993:A-12).

The Site 18511, Feature B lava excavation was relocated during the present survey (Figure 53). It is situated at the crest of a *pāhoehoe* ridge in the central portion of the site complex, approximately 24.7 meters northeast (65°meters) of the Feature A walled overhang. The lava excavation was found to currently measure c. 5.8 meters in length by c. 1.6 meters in width, and to be c. 1.5 meters in depth. There is a large amount of organic debris from growing vegetation [fountain grass (*Pennisetum setaceum*) and Christmas berry (*Schinus terebinthifolius*)] within the interior of the lava excavation. Numerous cobbles and boulders that were apparently removed from the lava excavation are scattered on the lava surface to the south.

A small vesicular waterworn boulder was observed within the lava excavation (Figure 54). Although this boulder shows no evidence of battering, it could have been brought to the site to be used as a hammerstone. No other cultural material was noted in or around the excavation. Feature B is currently in fair condition. This lava excavation may have been used as a quarry site during the pre-Contact period.

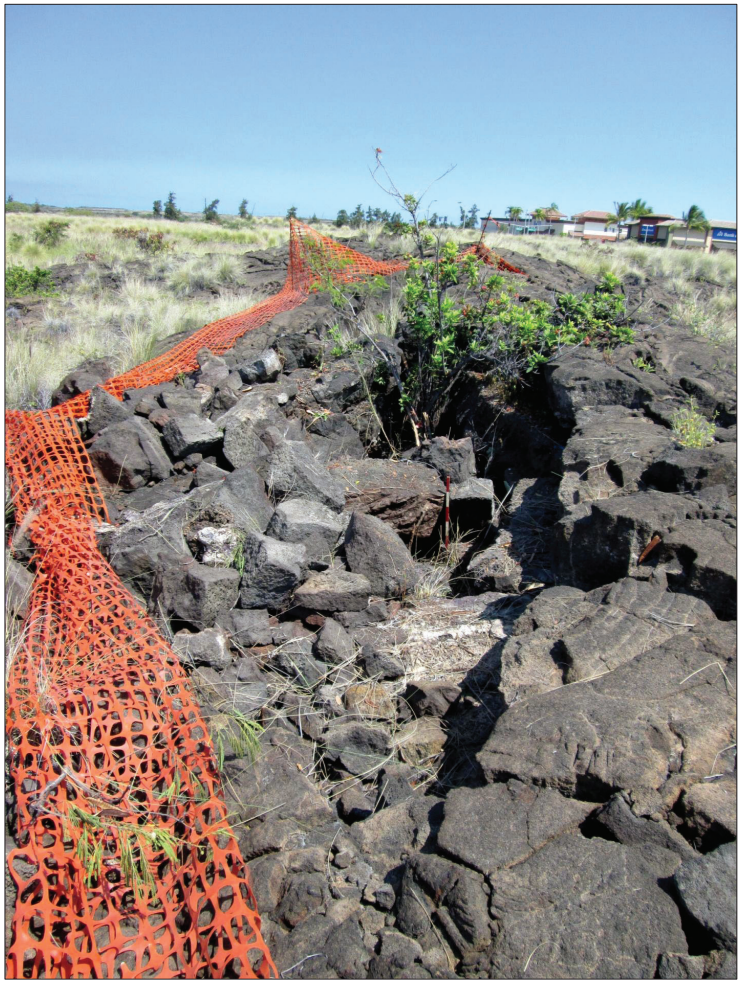


Figure 53. Site 50-10-27-18511, Feature B, lava excavation (view northwest).

Figure 54. Site 50-10-27-18511, Feature B, waterworn boulder.

Feature C

Site 50-10-27-18511, Feature C was originally recorded during the 1992 PHRI survey and described as a "burial cave" located "at the south base of a large pahoehoe pressure ridge. It contains scattered human bones" (O'Hare and Rosendahl 1993:A-12). Feature C was recorded as measuring c. 2.90 meters by c. 2.28 meters, with a maximum ceiling height of c. 0.82 meters (Figure 55). The PHRI feature description for Site 18511, Feature C further notes that:

> Entrance is possible from a 0.80 m by 0.60 m hole in the ceiling of the cave. The cave opens up both east and west from the opening, but skeletal material is present only in the west half. The cave floor is c. 0.72 m below the ground surface at the opening, but only a narrow strip (1.60 m long and 0.25 m wide) down the middle of the cave has a ceiling high enough (0.72-0.80 m high) to allow further access. This strip down the middle consists of a natural depression that had been filled with pahoehoe gravel and cobbles to create a smooth floor. Most of the scattered bone was observed either in this depression, on top or among the cobbles, or on a bare bedrock shelf adjacent to and south of the depression. The skeletal material consists of scattered finger, toe, and foot bones, some vertebrae, and one incisor. The west end of this tube is blocked by roof fall. A glass patent medicine bottle was observed in this roof fall.

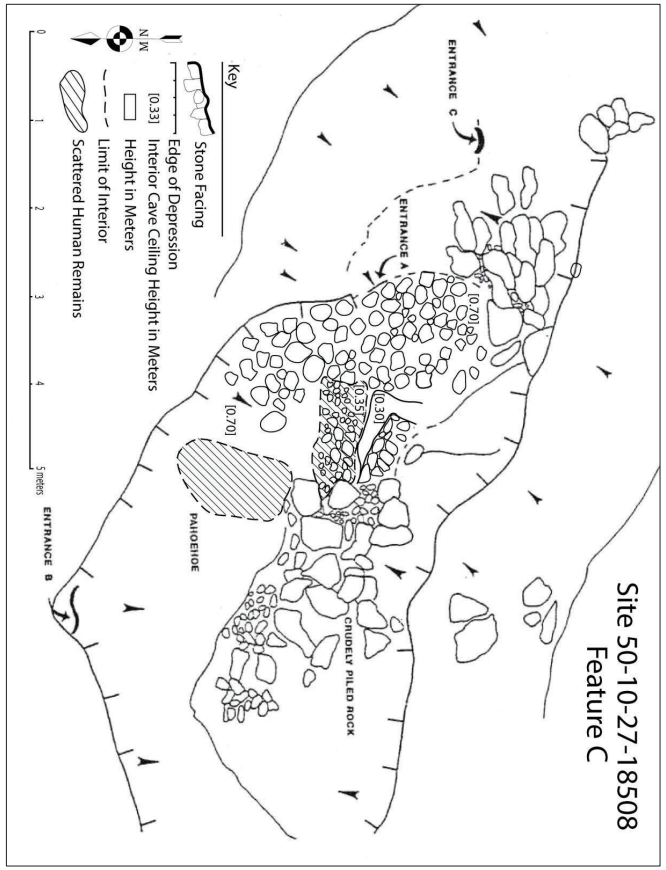


Figure 55. Plan view map of Site 50-10-27-18511, Feature C modified lava tube (base map from O'Hare and Rosendahl 1993:Figure A-5, with modifications from the present survey).

Pahoehoe cobbles and boulders have also been stacked on the cave floor below the entrance. The stacked area (c. 0.30 m by 0.90 m) is flush with the side of the cave on the north and west sides, and elevated c. 0.20-0.30 m above the cave floor on the south and east sides. Some rocks in this stacked area and some of the rocks in the central depression were moved during the present survey in order to see if an articulated burial was present in the cave. Only a *puka* shell (*Conus sp.*) was discovered in the stones by the entrance. A few more scattered bones were observed under the depression fill, but no major bones (long bones or cranial material) were present. It seems probable that a burial was once present in the cave, possibly on top of the level central area of the cave, but was later removed. This might have taken place during historic times when the cave might have been used for temporary habitation. The cave is wet, with continual dripping from the roof, and the glass bottle found in the cave maybe historic evidence for use of the cave as a water catchment area. The feature is unaltered-and in good condition. The glass bottle was collected, the *puka* shell was not, and the bones were left in place (O'Hare and Rosendahl 1993:A-12).

The Feature C modified lava tube was relocated during the present survey (Figure 56). It is situated at the northern edge of the Site 18511 complex, approximately 8.8 meters north (11°) of the Feature B lava excavation. The main entrance into the lava tube, labeled "Entrance A" on the PHRI site map (Figure 55), measures c. 0.80 meters by c. 0.60 meters. There are boulders roughly stacked around and partially blocking this entrance. The interior of the lava tube measures c. 8.0 plus meters in length by c. 3.0 meters in width, with a maximum ceiling height of c. 0.90 meters. The floor of the lava tube currently appears to be rough and unlevel due to rock fall.

Within the lava tube, east of the main entrance is a stone filled terrace, measuring c. 0.30 meters in height. Human skeletal remains were observed scattered within three concentrated areas inside of the lava tube. The areas that contain human bone fragments include: an area on top of the stone terrace, an area within a natural channel of the floor surface, and an area on a lava shelf just south of the natural channel. No long bones or cranial elements were present among the scatter of human skeletal remains. There were no other interior or exterior features noted within the lava tube.

No artifacts or other cultural material was observed within the Feature C lava tube. This lava tube currently appears to be in fair condition. Feature C served as a burial, most likely pre-Contact in age. It is possible that it was also utilized for ceremonial purposes.

Figure 56. Site 50-10-27-18511, Feature C modified lava tube entrance (view east).

Feature D

Site 50-10-27-18511, Feature D is a lava excavation that was discovered and recorded during the present survey (Figure 57). This lava excavation is located at the eastern end of the Site 18511 complex, approximately 19.8 meters east (111°) of the Feature C lava tube. It is situated on the slope of a low lava ridge. The excavation is irregular in shape, measuring c. 4.2 meters in length (east to west) by c. 2.8 meters in width (north to south), and c. 0.20 meters in depth. The upper layer of lava has been broken apart over a sizeable area, and block-like chunks of *pāhoehoe* appear to have been removed, leaving a relatively smooth (though sloping) interior floor, which is scattered with discarded subangular basalt boulders and cobbles.

A small vesicular basalt hammerstone that is discoidal in shape was observed within the excavated area (Figure 58). The hammerstone measures c. 0.9 centimeters in length, c. 0.8 centimeters in width, and c. 0.4 centimeters in thickness. The artifact was collected from the feature and, following documentation, was given into the care of the Queen Liliʻuokalani Trust for curation. Given the relatively small size of the artifact, it seems unlikely that it was used to break up the lava surface. Larger waterworn boulders, such as that found at Feature B, appear to have been more commonly utilized for that purpose. It is possible that the discoidal hammerstone was used to shape the edges of the stones removed from the excavation. However, though this too seems unlikely, taking into account its size and highly vesicular nature (which would have made it softer and less durable than a similar sized waterworn stone of dense basalt). It seems more probable that the artifact was used for some purpose not directly related to the excavation of the feature, as a hammerstone for softer material, or as a very coarse abrader.

The Feature D lava excavation is in fair condition. The fact that much of the broken up stone that originally formed the upper layer of the excavation's lava surface appears to have been removed, suggests that the feature was most likely utilized as a quarry for obtaining thickly tabular chunks of basalt stone that could be used elsewhere as building material. It is probable that Site 18511, Feature D dates to the pre-Contact period.

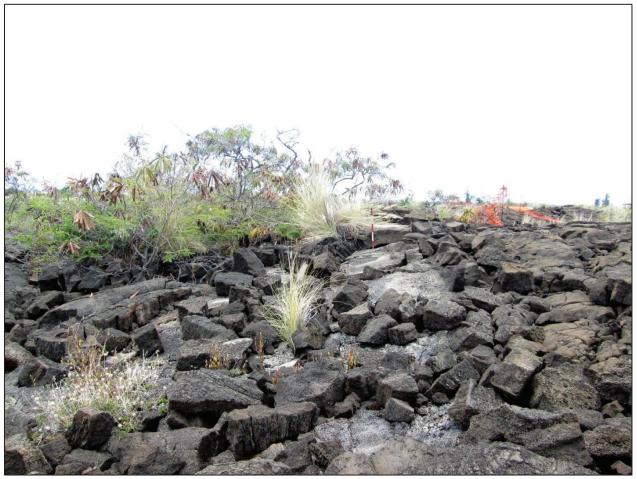


Figure 57. Site 50-10-27-18511, Feature D lava excavation (view west).

Figure 58. Site 50-10-27-18511, Feature D hammerstone.

Feature E
Site 50-10-27-18511, Feature E is a lava excavation that was discovered and recorded during the present survey (Figure 59). This lava excavation is located along the northeastern edge of the Site 18511 complex. It is situated approximately 8.5 meters west (288°) of the Feature D lava excavation along the same lava ridge. The excavation is roughly rectangular in shape, measuring c. 4.2 meters in length (northeast to southwest) by c. 1.6 meters in width (northwest to southeast). There is a natural fracture extending through the excavation in a northeasterly (59°) direction. Feature E is similar to Feature D, in that it appears only the first course of loose material was removed from the lava excavation. A small number of large boulders and cobbles remain within the interior of the excavation, mostly along its edges.

No cultural material was observed within the Feature E lava excavation. The feature is in fair condition. It seems likely that the lava excavation was utilized for the quarrying of basalt stone for use as building material during the pre-Contact period.

Figure 59. Site 50-10-27-18511, Feature E, lava excavation (view southwest).

SIHP Number: 50-10-27-18512
Site Type: Alignment
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18512 was identified during the 1992 PHRI survey and described as a "circular alignment of boulders" (O'Hare and Rosendahl 1993:A-12). The alignment was found to measure c. 1.80 meters by 1.72 meters, with a maximum height of 0.32 meters. The PHRI site description of Site 18512 also noted that:

> It is constructed of large pahoehoe slabs and boulders that have been placed on top of bare pahoehoe to form a ring. The boulders are c. 0.25-0.64 m in diameter, and the slabs are c. 0.15-0.22 m in diameter. Occasionally the ends of the boulders overlap, but there is no real piling. Most of the ring consists of just one course of rock. Three large boulders are placed on edge on the north side of feature. This feature is rather large to be a traditional prehistoric planting plot. The feature might have been associated with recent camping in the area. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-12).

From this description, the Site 18512 alignment appears similar to low walled enclosures found throughout coastal Keahuolū. Such structures have been tentatively identified as temporary windbreak shelters constructed during the pre-Contact period. Site 18512 was not located during the present survey. According to the PHRI site distribution map, the site was encountered toward the center of the project area in the area now occupied by the Target parking lot (Figure 33). The area of Site 18512, as plotted on the PHRI map, was inspected by Pacific Legacy archaeologists during the present survey, but no evidence of a circular alignment was found. The Site 18512 alignment appears most likely to have been destroyed during the construction of the Target store.

SIHP Number: 50-10-27-18513
Site Type: Agricultural Terrace Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18513 is a complex comprised of three terraces (Features A through C). The 1992 PHRI survey originally identified this site as an agricultural terrace complex. It was found to have an overall length of approximately 25.00 meters (east to west) and a width of c. 8.00 meters (north to south) (O'Hare and Rosendahl 1993:A-12-A-14).

Feature A
Site 50-10-27-18513, Feature A is described by PHRI as "a terrace constructed of pahoehoe cobbles and boulders piled and stacked on top of a naturally fractured pahoehoe outcrop"(O'Hare and Rosendahl 1993:A-13-A-14). Feature A was found to measure c. 5.50 meters in length by c. 2.50 meters in width, with a maximum height of 0.60 meters (Figure 60). The PHRI feature description of Site 18513, Feature A also notes that:

> The majority of the construction material is 0.20 m in diameter or larger and was probably obtained from the bedrock outcrop itself. The terrace is roughly rectangular, with the larger boulders used along the perimeter of the feature. The east side is flush with the general ground

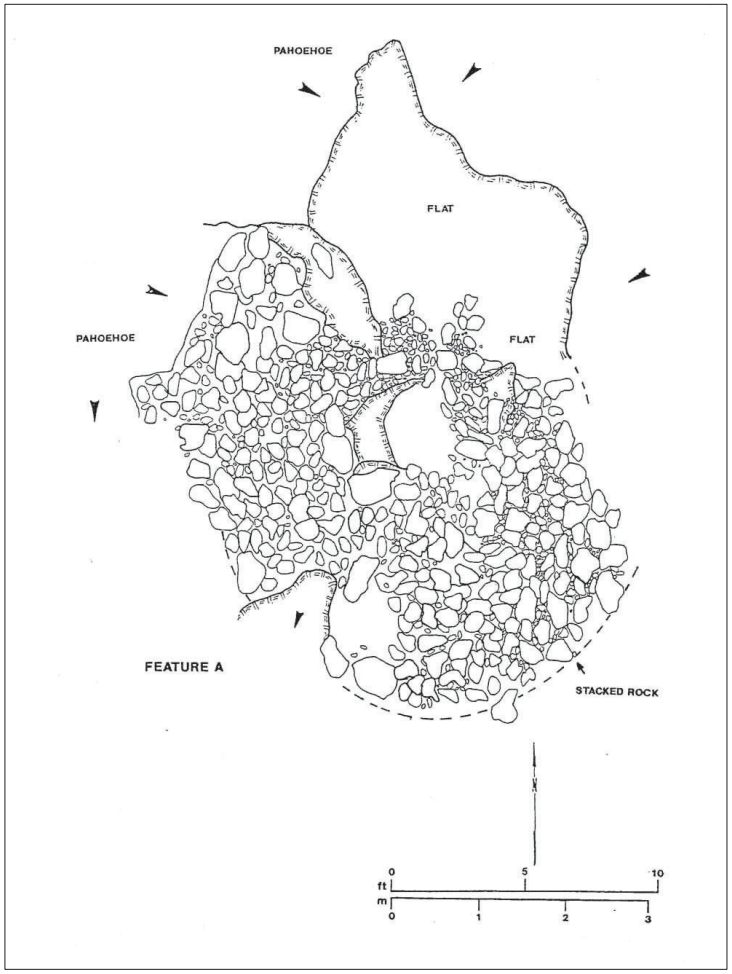


Figure 60. Plan view map of Site 50-10-27-18513, Feature A (O'Hare and Rosendahl 1993:Figure A-6).

surface, and the other sides are elevated c. 0.45 m to 0.60 m. Yellow flagging tape and a metal site tag inscribed with "T-11 2-2-84" were found near the east edge of the feature. The metal tag was solid aluminum, unlike PHRI's present metal tags. [It is not clear what survey this site tag dates from.]

An oval hole c. 1.28 m deep was observed in the center of the feature. The hole was probably formed by removing naturally fractured bedrock chunks from the top of the outcrop. The west edge of the hole is solid bedrock, and crudely piled rocks form the other sides. The hole could have functioned as a cupboard, or it may be the result of a test excavation. The feature is unaltered and in fair to good condition. No portable remains were observed at this feature. An approximately 0.10-0120 m soil deposit was noted on the ground around the feature (O'Hare and Rosendahl 1993:A-13).

Feature B

PHRI describes Site 50-10-27-18513, Feature B as a terrace "constructed on top of a fractured bedrock outcrop" (O'Hare and Rosendahl 1993:A-13). Feature B was found to measure c. 4.20 meters in length by c. 3.00 meters in width, and with a maximum height of c. 0.62 meters. The PHRI feature description of Site 18513, Feature B also indicates that:

The outcrop is generally level with the ground surface on the east side, and elevated c. 0.05-0.15 m above the ground surface elsewhere. The ground surface and the surface of the outcrop slope west. The terrace is constructed of pahoehoe cobbles and boulders. Most of the construction material consists of boulders c. 0.25-0.60 m in diameter, and was probably obtained from the outcrop itself. The east half of the outcrop is more level and regular. The surface of the outcrop is exposed in many places on the east side. Boulders are stacked up to three courses high to elevate the west side.

There is one depression in the center of the terrace, which may be just another example of the irregularity of the terrace surface. There is some collapse on the west side. The feature is unaltered and in fair condition. No portable remains were observed at this feature. There was a c. 0.10-0.20 m deposit of brown fine soil around the feature (O'Hare and Rosendahl 1993:A-13).

Feature C

Site 50-10-27-18513, Feature C is described by PHRI as a terrace "constructed on top of a heavily fractured pahoehoe bedrock outcrop" (O'Hare and Rosendahl 1993:A-13). Feature C was found to measure c. 3.75 meters in length by c. 3.30 meters by width, and with a maximum height of c. 0.82 meters. The PHRI feature description of Site 18513, Feature C also notes that:

The ground slopes slightly west in this area, but the surface of the outcrop is fairly level. Therefore, the outcrop itself forms a natural terrace, with the east end flush with the ground surface, and the middle elevated as much as c. 0.82 m above ground surface. Most of the material used to construct the terrace was probably obtained from the fractured outcrop itself. The rocks are cobbles (c. 0.15-0.25 m) to large pahoehoe boulders (c. 0.25-0.50 m) randomly piled two to three courses high on top of and around the outcrop. It is difficult to tell which rocks were artificially piled and which are natural. Some boulders on the outcrop are noticeably higher than the general surface level of the outcrop. The rocks have, been mapped as though they are part of the man-made terrace. The outcrop is exposed in several areas in the east half, and this area is generally level. The surface on the west half is irregular and slopes west.

There are two possible cupboards. One is formed on the south side by the overhang of the natural outcrop base. One is formed by boulders placed around a crevice in the outcrop. The rocks inside of this crevice were probably cleared out. The feature is unaltered and in good

condition. No portable remains were observed at this feature. A deep soil deposit (c. 0.10-0.20 m) was present all around the feature and in the floor of the south cupboard. There was no soil deposit on top of the feature or on the floor of the central cupboard (O'Hare and Rosendahl 1993:A-13).

The Site 18513 complex was not relocated during the present survey. According to the PHRI site distribution map, the site was encountered in the northeastern corner of the project area, near the corner of Luhia and Loloku Streets (Figure 33). During the present survey, the possible location of Site 18513, as plotted on the PHRI map, was inspected by Pacific Legacy archaeologists. No evidence of the three terraces was found. The Site 18513 agricultural complex appears to have been destroyed during the construction of Luhia Street or the adjoining buildings and parking areas.

SIHP Number: 50-10-27-18514
Site Type: Wall
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18514 is a stacked stone wall. The 1992 PHRI survey identified this site and described it as a "short, low wall " that "is constructed of pahoehoe cobbles and boulders stacked two courses high, and is oriented at 7°/187° "(O'Hare and Rosendahl 1993:A-13, A-15). During the 1992 PHRI survey, the wall was found to measure c. 1.50 meters in length by c. 0.80 meters in width, with a maximum height of c. 0.35 meters. The PHRI site description of Site 18514 also noted that:

The north end of the wall abuts an outcrop oriented perpendicular to the wall. This outcrop is elevated c. 0.30-0.60 m above the ground surface. The rocks are c. 0.15-0.35 m in diameter. Most of the boulders are piled on the west side. The top of the wall is irregular and slopes south, parallel to the ground surface slope.

There are scattered cobbles and boulders on the ground surface south of the wall, which may indicate that the wall was once longer. There is extensive bulldozer disturbance only 10.00 m south of this feature, and this area may have been disturbed also. The wall is unaltered and in poor condition. No portable remains or cultural deposits were observed at this feature. An approximately 0.05-0.10 m thick deposit of decaying organic matter was observed around the feature (O'Hare and Rosendahl 1993:A-15).

No suggestion was made as to the possible function of this wall.

The Site 18514 wall was not relocated during the present survey. According to the PHRI site distribution map, the site was encountered in the northeastern corner of the project area in the area presently occupied by the International Marketplace (Figure 33). During the present survey, the identified location of Site 18514, as plotted on the PHRI map, was inspected by Pacific Legacy archaeologists. No sign of the stacked stone wall was found. It appears probable that Site 18514 was destroyed during the construction of the International Marketplace.

SIHP Number: 50-10-27-18515
Site Type: Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18515 is a complex comprised of three features: two modified outcrops (Feature A and Feature B), and a stone alignment (Feature C). This complex was originally recorded during the 1992 PHRI survey. It was found to measure approximately 12.40 meters in overall length and c. 4.20 meters in overall width (O'Hare and Rosendahl 1993:A-15).

Feature A
Site 50-10-27-18515, Feature A is a modified outcrop, originally recorded during the PHRI survey and found to measure c.4.50 meters in length by c. 3.50 meters in width, with a maximum height of c. 0.35 meters (O'Hare and Rosendahl 1993:A-15). The PHRI feature description for Feature A also notes that:

> Pahoehoe cobbles and boulders are placed and piled on top of a large pahoehoe bedrock outcrop. This outcrop is elevated c. 0.60 m above the level of the general ground surface. The rocks are c. 0.08-0.30 m in diameter. The east side consists of a scatter of cobbles. On the west side, the cobbles are placed or piled one to three courses high. This feature is probably a clearing pile. It is unaltered and in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-15).

Feature B
The PHRI survey report describes Site 50-10-27-18515, Feature B as a modified outcrop measuring c. 4.50 meters in length by 3.00 meters in width, with a maximum height of c. 0.47 meters (O'Hare and Rosendahl 1993:A-15). The feature description for Site 18515, Feature B also indicates that:

> Small to medium cobbles are placed and piled one to two courses high on top of a bare pahoehoe bedrock outcrop. The outcrop is elevated c. 0.11-0.47 m above the general ground surface. The rocks are c. 0.15-025 m in diameter. The feature is unaltered and in poor condition. A waterworn cobble was observed on the ground at the southwest edge of the feature (O'Hare and Rosendahl 1993:A-15).

Feature C
Site 50-10-27-18515, Feature C is described in the PHRI report as a "semicircular alignment of c. 12 pahoehoe cobbles and boulders placed on top of a bare pahoehoe bedrock outcrop" (O'Hare and Rosendahl 1993:A-15). During the 1994 PHRI survey, the Feature C alignment was found to measure c. 3.50 meters in length by c. 1.50 meters in width, with a maximum height of c. 0.30 meters. The PHRI feature description for Site 18515, Feature C also notes that:

> The outcrop is elevated c. 0.25-0.35 m above the general ground surface. The rocks are c. 0.20-0.40 m in diameter. The alignment is oriented roughly at 157°/337°, and rocks are piled two courses high in a few places. This feature may once have been part of a planting plot. It is unaltered and in good condition. No portable remains or cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-15).

The Site 18515 complex was not located during the present survey. According to the PHRI site distribution map, the site was encountered in the northeastern corner of the project area, in the

area now occupied by the International Marketplace parking lot (Figure 33). During the present survey, the area of Site 18515, as plotted on the PHRI map, was inspected by Pacific Legacy archaeologists. No evidence of the complex was found. It would appear that the Site 18515 complex was destroyed during the construction of the International Marketplace.

SIHP Number: 50-10-27-18516
Site Type: Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18516 is a complex consisting of two features: a stone mound (Feature A) and a modified outcrop (Feature B) (Figure 61). The complex was originally recorded during the 1992 PHRI survey, and was found it to measure approximately 5.50 meters by c. 2.05 meters overall (O'Hare and Rosendahl 1993:A-15-A-17).

Feature A
Site 50-10-27-18516, Feature A is described in the PHRI survey report as "a low rectangular mound." It measured c. 1.45 meters in length by c. 1.22 meters in width, with a maximum height of 0.35 meters (O'Hare and Rosendahl 1993:A-17). The PHRI feature description for Site 18516, Feature A also notes that:

> It is constructed of pahoehoe cobbles and boulders piled two to three courses high on top of a naturally fractured, low pahoehoe dome. The majority of the feature is composed of small cobbles (c. 0.075-0.15 m in diameter). There are about six large pahoehoe slabs used as perimeter stones for the north and west sides of the mound. These slabs are c. 0.30-0.45 m in maximum diameter.
>
> The outcrop is exposed on the east and southwest sides of the mound, where it is only c. 0.02-0.03 m above the general ground surface. It is also exposed on the north side, where it is elevated c. 0.18 m above the general ground surface. Although the mound seems low, the presence of the pahoehoe slabs and the regular outline of the feature indicate that special care was taken in its construction. A 1.00 m by 1.00 m test unit (TU-3) was excavated into the mound to see if it had any cultural material or contained a burial. No burial was discovered, and no cultural material was recovered. The feature is unaltered and in good condition. An approximately 0.01 deposit of silt was noted around the outcrop (O'Hare and Rosendahl 1993:A-17).

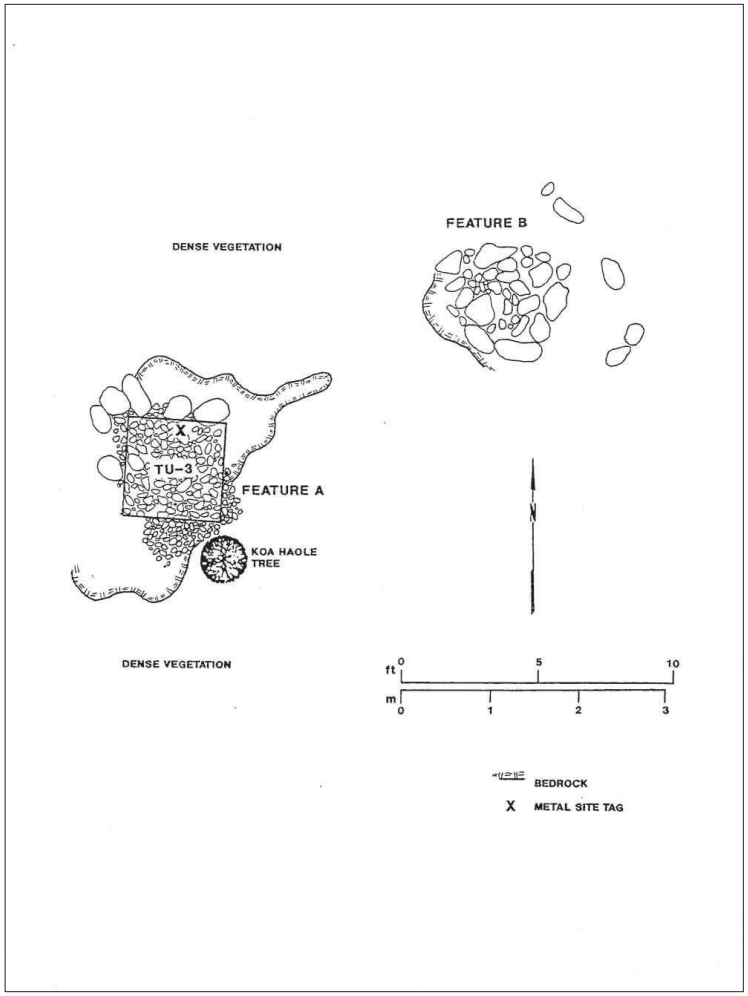


Figure 61. Plan view map of Site 50-10-27-18516 (O'Hare and Rosendahl 1993:Figure A-7).

Feature B

Site 50-10-27-18516, Feature B is a modified outcrop originally recorded during the 1992 PHRI survey. At that time it was found to measure c. 1.48 meters in length by c. 1.21 meters in width, with a maximum height of c. 0.37 meters (O'Hare and Rosendahl 1993:A-17). The PHRI feature description for Site 18516, Feature B also indicates that:

> It is constructed of pahoehoe cobbles and boulders placed one course deep on top of a low pahoehoe bedrock outcrop. The rocks are c. 0.10-0.60 m in diameter. The larger boulders are placed in a ring along the perimeter, and the cobbles are placed in the center. The center is depressed c. 0.15 m below the top of the perimeter. This feature was probably used as a planting plot. The outcrop is exposed below the feature on the south side. It is elevated only 0.10 m above the general ground surface. The outcrop is fractured, and the rocks used to construct the feature probably came from the outcrop itself. It is unaltered and in good condition. No portable remains were observed at the feature (O'Hare and Rosendahl 1993:A-17).

The Site 18516 complex was not relocated during the present survey. According to the PHRI site distribution map, the site was encountered in the northeastern corner of the project area, (Figure 33). During the present survey, the area of Site 18516, as plotted by PHRI, was inspected by Pacific Legacy archaeologists. This area appears to be situated *mauka* of Luhia Street and *makai* of the Queen Ka'ahumanu Highway, where the International Marketplace currently stands today. Therefore, the Site 18516 complex was most likely destroyed during construction activities for the International Marketplace.

SIHP Number: 50-10-27-18517
Site Type: Filled Depression
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18517 is a filled depression. The 1992 PHRI survey originally identified this site and found that it measured c. 4.10 meters in length by c. 1.40 meters in width, with no discernible height (O'Hare and Rosendahl 1993:A-17). The PHRI site description of Site 18517 also noted that:

> Pahoehoe cobbles are used to fill a linear crack to the lip of the crack, creating a level surface area. The cobbles are c. 0.10-0.15 m in diameter. The crack is oriented at 160°/340°. The depression might have been filled to create a planting area, or filled in for livestock safety. It is unaltered and in good condition. No portable remains or cultural deposits were observed on the surface of this site (O'Hare and Rosendahl 1993:A-17).

The Site 18517 filled depression was not relocated during the present survey. According to the PHRI site distribution map, the site was located in the northeastern corner of the project area, in the space between the current HPM Building Supply Store and the International Marketplace (Figure 33). During the present survey, the location of Site 18517, as plotted on the PHRI map, was inspected by Pacific Legacy archaeologists. They found no evidence of the site. The Site 18517 filled depression was most likely destroyed during construction of the HPM Building Supply Store or the International Marketplace.

SIHP Number: 50-10-27-18518
Site Type: Complex
Status: Not Relocated
Present Condition: Destroyed
Description: Site 50-10-27-18518 is a complex comprised of two features: a filled depression (Feature A) and a stone mound (Feature B). The 1992 PHRI survey originally recorded this complex and found it to have an overall length of c. 25.00 meters by c. 20.00 meters (O'Hare and Rosendahl 1993:A-17-A-18).

Feature A
Site 50-10-27-18518, Feature A is a filled depression originally recorded by the 1992 PHRI survey. It measured c. 6.25 meters in length by c. 4.00 meters in width, and had a height of 0.00 meters (O'Hare and Rosendahl 1993:A-17). The PHRI feature description for Site 18518, Feature A also notes that:

> Pahoehoe cobbles and boulders are used to fill an L-shaped depression in bare pahoehoe bedrock. The rocks are from c. 0.10-0.50 m in diameter. The depression is filled to the top. The surface is fairly level, but still fairly rough and uneven with many spaces between the rocks. It is possibly altered and in good condition. A thin wire artifact, bent double to possibly allow for cooking, was found on top of the rocks. It probably came from a nearby modern rock ring and recent historic trash scatter c. 3.00-4.00 m southwest of the feature. No cultural deposits were observed at this feature (O'Hare and Rosendahl 1993:A-17).

Feature B
Site 50-10-27-18518, Feature B was originally identified during the 1992 PHRI survey and described as a "linear mound" (O'Hare and Rosendahl 1993:A-17-A-18). The mound was found to measure c. 5.00 meters in length by 3.00 meters in width, and had a maximum height of c. 0.80 meters. The PHRI feature description for Site 18518, Feature B also indicates that:

> It is constructed of pahoehoe cobbles and boulders piled two to five courses high on top of bare pahoehoe bedrock. The mound is oriented with the long axis at 165°/345°, and is dome-shaped in profile. The north end consists of four to five courses of stone, and the south end consists of only two courses of stone. This feature may have functioned as a low wall in a historic camp site. There were several historic artifacts in the area. The feature is unaltered and in good condition. No portable remains or cultural deposits were observed on the surface of this feature (O'Hare and Rosendahl 1993:A-17-A-18).

The Site 18518 complex was not relocated during the present survey. According to the PHRI site distribution map, the site was encountered in the northeastern corner of the project area, in the area presently occupied by the International Marketplace (Figure 33). During the present survey, the identified location of Site 18518, as plotted on the PHRI map, was inspected by Pacific Legacy archaeologists. No filled depression or stone mound was observed in this area. The Site 18518 complex was most likely destroyed during the construction of the International Marketplace.

6.2 Newly Identified Sites

In addition to the four previously recorded sites that were relocated, the current survey identified and documented 6 newly discovered sites (Figure 34). These included a lava excavation (Site 50-10-27-30207); a stone mound (Site 50-10-27-30208); a small enclosure (Site 50-10-27-30209); a complex composed of a modified overhang, a lava excavation, a C-shaped wall, and a small roughly oval enclosure (Site 50-10-27-30210); and a historic era petroglyph consisting of the initials K. C. (Site 50-10-27-30211), and a C-shaped Wall (Site 50-10-27-30212) (Table 3). These newly discovered sites are located either in the open area *makai* of the Target shopping complex or across Makala Street *mauka* of the former Swing Zone driving range (Figure 35).

Table 3. List of Newly Discovered Archaeological Sites within the Kona Commons Survey Area

SIHP No.	Field No.	Feature	Site/Feature Type	Possible Age	Possible Function
50-10-27-30207	T-002		Lava Excavation	Pre-Contact	Uncertain
50-10-27-30208	T-003		Stone Mound	Pre-Contact	Marker
50-10-27-30209	T-004		Enclosure	Pre-Contact	Habitation
50-10-27-30210	T-005		Complex	Pre-Contact	Habitation/ Storage/ Uncertain
		A	Modified Overhang	Pre-Contact	Storage
		B	Lava Excavation	Pre-Contact	Uncertain
		C	C-shaped Wall	Pre-Contact	Habitation
		D	Enclosure	Pre-Contact	Habitation
50-10-27-30211	T-006		Petroglyph	Historic	Communication
50-10-27-30212	T-007		C-shaped Wall	Pre-Contact	Habitation
50-10-27-	T-008		Trail	Historic	Travel

6.2.1 Site Descriptions of Newly Discovered Sites
The following are detailed descriptions of the newly identified sites documented during the current survey.

SIHP Number: Site 50-10-27-30207
Field Number: T-002
Site Type: Lava Excavation
Description: Site 50-10-27-30207 consists of a lava excavation (Figure 62) located in the southern (*makai*) portion of the project area, approximately 30 meters *mauka* of the Kuakini Highway and 100 meters southeast (118°) from the Site 50-10-27-18502 modified depression. The site is situated on a rolling *pāhoehoe* lava outcrop. It is irregular in shape and measures approximately 0.70 meters (east to west) by c. 0.45 meters (north to south), with a maximum depth of c. 0.45 meters. The feature has been excavated into a lava blister and the base of the lava excavation consists of the bedrock floor of the blister. No soil is present within the excavation. The stones that were removed from the excavation are absent and appear to have been carried away, though several basalt boulders and cobbles are located just east of the excavation in a small crack in the bedrock.

No surface cultural material was observed within or surrounding the Site 50-10-27-30207 lava excavation. Site 50-10-27-30207 appears to be in fair condition. It seems probable that this lava excavation served as a small quarry from which stones were removed to be used as building material. The site was most likely created during the pre-Contact period.

Figure 62. Site 50-10-27-30207, lava excavation (view east).

SIHP Number: Site 50-10-27-30208
Field Number: T-003
Site Type: Stone Mound
Description: Site 50-10-27-30208 consists of a newly identified stone mound. The site is located in the southern portion of the project area, approximately 90 meters north of the Kuakini Highway and c. 70 meters west of Loloku Street. It is situated c. 59.9 meters northeast (33°) of the Site 50-10-27-30207 lava excavation. The stone mound is constructed on top of an undulating *pāhoehoe* lava outcrop (Figure 63). It appears to be irregular in shape, comprised of loosely piled sub-angular basalt boulders and cobbles. The mound measures c. 1.4 meters in length (northwest to southeast) by 1.0 meters in width (northeast to southwest), with a maximum height of 0.25 meters above the surrounding ground surface (Figure 64).

No cultural material was observed at Site 50-10-27-30208. The stone mound is in poor condition and appears to be mostly tumbled to the southwest. Site 50-10-27-30208 may possible have served as a marker due to its location atop a slightly raised area of *pāhoehoe* lava. It is not clear, however, what the mound was intended to mark. The construction style of the mound suggests that it may be traditional in age.

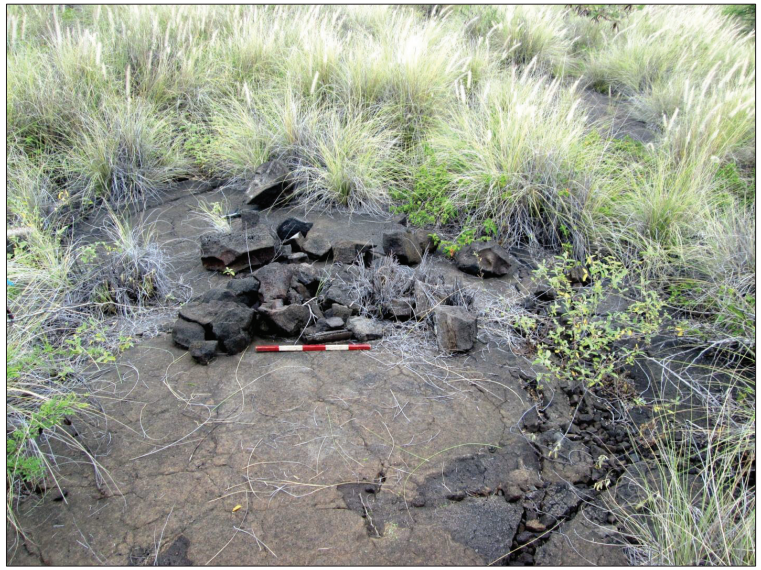


Figure 63. Site 50-10-27-30208, stone mound (view west).

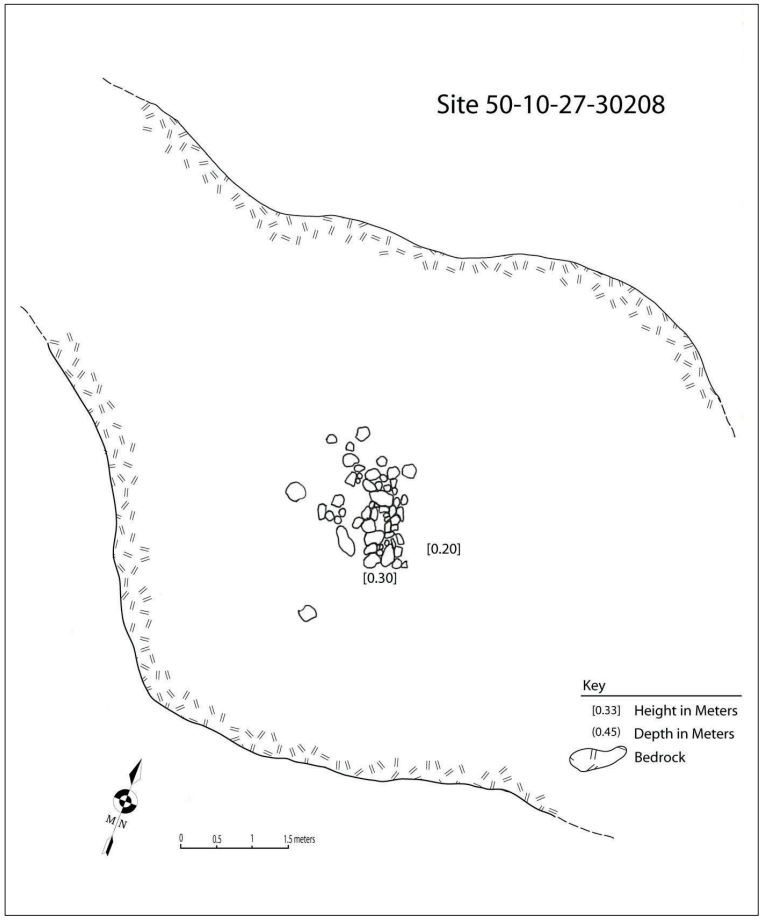


Figure 64. Plan view map of the Site 50-10-27-30208 stone mound.

SIHP Number: Site 50-10-27-30209
Field Number: T-004
Site Type: Enclosure
Description: Site 50-10-27-30209 consists of a newly identified, badly disturbed stone walled enclosure. The site is located in the central southern portion of the project area, approximately 14 meters east of Makala Boulevard and c. 159.6 meters southwest (235°) of the Site 50-10-27-18511 complex. It is situated on a large exposed slab of *pāhoehoe* lava (Figure 65). The enclosure is irregular in shape and its surrounding wall stands at most 2 courses high (Figure 66). This badly tumbled wall was constructed of subangular basalt medium to small boulders and cobbles, as well as *pāhoehoe* slabs. Some of these slabs may have originally been set on edge and supported by the smaller stones. The enclosure wall is highest along sections of its northern perimeter, while its southern section is lower and more scattered. The feature measures c. 2.4 meters in exterior length (northwest to southeast) by 1.8 meters in exterior width (northeast to southwest), with a maximum height of c. 0.25 meters.

No cultural material was observed in or around the site. Site 50-10-27-30209 appears to be in poor condition. It was most likely utilized windbreak shelter as a for short term habitation during the pre-Contact period.

Figure 65. Site 50-10-27-30209, enclosure (view north).

Figure 66. Plan view map of the Site 50-10-27-30209, enclosure.

SIHP Number: Site 50-10-27-30210
Field Number: T-005
Site Type: Complex
Description: Site 50-10-27-30210 is a complex consisting of four individual features: a modified overhang (Feature A), a lava excavation (Feature B), a C-shaped wall (Feature C), and an enclosure (Feature D). The site is located at the central southwestern portion of the project area, approximately 60 meters west of Makala Boulevard and just east of the former Swing Zone driving range. Feature A of the site is situated c. 16.1 meters northeast (38°) of the Site 50-10-27-18508 walled overhang.

Feature A
Site 50-10-27-30210, Feature A is a small modified overhang located at the northern portion of the Site 50-10-27-30210 site complex. It is situated approximately 10.9 meters north (349°) of the Feature B lava excavation (Figure 68). The overhang is formed by a partially collapsed lava blister. It is oriented roughly east to west, with the opening facing north (Figure 67). Angular basalt boulders and cobbles have been stacked to the southwest of the overhang, narrowing the opening. The interior of the overhang is covered in loose rubble with no soil. The modified overhang measures c. 1.5 meters in length, is c. 2.0 meters deep and has a maximum height of c. 0.60 meters. Feature A is in fair condition. The overhang appears too small to have served as a temporary shelter, and may have been used as a storage area during the pre-Contact period.

Figure 67. Site 50-10-27-30210, Feature A modified overhang (view south).

Figure 68. Plan view map of the Site 50-10-27-30210 complex.

Feature B

Site 50-10-27-30210, Feature B is a lava excavation located at the central portion of the Site 50-10-27-30210 site complex, approximately 10.9 meters south (169°) from the Feature A modified overhang (Figure 68). The Feature B lava excavation is situated near the top of a low knoll of *pāhoehoe* lava. It is irregular in shape and measures approximate 1.3 meters in length (northeast to southwest) by c. 0.75 meters in width (northwest to southeast), and has a maximum depth of 0.37 meters (Figure 69). Located within the interior of the excavation is a single basalt boulder measuring c. 0.60 by 0.35 meters. Several other basalt boulders, that appear to have originally been removed from the lava excavation, are loosely piled less than 1 meter to the north of the feature. A small amount of soil and organic debris from fountain grass was noted on the floor of the lava excavation. No cultural material was observed within or surrounding the feature. It seems likely that the Feature B lava excavation was created during the traditional period, either as a quarry for building stone or as a small planting area (the large stone having fallen or been placed in its interior after abandonment). The feature's original purpose remains uncertain.

Figure 69. Site 50-10-27-30210, Feature B lava excavation (view northeast).

Feature C
Site 50-10-27-30210, Feature C is a C-shaped wall located in the southern portion of the Site 50-10-27-30210 complex, approximately 2.0 meters south (174°) of the Feature B lava excavation (Figure 68). The feature is constructed on a relatively level surface of *pāhoehoe* lava. At present, the wall consists of a single course of basalt cobbles, but it appears originally to have consisted of two or more courses in height in some sections (Figure 70). The C-shape wall is open to the northeast. It measures c. 2.2 meters long (east to west) by 1.2 meters deep (north to south), with a maximum height of 0.12 meters.

No cultural material was observed at this feature. Site 50-10-27-30210, Feature C is in poor condition. This low windbreak wall was most likely utilized as a temporary shelter during the pre-Contact period.

Figure 70. Site 50-10-27-30210, Feature C C-shaped wall (view southwest).

Feature D
Site 50-10-27-30210, Feature D is a small enclosure located at the southern end of the Site 50-10-27-30210 complex (Figure 68). It is situated approximately 1.0 meter southwest (134°) of the Feature C C-shaped wall. Feature D appears to have originally been roughly circular in shape, but a number of stones from its eastern wall are presently scattered throughout the interior (Figure 71). The enclosure wall is constructed of small to medium subangular basalt boulders, cobbles and *pāhoehoe* slabs. These stones may originally have been loosely stacked or piled, but now are mostly tumbled. The number and size of the stones along the eastern section of the wall suggests that this portion was originally slightly higher than the others. Several of *pāhoehoe* slabs in this area may have been set upright and supported by smaller stones. The northwestern edge of the enclosure wall incorporates a raised section of *pāhoehoe* lava bedrock (c. 0.17 meters in height). The Feature D enclosure measures c. 3.20 meters in length (east to west) by 2.90 meters in width (north to south), with a maximum height of 0.20 meters.

No cultural material was observed within or surrounding this feature. Site 50-10-27-30210, Feature D is in relatively poor condition. The structure likely served as temporary windbreak shelter built and used during the pre-Contact period.

Figure 71. Site 50-10-27-30210, Feature D enclosure (view southwest).

SIHP Number: Site 50-10-27-30211
Field Number: T-006
Site Type: Petroglyph
Description: Site 50-10-27-30211 consists of a single petroglyph located in the southeastern portion of the project area, approximately 30 meters west of Loloku Street and directly across from the BMW Dealership parking lot. It is situated c. 41.8 meters northeast (65°) from the Site 50-10-27-30208 stone mound.

The petroglyph consists of the two letters "KC" that have been pecked into the surface of a slight westward facing *pāhoehoe* slab (Figure 72). The letter K has serifs on its ends, while the serifs are not so clear on the letter C (which may not possess any). It appears that the letter C may have been pecked over a previous image, possibly a letter or a portion of a letter (Figure 73). The petroglyph measures c. 18.0 cm in overall length and c. 10.0 cm in width.

No cultural material was observed near or around the site. Site 50-10-27-30211 appears to be in fair condition. The petroglyph is not carved in the distinctive print block type style modeled after the printed letters seen in primers and other missionary texts, which often characterizes letter petroglyphs dating from the early historic period. The simpler form of the letters in this image suggests that it dates to the later historic period, though when it was carved is uncertain.

Figure 72. Site 50-10-27-30211, petroglyph (view southwest).

Figure 73. Site 50-10-27-30211, tracing of petroglyph (view southwest).

SIHP Number: Site 50-10-27-30212
Field Number: T-007
Site Type: C-Shaped Alignment
Description: Site 50-10-27-30212 is a somewhat disturbed C-shaped alignment of stones. The site is located in the *makai* portion of the survey area, approximately 54 meters *mauka* of the Kuakini Highway, and c. 36 meters northeast (69°) from the Site 50-10-27-30207 lava excavation. It is situated atop roughly level *pāhoehoe* lava that is heavily vegetated in fountain grass with some stunted *koa haole*.

Site 50-10-27-30212 consists of a roughly C-shaped alignment of small to medium boulders with some cobbles and pebbles (Figure 74). The structure is somewhat tumbled, and the alignment may originally have been a wall stacked up to two courses in height. The larger stones appear to have formed the base of the wall, with the cobbles and pebbles filling gaps between them. The C-shape is open to the northwest, though a tumbled wall stone now partially blocks the entrance. The structure measures c.1.95 meters in exterior length (northwest to southeast) by c. 2.05 meters in exterior width across the wings (southwest to northeast). The structure's interior appears to have originally measured c. 1.5 meters in length by 1.25 meters in width before the walls tumbled. The present alignment rises to a maximum height of 0.25 meters, though the wall appears to have originally been somewhat higher. The interior of the structure is composed of relatively level *pāhoehoe* lava.

Figure 74. Site 50-10-27-30212 C-shaped alignment (view north).

No artifacts or other cultural materials were observed within or surrounding the structure. The Site 50-10-27-30212 C-shape is in fair condition, though somewhat tumbled. It appears to have originally served as a crude windbreak shelter, most likely constructed and utilized during the pre-Contact period.

SIHP Number: Site 50-10-27-30287
Field Number: T-008
Site Type: Trail
Description: Site T-008 is a remnant segment of historic trail running diaginally through roughly through the *makai* portion of the Kona Commons survey area. The route of the trail was initially recognized on the 1924 USGS topographic map of Keahole Point Quadrangle, where it appears as a dotted line connecting the historic Māmalahoa Trail with the traditiinal coastal trail. This smaller trail branches off the Māmalahoa Trail in the present Kona industrial area and extends northwest, joining the coastal trail in the vicinity of the former Mākā'eo settlement (now occupied by the Old Kona Airport Park). Development has destroyed both ends of the trail, leaving only a short intact section that runs diagonally through the undisturbed portion of the Kona Commons survey area.

A physical examination of the area revealed an intermittent and faint, but discernable, line of abrasion on the surface of the *pāhoehoe* lava (Figure 75). This wear pattern would have been caused by the passage of shod horses and mules along the trail, their iron shoes eroding the lava, wearing away the more glossy surface and leaving a distinctive line of darker lava. In some places, the bed of the trail is slightly (less than a centimeter) depressed, having been worn down by the passage of shod animals. The discoloration that marks the trail bed varies slightly along its length, but averages c. 0.7 meters in width. The visible course of the trail is intermittent, being broken at one point toward its western end by a line of bulldozer push and being obscured in other areas by vegetation. The visibility of the trail varies. It is most evident at its northwestern end, just before it is broken by the shoulder of Makala Blvd., and again near its center. It is least visible at its southeastern end near Loloku Street.

There are occasional areas of battering along the course of the trail (Figure 76). These consist of concentrations of shallow marks in the surface of the lava where it appears to have been struck repeatedly by a hard object such as a stone. Areas of battering can be found both within and adjacent to the trail. They seem to be the result of some processing activity, but what that activity was or how it may have been related to the trail is uncertain. No portable cultural material was observed on or alongside the trail.

Although relatively faint and difficult to discern over most of its length, the trail appears to be in fair condition. The best preserved section (most visible) is approximately six meters in length and located at its western end. Here it is traceable for approximately 15 meters before it is cut by a line of bulldozer push. The second most visible segment is closer to the center of the surviving trail segment. Here there are roughly 12 meters of clearly discernible trail. Given its direct association with the Māmalahoa Trail, this smaller trail seems most likely to be historic in age. It would seem to have served as a route of travel for individuals leaving the Māmalahoa Trail for the coastal settlements of Mākā'eo and Pawai.

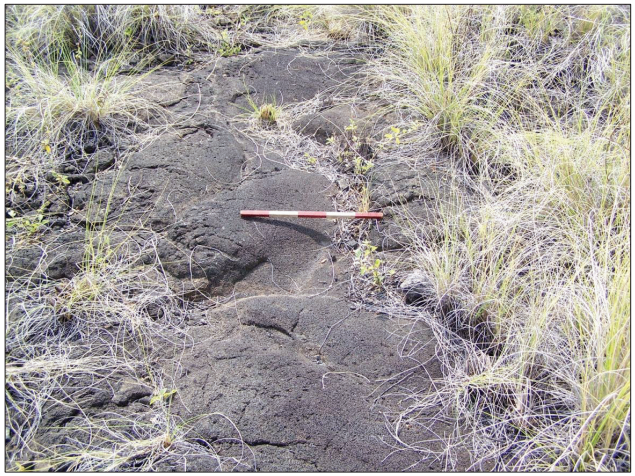


Figure 75. Abrasions marking the course of the Site 50-10-27-30287 trail (view southwest).

Figure 76. Trail bed and battering marks (view southwest).

6.3 Site Distribution

Given the amount of ground disturbance that has taken place, it would seem unwise to make any definitive statements as to traditional site distribution and land use patterns within the Kona Commons project area. However, based upon the finding of the 1992 PHRI survey, coupled with the additional information provided by the present survey, it is possible to make some general observations. The archaeological sites located within the 100 acre survey area are not evenly distributed. They appear to be concentrated either in the project area's northeast corner or scattered over its southern half (Figure 77).

Those sites clustered within the northeastern corner of the survey area (Sites 50-10-27-18513 through 18518) appear to be concentrated around the alignment of a stretch of the Māmalahoa Trail (Site 50-10-27-00002) that formerly ran through this area (Figure 77). This section of trail was identified and documented during the 1992 survey (O'Hare and Rosendahl 1993:A-1). The sites flanking the trail included a complex of three rough terraces that were interpreted as being agricultural in nature (Site 18513); a short (1.5 meter) and very low (0.35 meter) stone wall segment (Site 18514); a complex of two modified outcrops that were identified as possible clearance piles and a C-shaped alignment that may have served as a windbreak shelter (Site 18515); a complex consisting of a stone mound and a modified outcrop (Site 18516); a filled depression (Site 18517); and a complex consisting of a filled depression and a stone mound (Site 18518). It is not clear whether the location of these sites is due to the proximity of the historic era trail or whether it is related to another aspect of area, the presence of cultivatable soil.

The northeastern corner of the Kona Commons parcel is the only portion of the project area that is covered by older lavas belonging to the 11,000 to 30,000 year old flow (Figure 4). Those lavas that cover the remainder of the project area are much younger in age (1,500 to 3,000 years). These younger lavas consist mostly of barren *pāhoehoe* with little surface soil. Atop the older flow, however, thicker soils have had time to develop. These soils belong to the Punaluu Series of extremely rocky peats (rPYD) (see Section 2.2). They are relatively thick, fertile, and well suited for dryland cultivation. The concentration of archaeological site recorded in the northeastern corner of the project area during the 1992 survey may be directly related to the presence of this soil (Figure 78). A similar range and density of sites was noted in the adjacent soil area located just *mauka* of the Queen Kaʻahumanu Highway during the PHRI survey conducted in 1990 (Donham 1990). Many of these sites were also interpreted as being agricultural in nature. Regretfully, this area has been badly disturbed by bulldozer activity in the years following the initial survey (Reeve et al. 2015). Interestingly, the area around the present International Marketplace, which appears, from the archaeological record, to have been a focus of traditional activity, also corresponds with the location of the place name "Namahana" as shown on Joseph S. Emerson's map of the north Kona district drafted around 1880 (see Section 3.3).

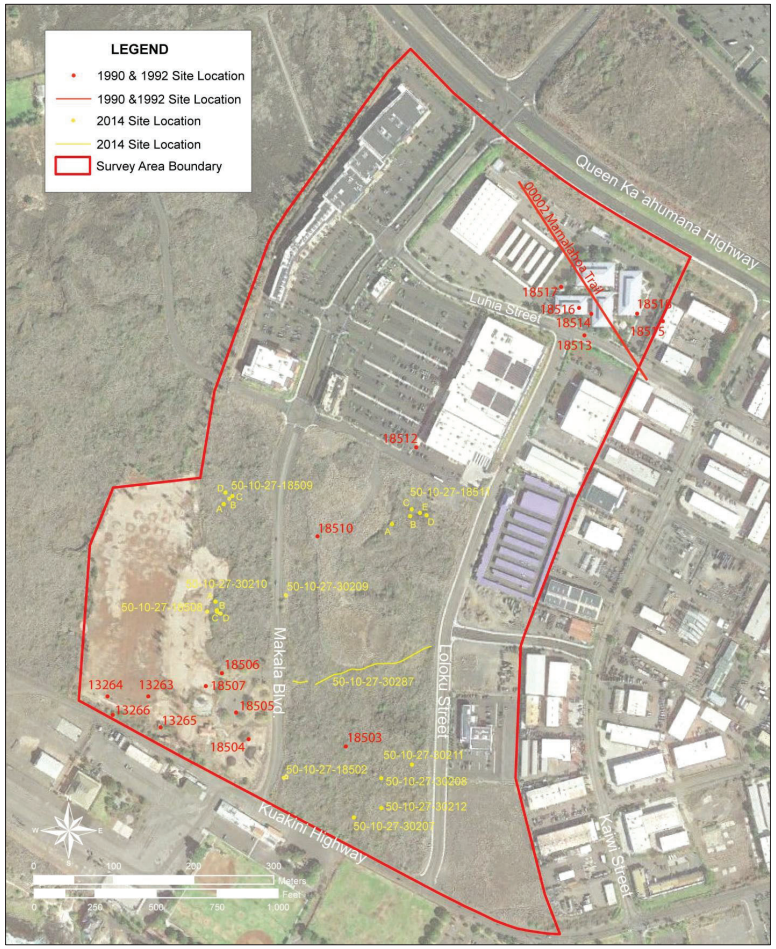


Figure 77. Locations of archaeological sites identified during the 1990 and 1992 PHRI surveys as well as the current survey (background aerial from Google Earth).

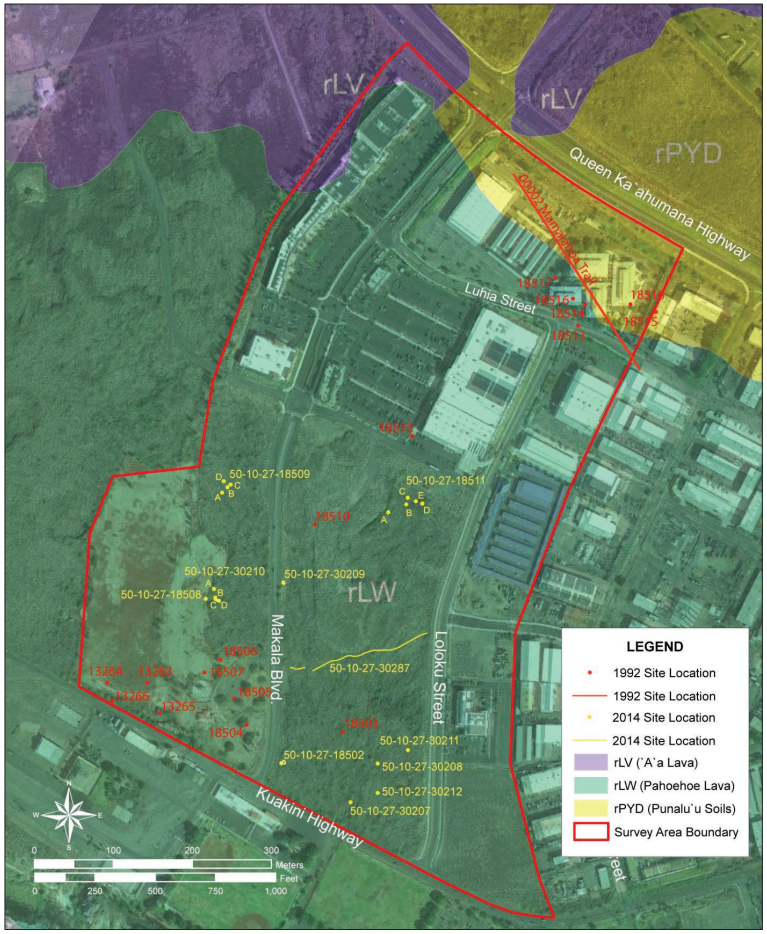


Figure 78. Comparison of soil areas and site locations.

The remaining archaeological sites encountered within Kona Commons are scattered throughout the *makai* portion of the survey area (Figure 77). These sites consist primarily of small features, often elements of the natural landscape that have been modified for use. Some features are found clustered together in small complexes, while others are isolated. None appear to represent sites of permanent habitation. Most are suggestive of the temporary use of the area by individuals living elsewhere, either along the coast or in the uplands, and only traveling through this relatively inhospitable portion of the coastal *kula* zone. The presence of the Site 50-10-27-30287 trail transecting the area only adds to this impression.

6.4 Major Types of Structural Features

The range of archaeological features encountered during the supplemental inventory survey of the 100 acre Kona Commons property was relatively small. The majority of these features fall within a limited number of specific feature types. The relative abundance of these feature types is shown in Table 4. Their relative locations are shown in Figure 79. As can be seen in Table 4, the most frequently encountered features were lava excavations (6), followed by stone mounds (3), modified overhangs (3), enclosures (2), and C-shaped walls/alignments (2). The remaining feature types (modified depression, modified lava tube, petroglyph, and trail) are each represented by only one example.

Table 4. Relative Abundance of Feature Types Within the Survey Area*

Feature Type	Number	%
Lava Excavation	6	30%
Stone Mound	3	15%
Modified Overhang	3	15%
Enclosure	2	10%
C-Shaped Wall/Alignment	2	10%
Modified Depression	1	5%
Modified Lava Tube	1	5%
Petroglyph	1	5%
Trail	1	5%
Total	**20**	**100.0%**

*Site 18509, Feature B filled depression is considered a natural feature and therefore not included.

If one goes back and examines those features that were identified during the 1992 survey, but not relocated during the current survey, one finds a similar range of feature types. The 1992 survey recorded primarily small features including: modified outcrops (7), lava excavations (3), terraces (3), stone mounds (3), C-shaped alignments (1), enclosures (1), wall segments (1), and filled depressions (4), which may have been natural features. The only smaller feature types identified during the original survey, but not present in the surviving undisturbed portions of the project area, were crude terraces and the single wall segment.

Figure 79. The range of feature types present within the Kona Commons survey area (aerial base from Google Earth).

In addition to these smaller feature types, the 1992 survey also documented three more substantial sites: the Māmalahoa Trail, the Site 18504 large walled enclosure with its associated internal walls, and the Site 18506 lava tube with its internal walls and fire hearths. The latter two sites were located toward the western edge of the survey area, closer to the former coastal settlement of Mākāʻeo.

The Site 18506 lava tube appears to have been a natural feature utilized as a temporary shelter, a somewhat larger and more spacious version of the modified overhangs found elsewhere in the project area. The discovery, within the tube, of two fire hearths, a bone fishhook, a cowry octopus lure, and the recovery from within the excavated hearth of marine gastropods (*Nerita picea* and *Cypraea caputserpentis*), echinoid remains, and *kukui* (candlenut, *Aleurites moluccana*) nut shell fragments, suggests that it had served as an overnight camp for individuals fishing along the adjacent coastline (O'Hare and Rosendahl 1993:15). The purpose of the Site 18504 large walled enclosure is uncertain. The presence of coral might possibly suggest that the structure served some ceremonial function, but this is far from certain. The subsequent destruction of both of these sites prevents any further efforts at interpretation.

The following sections provide more detailed discussions of the main site types encountered during the course of the current survey.

6.4.1 Lava Excavations

Among the most ubiquitous and enigmatic features identified during the present survey were relatively shallow excavations into the surface of the lava. Such features are often associated with loose piles or scatters of lava boulders that appear to represent the material removed during the excavation. The 1992 archaeological inventory survey identified these features as "pahoehoe excavations." Surveys conducted in other areas of Keahuolū (Reeve et al. 2009:45), as well as in other parts of North Kona (Malalawena, Reeve et al. 2010:68), have encountered these excavations on both *pāhoehoe* and *ʻaʻā* lava flows (though they are less commonly on *ʻaʻā*). For this reason, they are referred to here simply as lava excavations.

Lava excavations were found scattered throughout the project area (Figure 79). While most often encountered in the vicinity of other features, some excavations are relatively isolated with no surviving surface structures located anywhere nearby. The typical lava excavation consists of a patch of *pāhoehoe* (or, in other areas, *ʻaʻā*) lava that has been battered until the surface layer fractures. The broken pieces, which often take the form of angular or tabular blocks, can then be extracted, leaving a shallow, flat bottomed depression (Figure 80). On occasion small lava blisters have been broken open to create a shallow depression in the lava. Excavations also occurred along the base of lava ridges where the breaking up of the lava revealed shallow overhangs. The resulting loose rubble has often been removed from the excavation and either piled around its edges or apparently taken away for use elsewhere. In some cases, at least some of this rubble has fallen or been placed back into the excavation, partially covering the floor. In areas closer to the coast, it is not unusual to encounter one or more waterworn basalt boulders within or near a lava excavation. Such stones usually exhibit signs of battering at one or both ends. It seems likely that these boulders were utilized as large hammerstones to break up the lava so that blocks of it could be removed.

Figure 80. Example of a lava excavation (Site 50-10-27-18511, Feature E).

Various explanations have been put forward to explain the creation of these excavations, which occur throughout the lava lands of the Kona and Kohala districts and inland as far as Pōhakuloa in the saddle between Mauna Kea and Mauna Loa (Nakamura et al. 1998:112). Their relative abundance suggests that they served some definitive purpose(s). The 1990 report of the PHRI surveys conducted within other portions of Keahuplū proposed that some of these lava excavations may have been utilized as quarries for the acquisition of building material, while others were created to act as shallow depressions which could be filed with mulch and used as small planting areas for the cultivation of crops (Donham 1990:19). The use of lava excavations as quarries was initially proposed in 1972 by Moore and Bevaqua who recorded some 230 pits in the *ahupuaʻa* of Waikoloa (Moore and Bevaqua 1972). They suggested that the upper layers of the excavated *pāhoehoe* were used to fashion lava abraders, while the lower layers were used for building material (Moore and Bevaqua 1972:18-20).

An alternate proposal, that lava excavations were created for use as planting pits, was put forward by William Barrera as early as 1971 (Barrera 1971:60). This theory has been proffered by a number of researchers (Carter 1986, Hammatt et al. 1987, and O'Hare and Goodfellow 1994), though most have suggested a multiple use for these features. Tom Dye has argued that traditional cultivation in excavated pits was only undertaken in areas of *ʻaʻā* lava, and that the marginal environments in which they are found and their sporadic distribution would argue against their agricultural use. The meager amount of crops that could be produced would not have warranted the apparent intensive effort involved in creating the pits themselves (Dye 2002:96).

If lava excavations were used for the cultivation of *ʻuala* (sweet potatoes, *Ipomoea batatas*) and other dryland crops, the pits would need to have been filled with soil or vegetable mulch. Only one lava excavation within the Kona Commons project area was found to contain a small amount of soil. If, as has been suggested, some lava excavations were filled with mulch and utilized for planting, most of the soil these features may once have contained has long since dissipated. This general lack of interior soil could be taken as an indicator that these features were not utilized for the cultivation of crops. However, recent analysis of soil samples taken from lava excavations located in the *ahupuaʻa* of Kaʻūpūlehu, North Kona, revealed the presence not only of Poaceae Heteropogon-type pollen, which might indicate the expected presence of *pili* grass (*Heteropogon contortus*), but also of *Ipomea batatas*-type pollen, suggesting that the excavation may have been used for the cultivation of *ʻuala* (sweet potatoes) (Cleghorn and McIntosh 2012:14). Additional pollen testing needs to be undertaken at lava excavations in other areas of Kona (including within the present project area) to provide support for these preliminary results, but it appears possible that at least some lava excavations may have been utilized for cultivation.

This hypothesis may be supported by ethnohistoric accounts. There exist references in the ethnographic literature that description the use of mulch in the growing of crops on "bare lava." One such reference appears the writings of botanist William Hillebrand, who was a resident of the Hawaiian Islands from 1850 to 1870. In his book *Flora of the Hawaiian Islands*, Hillebrand remarked that, "The natives of Puna, Hawaii raise good crops of sweet-potatoes in the hollows and cracks of bare lava by simply covering the budding sprigs with decayed leaves and herbs" (Hillebrand as cited in Ladefoged et al. 1987).

Missionary Chester Lyman describes such plantings which he encountered while visiting the Kamoamoa area of the Puna district.

> We passed a potato patch in the broken lava which exceeded anything I had seen. Not a particle of soil was anywhere to be seen, and the holes dug among the stones to receive the potatoes were some of them 6 feet in depth – thus securing a degree of moisture and shelter from the sun – though no more soil than on the surface (Emory et al. 1959:24)

In describing the dryland cultivation of *kalo* (taro, *Colocasia esculenta*) and *ʻuala* (sweet potatoes, *Ipomoea batatas*) on the island of Hawaiʻi, the Hawaiian language newspaper *Ka Nupepa Kuokoa* (in an article published on March 24, 1922) makes reference to mulch being placed within "hollows made on the *pāhoehoe*."

> Another way of doing this [planting dryland *kalo* (taro) or *ʻuala* (sweet potato)] was to rot weeds where the soil was good and then carry them to fill the hollows made on the *pāhoehoe* and then plant whatever plants he chose. O my reader, the proofs of these are on Hawaiʻi. There are the *pāhoehoe* lava beds walled in by the ancestors, in which sweet potatoes and sugar cane were planted and they are still growing today (cited in Handy et. al. 1972:131-132).

This reference would appear to suggest that lava excavations, similar to those encountered in the present project area, may have been mulched and planted with either *kalo* (taro) or *ʻuala* (sweet potato) during both the pre-Contact and early historic periods.

It has also been suggested that lava excavations, particularly those located in the uplands at places such as Pōhakuloa, were created to serve as nesting areas for ground nesting sea birds, such as shearwaters or the *ʻuaʻu* (dark rumped petrel, *Pterodroma sandwichensis*), whose eggs or juveniles could then be harvested for food (Nakamura et al. 1998;116). This theory, that lava excavations were created and used as artificially enhancing nesting areas, is interesting in that it proposed the intentional localization of a usually dispersed resource and the first steps in what might be considered the semi-domestication of wild birds. Some possible support for this theory was found at the *ahupuaʻa* of Manini'owali and Kuki'o 2 in North Kona where over 1,200 excavated *pāhoehoe* pits recorded (Dye 2002:95-96). A small number of pits (nineteen in all) were found to contain gravel-size pieces of pumice which were interpreted as having been digested and excrete by sea birds.

In some cases it would appear that the purpose of the excavation was to find and open a natural overhang at the base of a lava ridge. Most of these overhangs are too small to have served as temporary shelters, though some might have been utilized as storage areas.

There remains no definitive explanation as to why lava excavations were created or what purpose they served. It is obvious from their distribution that they frequently occur in roughly the same areas where one encounters more formal sites, and that they are most common in areas of higher site density. This might lend support to the theory that some of them were created as quarries where blocks of broken up *pāhoehoe* could be acquired for use in the construction of walls and other structural features. If the pollen evidence can be trusted, other lava excavations may have served as planting areas where imported soil and mulch was accumulated to grow dryland plants such as *ʻuala* (sweet potato, *Ipomoea batatas*) and dryland

kalo (taro, *Colocasia esculenta*). It is also possible that those lava excavations located along the bases of lava ridges could have been used to open or widen natural overhangs that could then be used as crude storage areas. Their use as artificial nesting areas for seabirds is also a possibility. It appears likely that lava excavations served a range of functions depending upon their location and the needs of the individuals who created them.

6.4.2 Stone Mounds

Stone mounds were encountered at three sites during the current survey. These features consist of low, roughly built piles of subangular basalt boulders and cobbles constructed atop relatively level areas of *pāhoehoe* lava. All of the mounds identified are disturbed and badly tumbled (Figure 81). The isolated and scattered nature of the mounds documented would tend to suggest that they were not utilized as planting or cultivation clearance features. Such agricultural mounds would be expected to be found clustered together in groups. Instead, it appears more likely that the mounds identified within the Kona Commons survey area were erected to serve as markers, though what exact they were intended to mark is uncertain.

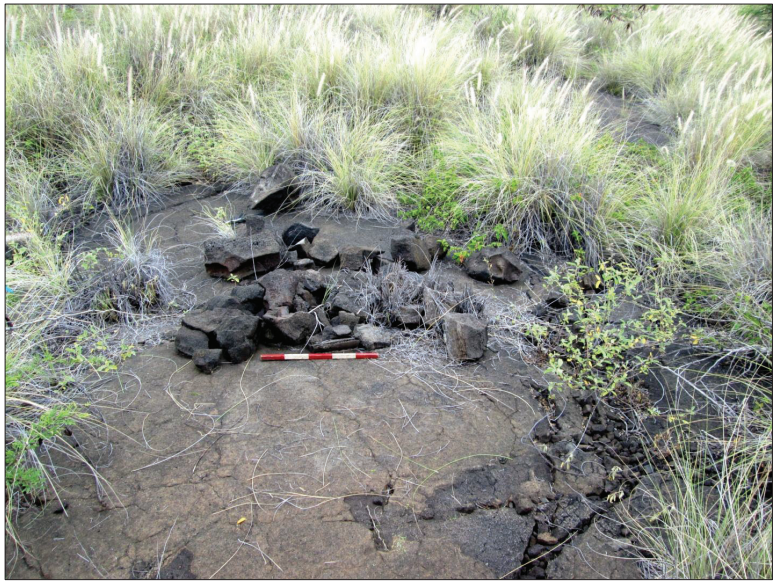


Figure 81. Example of a collapsed stone mound (Site 50-10-27-30208).

6.4.3 Modified Overhangs

Three modified overhangs were documented during the current survey. Sites 18508 and 18511, Feature A are just large enough to possibly have served as temporary shelters where individuals traveling through the area could have taken temporary refuge from the wind and sun (Figure 82). Their shade could have been supplemented by some form of vegetation. Given their shallow overhangs and rough floors, it seems less likely that these sites were used as overnight shelters. The even smaller size of Site 50-10-27-30210, Feature A suggests that it is more likely to have served as a storage area, where items could be placed in a relatively protected environment for later retrieval. None of the overhangs showed evidence of being used for water catchment.

Figure 82. Example of a modified overhang (Site 50-10-27-18508).

6.4.4 Small Enclosures and C-shaped Walls/Alignments

Two other very distinctive feature types that were encountered within the present survey area, but which are even more common in other areas of coastal Keahuolū, are low stone walled enclosures and C-shaped walls. These structures are almost always constructed on patches of relatively smooth and level *pāhoehoe* lava (Figure 83).

Figure 83. Example of a low walled enclosure (Site 50-10-27-30210, Feature D).

They are generally relatively small in area, often measuring less than 3 by 3 meters overall. Although of slightly different form (enclosures are roughly circular or oval in shape with a completely encircling wall while C-shapes have one section of their perimeter wall left open) they differ little in their general method of construction. Both enclosures and C-shaped walls are constructed primarily of small to medium subangular basalt boulders and cobbles, and *pāhoehoe* boulder slabs.

The slabs, though now collapsed, appear to have originally been set on edge and supported by smaller stones. Usually there is a greater concentration of stones and *pāhoehoe* slabs along one section of the encircling wall. This originally higher and slightly more substantial wall section may have been positioned to block the force of the prevailing wind. The orientation of this higher wall section was found to vary between structures, suggesting that they were constructed under differing wind conditions.

It is possible that these features may have served as what the PHRI survey report refers to as "planting plots", with the interior of the low walled enclosures or C-shapes being filled with mulch to create a cultivatable area. Although young plants might need to be sheltered from the

wind, one would think that the cultivation of dryland crops such as *'uala* (sweet potato, *Ipomoea batatas*) would have been undertaken more successfully in natural or created depressions (such as lava excavations) rather than atop areas of level *pāhoehoe* lava surrounded by low walls of stone.

It seems more probable that these low walled features were constructed as temporary windbreak shelters by individuals traveling across or working in the survey area. Their relatively small size and rough construction indicate that they were structures of convenience, built relatively quickly and occupied on a short term basis. These features, unless they were somehow roofed over with palm fronds, a mat, or some other material, would only have provided protection from the wind and not from the sun. The level stretches of *pāhoehoe* lava on which they were constructed would have served to reflect the sun and increase the heat. For this reason, they do not appear to be inviting spots to rest during the day. At night, however, with the residual heat radiating up from the lava and a *pāhoehoe* slab wall to block the wind, they might (with the addition of a flooring of cut *pili* grass) provide comfortable sleeping areas. The size of most enclosures suggests that they were built to shelter a single individual. They are too small to have served as much more than simple sleeping areas. None of the enclosures or C-shaped walls were found to have associated stone-lined hearths or other evidence of cooking, and none contained any midden remains or other surface cultural materials.

6.4.5 Modified Depression

The single modified depression located within the present survey area (Site 50-10-27-18502) consists of a collapsed lava blister with some modifications along its edges. The site is of questionable age, and it is not certain whether the stones loosely stacked along one section of its internal face were placed there during the pre-Contact period, or far more recently. The abundance of modern trash present at the site suggests that it may have been used as a campsite by the homeless people known to frequent the project area. A 0.50 by 0.50 meter square test unit was excavated into the floor of the depression during the 1992 survey (O'Hare and Rosendahl 1993:A-1). This excavation, which was continued approximately 0.24 meters down to bedrock, yielded fragments of bottle glass, window glass, dog bones, crustacean remains, and small pieces of aluminum foil. No distinctively traditional cultural material was encountered. The presence of this material might possibly suggest that the depression was used as a dumping area prior to the 1992 survey. No direct evidence was found for the prehistoric use of the site.

6.4.6 Modified Lava Tube

The only modified lava tube that survives within the Kona Commons project area (Site 50-10-27-18511, Feature B) appears to have been used as a burial cave. The human remains present within the eastern portion of the tube were found to consist of "scattered finger, toe, and foot bones, some vertebrae, and one incisor" (O'Hare and Rosendahl 1993:A-12). The PHRI survey report, noting the fragmentary nature of the bone material present and observing the absence of long bones or cranial material, suggested that the original burial had been removed and that the remaining bones had been left behind at that time (O'Hare and Rosendahl 1993:A-12).

The 1992 survey also recovered a historic A clear glass patent medicine bottle from the back of the tube. The survey report suggested that this glass bottle provides evidence for the possible use of the cave as a water catchment feature during the historic period. At the time of the 1992

survey, the cave was found to be wet, with continual dripping from the roof. The only other cultural material noted in the tube during the 1992 survey was the waterworn top of a small conus shell with a hole through its center, what the report referred to as "a *puka* shell (*Conus sp.*)", which was found among the stones by the cave entrance (the stones had been moved to see whether there was an articulated burial present beneath them) (O'Hare and Rosendahl 1993:A-12). This natural conus shell bead may have formed part of an ornament associated with the burial. No additional cultural material was noted during the current survey. This lack of midden or other cultural remains would seem to suggest that the Site 18511, Feature C lava tube was not used as a temporary habitation shelter. This may have been due to the cramped nature of the tube's interior.

The PHRI report suggests that the lava tube was initially used as a burial chamber for an adult individual (judging from the remaining bones), but that most of the skeleton was subsequently removed for reburial elsewhere (possibly, according to the report, to allow for the use of the tube as a water catchment feature during the historic period).

6.4.7 Petroglyph

A single petroglyph was identified within the survey area. This relatively small image (Site 50-10-27-30211) appears to consist of the two Latin letters K and C (Figure 84). These letters could possibly represent an individual's initials. The style of the letters suggests they may date to the later historic period. Earlier petroglyph names and initials were usually created in the more elaborate serif style similar to that used for the printing of school books and religious texts by the missionary press in Lāhainā. The use of more simplified letters (though still in a serif style) appears to date from later in the historic period. The date of this particular image is uncertain. The absence of the letter C from the Hawaiian alphabet might suggest that the individual whose initials appear pecked into the lava at Site 50-10-27-30211 did not possess a Hawaiian last name.

Figure 84. The two letters pecked into the lava at Site 50-10-27-30211.

6.4.8 Trail

A remnant segment of a single historic trail was documented during the current survey. This site was not identified during the previous 1993 PHRI survey. The route of the trail was initially recognized from documentary sources. A subsequent field investigation lead to the observation of linear stretches of worn *pāhoehoe* lava that appeared to indicate the bed of the historic trail. This remnant trail segment runs diaginally across roughly the *makai* portion of the Kona Commons survey area (Figure 79).

The only known documentary source to either mention the trail or show its route is the 1924 United State Geological Survey (USGS) topographic map of the Keāhole Point Quadrangle (Figure 23). Three distinct trails are recognizable on this map, where they appear as dashed lines. One of these trails runs along the coast from Kailua Bay and extends as far as Pawai Bay, located at the northern end of the present Old Kona Airport Park. This appears to represent the course of the traditional coastal trail. A second trail, which runs northwest from Kailua town and somewhat inland of the coast, represents the alignment of the historic Māmalahoa Trail. A third trail branches off of the Māmalahoa Trail within the vicinity of the present Kona industrial area (as can be seen when the 1924 map is overlaid atop a contemporary USGS topographic map, Figure 24) and runs southwest, connecting to the coastal trail near the survey point of Mahiahale. Although both the coastal trail and Māmalahoa Trail are shown on other early historic maps, this is the only time that the connecting trail appears in any known documentary sources.

In order to more precisely determine the course of this historic trail, its route (as shown on the 1924 USGS topographic map) was overlaid atop a contemporary aerial photograph of the area (Figure 85). A detailed field examination of the possible route of the trail was then undertaken by Pacific Legacy archaeologist Rowland Reeve, assisted by Michael Vitousek, Hawai'i Island archaeologist with the Hawai'i State Historic Preservation Division and Rick Gmirkin, archaeologist for the Ala Kahakai National Historic Trail. This examination resulted in the identification of faint traces of abrasion on portions of the *pāhoehoe* lava surface as might be caused by the passage of shod horses and mules. This wear pattern formed a roughly linear track that corresponded relatively well with the indicated route of the trail (Figure 86). These remnant traces of the trail were mapped using Global Positioning System equipment and are shown in Figure 87.

There are no other physical manifestations of the trail beyond the abrasion of the lava surface (no laid trail bed or stone curbing as found on the Māmalahoa Trail). As can be seen in Figure 87, the northeastern end of the trail, where it would have connected to the Māmalahoa Trail, has been destroyed by the development of the Kona industrial area, while its southwestern end, where it would have joined the coastal trail, was demolished during the construction of the Old Kona Airport. All that remains is a roughly 174 meter long remnant section in what would have originally been the central portion of the trail. This remnant is itself cut into two parts toward its western end by a line of bulldozer push.

It is not clear whether the Site 50-10-27-30287 trail existed during the pre-Contact period, or whether it was simply a post-Contact development resulting from the need to connect the historic Māmalahoa Trail with the traditional shoreline trail and the coastal settlement of

Figure 85. Relative locations of the 1924 USGS map trail alignments overlaid atop an aerial photograph (background aerial from Google Earth accessed 2015).

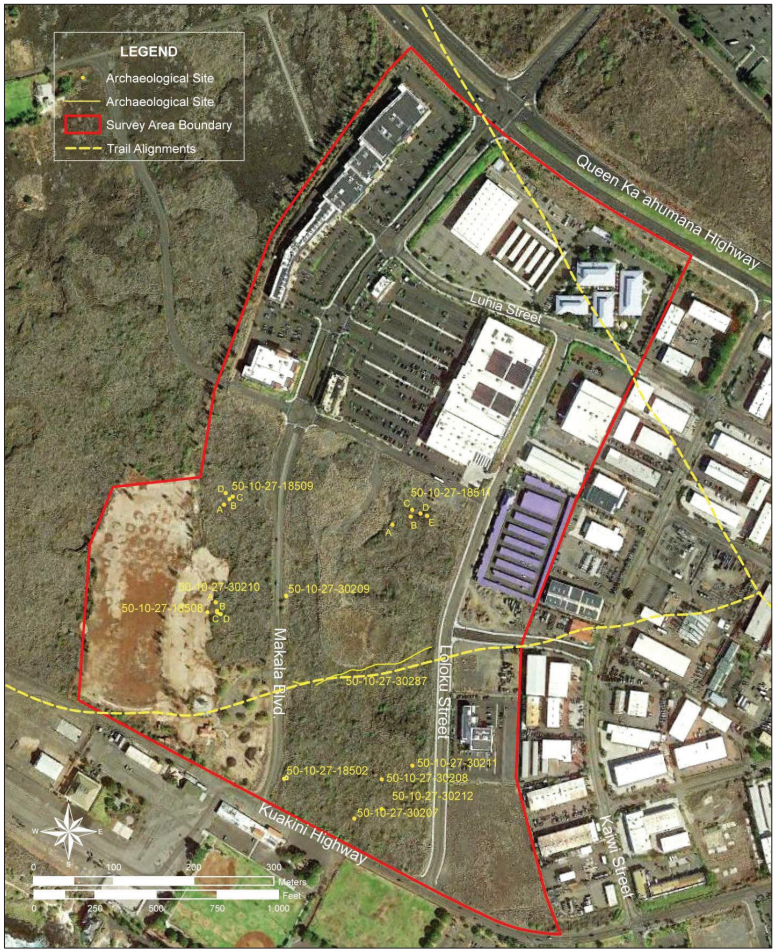


Figure 86. Alignment of the Site 50-10-27-30287 trail compared to the trail alignment shown on the 1924 USGS map (background aerial from Google Earth accessed 2015).

Figure 87. Visible remnants of the Site 50-10-27-30287 historic trail (background aerial from Google Earth, accessed 2015).

Pacific Legacy Historic Preservation

Mākāʻeo (situated in the area now covered by the Old Kona Airport). The Māmalahoa Trail is thought to have been constructed sometime between 1836 and 1855 (see Section 3.5.3). It was intended to supplement the traditional coastal walking trail (*ala kahakai*) by providing a more direct route for horse and wagon traffic to travel between the growing town of Kailua and the settlements of North Kona and South Kohala. If one assumes that the route of the Māmalahoa Trail was a historic development, and that it did not overlay an existing traditional trail, then it seems most likely that the Site 50-10-27-30287 connector trail is also of historic age.

6.5 Site Summary

In all, a total of 11 archaeological sites (containing 21 component features) were identified and documented during the present Supplemental Archaeological Inventory Survey. These sites appear to be traditional, historic, and modern in age (Table 1). The majority of the surviving features were found to be relatively small in size, consisting either of relatively crudely built structures or slightly modified natural features. Of these, six appear to possibly represent temporary habitation shelters (Table 5). The three stone mounds appear to have served as landscape markers of some kind. Two of the lava excavations recorded may have been utilized as planting areas for dryland crops, while the remaining two seem to represent stone quarrying sites. The small size of one of the modified overhangs suggests it may have been used as a storage area. The single modified lava tube appears to have served primarily as a burial chamber, with the possibility that it was later reutilized as a water catchment feature, though this is far from certain. The historic petroglyph may display someone's initials, while the modified depression seems to represent a modern dump/camp site. The historic trail appears to have served as a route of travel connecting the Māmalahoa Trail with the coastal trail. The function of the two remaining features is uncertain.

Table 5. Relative Frequency of Possible Feature Functions*

Possible Function	Number	%
Habitation	6	30%
Marker	3	15%
Agriculture	2	10%
Quarry	2	10%
Storage	1	5%
Burial	1	5%
Communication	1	5%
Habitation/Dump	1	5%
Travel	1	5%
Uncertain	2	10%
Total	**20**	**100.0%**

*Site 18509, Feature B filled depression is considered a natural feature and therefore not included.

Pacific Legacy Historic Preservation

7.0 SUBSURFACE TESTING

An additional component of the current Supplemental Archaeological Inventory Survey was the testing for subsurface lava tubes undertaken within the *makai* portion of the Kona Commons survey area. This testing was conducted by Geolabs, Inc. with the assistance of archaeologists from Pacific Legacy. It was undertaken to determine whether any large, subsurface lava tubes were present in that portion of the survey area located just inland of the Kuakini Highway.

As part of its planned development of the Old Kona Airport Park, the Queen Liliʻuokalani Trust and the County of Hawaiʻi are considering rerouting a portion of the present Kuakini Highway by moving it slightly inland and running it parallel to the present road. This new alignment would take it through the *makai* portion of the Kona Commons project area. In order to determine whether this proposed route is feasible, the Queen Liliʻuokalani Trust wished to test for the possible presence of large, subsurface lava tubes along the new alignment. Testing was to take the form of drilling to obtaining subsurface core samples at five locations along the route (Figure 88). Following consultation with the Hawaiʻi State Historic Preservation Division, it was agreed that this subsurface boring would be considered part of the testing phase of the present supplemental archaeological survey and its procedures and results were to be included in this report.

7.1 Boring Locations

Five locations were identified for test boring. These bore hole locations were designated as boring sites B-1 to B-5. Three of these sites (B-1 to B-3) were situated within the area of the former Swing Zone driving range, on land that had previously been grubbed and landscaped. The remaining two boring sites (B-4 and B-5) were located in undeveloped lands just west of Loloku Street (Figure 88). The present survey had identified some archaeological features in the vicinity of bore holes B-4 and B-5 (Figure 89). These included newly identified Sites 50-10-27-30207, 30208, 30211, and 30212.

7.2 Preparation of Access Route

Prior to the undertaking of test boring in the undisturbed lands west of Loloku Street, it was necessary to cut an access route that would allow the drilling rig and its accompanying water truck to drive in to boring locations B-4 and B-5. A bulldozer would be employed to grub and grade this access route. Since the three boring sites located in the former Swing Zone area were situated on lands that were relatively level and accessible, having been previously been grubbed during construction of the driving range, no bulldozing was required in that area.

The grubbing and grading of the access road was undertaken on the 22 August 2014. Both the bulldozing and subsequent drilling were supervised by Mr. Lloyd Kainoa of Geotech, who worked with the archaeologist from Pacific Legacy to insure that no archaeological remains were disturbed during the course of subsurface testing.

Figure 88. Locations of the five boring sites within the Kona Commons project area (base aerial from Google Earth).

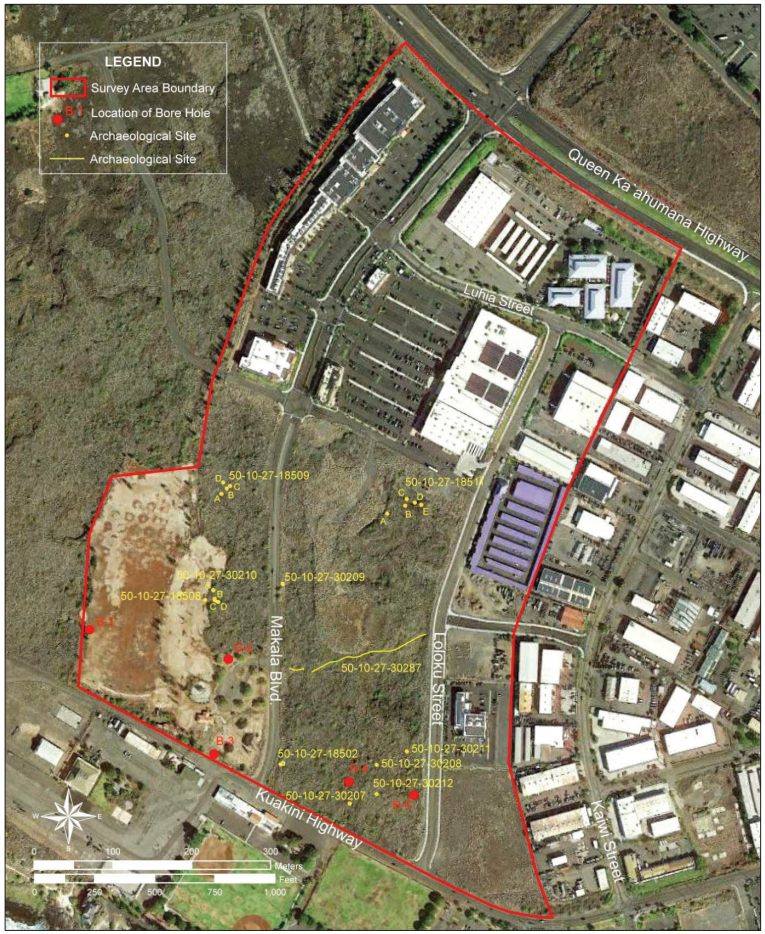


Figure 89. Locations of boring sites in relationship to identified archaeological sites (base aerial from Google Earth accessed 2015).

Before bulldozing operations commenced, the boundaries of all of identified archaeological sites located within the more *makai* portion of the Kona Commons project area were marked off with flagging tape to make them clearly visible. Although the planned access route for the drilling equipment was to extend in from Loloku Street to provide ingress to boring locations B-4 and B-5, in order not to damage the sidewalk edging Loloku Street, the bulldozer was forced to transit in from Makala Boulevard. The plan was for the dozer to drive from Makala in to boring location B-4 and then begin cutting the access route from there out to Loloku Street.

Prior to the initiation of work, the archaeologist provided the bulldozer crew with an archaeological awareness briefing. This briefing gave them an overview of the archaeological and cultural background of the Kona Commons project area and familiarized them with the identified historic properties located within and adjacent to the area in which they would be working. The construction crew was also instructed as to the proper procedures to follow in order to avoid adversely impacting these sites and informed of the appropriate protocols should they encounter previously unidentified archaeological features and/or human remains.

The archaeologist and Mr. Kainoa then walked the proposed bulldozer path from Makala Boulevard to boring location B-4, marking it with clearly visible flagging tape. The path was laid out so as to avoid all identified archaeological sites and was inspected to insure that no previously unidentified sites were situated within the proposed route. From boring location B-4, the alignment of the access route was laid out so that it ran between Site 50-10-27-30208 (a stone mound) and Site 50-10-27-30212 (a C-shaped shelter), leaving approximately 20 meters between the sites and the path. It was then continued to boring location B-5 and on to Loloku Street. Once it was graded, the drilling machine and water truck would be able to enter from Loloku Street and use this route to access both boring locations B-4 and B-5.

When the path had been laid out and marked, the archaeologist led the bulldozer in along it from Makala Boulevard to Loloku Street. The bulldozer then began grubbing and leveling the access route back to drilling location B-5 (Figure 90), and then on, between Sites 30208 and 30212 (Figure 91), to boring location B-4. In order to level the path for the drilling vehicles, the bulldozer ripped high spots and filled low spots. No identified archaeological sites were impacted by these ground disturbing activities, and no subsurface lava tubes were uncovered by the dozer.

7.3 Core Drilling

Drilling operations took place between 28 August and 29 August 2014. These activities were supervised by Mr. Lloyd Kainoa of Geotech, Inc. with the assistance of an archaeologist from Pacific Legacy who accompanied the drilling team for their entire duration on site. Prior to the start of drilling, the archaeologist provided the drilling crew with an archaeological awareness briefing similar to that given to the bulldozer crew. The archaeologist then observed the work to insure that no archaeological sites were adversely impacted and that no previously unidentified archaeological features were discovered.

Figure 90. Bulldozer grading access road to drill sites (view north).

Figure 91. Bulldozer working between Sites 30212 (in foreground) and 30208 (view west).

Drilling equipment consisted of a drill rig and a water truck to supply the water needed to cool down the drill (Figure 92). The drill itself consisted of four segments, each 5 feet in length and 3 inches in diameter. Core samples were collected from each bore hole (Figure 93). At the completion of each drilling, the drill hole was sealed with rock and soil.

During drilling operations at bore holes B-4 and B-5, which were completed the first day of drilling, the drill rig and water truck remained on the access route at all times. The drilling locations were intentionally situated at the center of the access path. None of the archaeological sites located in the surrounding area were adversely impacted. For the three remaining bore holes, located on previously disturbed land in the old Swing Zone driving range, the archaeologist investigated each area prior to the start of drilling activities and insured that no archaeological remains were present either in the drilling area or along the access route in. Bore hole B-3 was situated in an area adjacent to the Swing Zone parking lot that had been previously paved, while bore hole B-2 was in a graded area and bore hole B-1 was in an area of soil fill. None of the borings revealed the existence of subsurface lava tubes.

Figure 92. Drilling at bore hole B-2.

Figure 93. Core samples from bore hole B-4.

8.0 SIGNIFICANCE ASSESSMENTS

8.1 HISTORIC SIGNIFICANCE

The National Historic Preservation Act of 1966 (as amended) authorizes the Secretary of Interior to maintain and expand a National Register of Historic Places (NRHP). The National Register contains a listing of districts, sites, buildings, structures and objects determined to be significant to American history, architecture, archaeology, engineering and culture. A property is deemed eligible for listed on the NRHP if it meets the criteria for evaluation defined in the Code of Federal Regulation Title 36 (36 CFR §60.4):

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and
>
> (a) That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (b) That are associated with the lives of persons significant in our past; or
>
> (c) That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) That have yielded, or may be likely to yield, information important in prehistory or history.

The State of Hawai'i recognizes the above criteria under Hawai'i Revised Statutes (HRS §13-275-6 (b)). These state level criteria reflect the Secretary of the Interior's standards for listed on the National Register of Historic Places as defined in the Code of Federal Regulation Title 36 (36 CFR §60.4), but also include a fifth significance criterion to the evaluation process. Under this criterion a historic property can be recognized as significant if it is known to:

> (e) Have an important value to the Native Hawaiian people or to another ethnic group of the State due to associations with cultural practices once carried out or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts – these associations being important to the group's history and cultural identity.

In addition, the State of Hawai'i recognizes that, "A group of sites can be collectively argued to be significant under any of the criteria" listed above (HRS §13-275-6 b).

8.2 Assessed Significance of Project Area Sites

The eleven historic properties identified during the present archaeological inventory survey have all been assessed as to their significance under the Secretary of Interior's standards for listing on the National Register of Historic Places (NRHP) based upon one or more of the criteria defined in 36 CFR §60.4 and Hawai'i Revised Statute §13-275-6. These sites were found to be significant under two of the four criteria (Table 6).

The most significant and culturally sensitive of the sites documented during the present survey is the Site 50-10-27-18511, Feature C lava tube burial, which contains a scattering of human remains. This burial site, first recorded in 1992, was recommended for preservation in the original PHRI Archaeological Inventory Survey report and was included in a subsequent Burial Treatment Plan prepared by PHRI for several sites located within Queen Lili'uokalani Trust's Keahuolū lands that were found to contain human remains (Maly and Rosendahl 1993).

Site 50-10-27-18511, Feature C is the only archaeological feature identified within the project area that can be considered as being significant for more than simply its information content. The composition and condition of the remaining ten sites indicates that their significance rests solely in the information they contain, and that information appears to have been adequately documented during the 1992 and present archaeological surveys.

Pacific Legacy Historic Preservation

Table 6. Significance Assessments and Treatment Recommendations of Kona Commons Sites

SIHP No.	Feature	Site / Feature Type	Possible Function	Significance (A,B,C,D,E)	Recommended Treatment
50-10-27-18502		Modified Depression	Habitation	D	No Further Work
50-10-27-18508		Walled Overhang	Habitation	D	No Further Work
	A	Stone Mound	Agriculture	D	No Further Work
50-10-27-18509	B	Filled Depression	None		No Further Work
	C	Stone Mound	Agriculture	D	No Further Work
	D	Lava Excavation	Agriculture	D	No Further Work
	A	Modified Overhang	Habitation	D	No Further Work
	B	Lava Excavation	Agriculture	D	No Further Work
50-10-27-18511	C	Modified Lava Tube	Burial	D,E	Preservation
	D	Lava Excavation	Quarry	D	No Further Work
	E	Lava Excavation	Quarry	D	No Further Work
50-10-27-30207		Lava Excavation	Uncertain	D	No Further Work
50-10-27-30208		Stone Mound	Marker	D	No Further Work
50-10-27-30209		Enclosure	Habitation	D	No Further Work
	A	Modified Overhang	Storage	D	No Further Work
	B	Lava Excavation	Uncertain	D	Data Recovery
50-10-27-30210	C	C-shaped Wall	Habitation	D	No Further Work
	D	Enclosure	Habitation	D	No Further Work
50-10-27-30211		Petroglyph	Communication	D	No Further Work
50-10-27-30212		C-Shaped Wall	Habitation	D	No Further Work
50-10-27-30287		Trail	Travel	D	Partial Preservation With Interpretation

Pacific Legacy Historic Preservation

9.0 RECOMMENDED TREATMENTS

9.1 PREVIOUS RECOMMENDATIONS

The report of the 1990 PHRI archaeological inventory survey assessed the four sites located within the present Kona Commons survey area as being significant solely for their informational content. It determined that, "The documentation undertaken as part of the [1990] inventory survey has adequately recovered this information and no further data collection is necessary" (Donham 1990:35-40). For this reason, the sites were recommended for no further work.

The 1992 PHRI archaeological inventory survey report assessed 16 of the 18 identified sites as being significant solely for their information content (O'Hare and Rosendahl 1993:16-18). The section of the Māmalahoa Trail (Site 50-10-27-00002) that rested within the survey area was assessed as significant for its information content, its cultural value, and as an excellent example of a site type. The lava tube burial (Site 50-10-27-18511) was assessed as significant both for its information content and its cultural value.

The report recommended that data recovery excavations be undertaken at four of the 18 sites. These included the Site 50-10-27-18506 lava tube complex, the Site 18513 agricultural terrace complex, the Site 18515 complex, and the Site 18518 complex (none of these sites were relocated during the current survey and all are presumed to have been destroyed). Two of the sites (Sites 50-10-27-00002 and 18511) were recommended for preservation. It was felt that the AIS had fully documented the remaining 12 sites and that no further work was required at them. Of the two sites deemed worthy of preservation, the Māmalahoa Trail (Site 50-10-27-00002) was recommended for further data collection followed by preservation with interpretive development. The Site 50-10-27-18511 lava tube burial was recommended for provisional further data collection and preservation "as is."

Subsequent to the completion of the PHRI AIS report for the Kona Industrial Subdivision (KIS) Expansion Site (as the Kona Commons area was then referred to), and as a result of discussions between Belt Collins Hawai'i and the Hawai'i State Historic Preservation Division (SHPD), Belt Collins submitted a letter to the Nā Ala Hele Hawai'i Island Advisory Council asking whether the Council had any objection to the State relinquishing its claim to the segment of the Māmalahoa Trail located within the KIS Expansion area. The Council responded with a letter stating that it had no objections to the State relinquishing its claim to the trail segment (PHRI 1993). Belt Collins & Associates subsequently requested, in a letter dated September 29, 1993 to SHPD, that the mitigation commitment regarding the segment of the Māmalahoa Trail located within the KIS Expansion area be altered from "preservation" to "further data collection." It appears that the decision was made not to preserve the fragment of the historic Māmalahoa Trail present within the survey area.

In a November 23, 1993 letter to SHPD, PHRI requested that the mitigation of the six sites located within the 100 acre KIS Expansion area, which were slated for either data recovery or preservation, be included within the previously prepared Mitigation Plan for the Queen

Lili'uokalani Trust lands (Jensen et al. 1992). PHRI also proposed that the treatment recommendations suggested in the original AIS be amended. It proposed that two of the six sites (the Māmalahoa Trail and the Site 50-10-27-18506 cave shelter) undergo further data recovery, that the Site 50-10-27-18511 lava tube burial be preserved, and that the remaining three sites (Sites 50-10-27-18513, 18515, 18518) be considered to require no further work.

In 1993, a Burial Treatment Plan (BTP) was developed by PHRI for the Queen Lili'uokalani Trust's Keahuolū lands (Maly and Rosendahl 1993). This plan addressed nine known and possible human burials. Eight of these burials had been discovered during a 1990 PHRI survey of 1,100 acres of Queen Lili'uokalani Trust lands (including the Urban Phase I, II and III and Conservation zoned parcels). The final burial considered in this BTP was the Site 50-10-27-18511 lava tube burial identified during the 1992 PHRI survey of the 100 acre Kona Commons property. The Burial Treatment Plan did not address specific burials in detail, but recommended that all confirmed and potential burials be preserved in place (Maly and Rosendahl 1993:4). The Burial Treatment Plan appears to have been considered by the Hawai'i Island Burial Council during its meeting on November 3, 1993. It was apparently approved by the Council with an amendment to provide 30-foot protective buffers around the sites during construction, instead of the 5 meter buffers recommended in the original BTP (Belt Collins & Associates 1993). It also appears that the BTP was approved by the State Historic Preservation Division in September of 2002 (Belt Collins Hawai'i 2008).

Although data recovery was recommended for the Māmalahoa Trail and the Site 50-10-27-18506 cave shelter, there is no record of a Data Recovery Plan being prepared or data recovery investigations being undertaken prior to the development of the area.

In 2008, a Final Environmental Assessment (EA) and Finding of No Significant Impact report was prepared by Belt Collins Hawai'i for the proposed Kona Commons project. This EA addressed the development of 67 acres within the Kona Commons property. The only archaeological site within the property that was mentioned in the EA was the Site 50-10-27-18511 lava tube burial. The AIS indicated that, prior to any land disturbance activities, a thirty-foot-wide buffer would be established around Site 18511, "in accordance with the November 1993 burial treatment plan recommended by the Hawai'i Island Burial Council and subsequently approved by the State Historic Preservation Division in September 2002." (Belt Collins Hawai'i 2008).

9.2 RECOMMENDED TREATMENTS

The present Supplemental Archaeological Inventory Survey (SAIS) documented a number of sites not previously recorded during the 1992 PHRI survey, and also identified additional features within several of the sites that were recorded. For this reason a completely new set of significance recommendations has been prepared (Table 6). The categories of treatment recommended in the present table include the following:

No Further Work: When a site is determined significant solely for its informational content and that information has been adequately documented during the present archaeological inventory survey, no further work is suggested.

Data Recovery: Data recovery is recommended when a site is deemed significant solely for its informational content, but when the documentation of that content requires more detailed investigation than included within the scope of the archaeological inventory survey. Data recovery investigations often involve subsurface excavation, and are likely to uncover additional information (in the form of internal features, subsurface artifacts, midden, and other cultural remains) not documented during the inventory survey.

Preservation: This category involves the preservation of a site and its features, either in part or in their entirety. It is most often applied to sites which have been determined to be significant for more than simply their informational content (that have been assessed as significant under criteria A, C or E).

Of the eleven archaeological sites identified within the Kona Commons parcel during the present survey, eight have been recommended for No Further Work, one has been recommended for Data Recovery, one has been recommended for Preservation as is, and one for partial Preservation and interpretation (Table 6 and Table 7).

Table 7. Recommended Treatments

Recommended Treatments	No. of Sites
No Further Work	8
Data Recovery	1
Preservation	2
Total	**11**

Most of the archaeological structures present within the project area (such as low stone mounds, C-shaped walls, and enclosures) have been constructed directly on atop *pāhoehoe* bedrock and therefore possess no excavation potential. The same is true for the majority of the modified natural features. In such cases, the detailed recording undertaken during both the 1992 and present archaeological surveys has been sufficient to record all of the information these sites are likely to yield.

Eight sites are recommended for No Further Work. These small and rather crudely constructed features include collapsed stone mounds (Site 18509, Feature A, Site 18509, Feature C, and Site 50-10-27-30208), enclosures (Site 50-10-27-30209 and Site 50-10-27-30210, Feature D), and low C-shaped walls (Site 50-10-27-30210, Feature C, and Site 50-10-27-30212). All of these structure rest directly on lava bedrock. Also recommended for No Further Work are modified natural features such as modified lava overhangs (Sites 18508, Site 18511, Feature A, and Site 50-10-27-30210, Feature A) and the modified depression (Site 18502), as well as the apparently natural "filled depression" (Site 18509, Feature B), the late historic petroglyph (Site 50-10-27-30211) and those lava excavations containing no soil (Site 18509, Feature D, Site 18511, Feature B, Site 18511, Features D and E, and Site 50-10-27-30207). The detailed recording undertaken during both the 1992 and present surveys, as presented in Section 6.0 of this report, adequately documents the informational content of these eight sites.

Data Recovery is being recommended for Site T-005, Feature B, the only lava excavation identified during the present survey as containing soil. Previous archaeological researches have suggested a number of possible functions for lava excavations. This type of feature may have been created during quarrying activities to obtain building material for nearby sites, they may be the result of "prospecting" for lava tubes that could be used for shelters or storage areas, or they may have been created to open up shallow depressions in the lava that could then be filled with mulch and utilized as planting areas. While the information obtained during the present survey can be said to adequately document the Site 50-10-27-30210, Feature B lava excavation, it is recommended that as part of data recovery activities the lava excavation be excavated and soil samples collected. The resulting soil samples should be submitted for pollen and phytolith analysis. Such analyses may indicate the presence or absence of pollen or starch grains from cultigens such as *'uala* (*Ipomoea batatas*, sweet potato). Microbotanical remains identified as belonging to *Ipomoea batatas* have been recovered from shallow lava excavations located further north along the Kona coast in the *mauka* portion of the *ahupua'a* of Ka'ūpūlehu (Cleghorn and McIntosh 2013:14). These finding would appear support the proposition that at least some lava excavations were used in the pre-Contact period for crop cultivation. If similar analyses are conducted on soil samples collected from Site 50-10-27-30210, Feature B, similar, or at least comparative results, may be forthcoming.

The results of pollen and phytolith analyses from samples collected during data recovery at Site 50-10-27-30210, Feature B could help to shed light on the question of whether some of the lava excavations within the present project area did indeed serve as planting areas. It is also recommended that comparative baseline samples be taken from shallow soil deposits located outside of the lava excavation in areas not well suited for direct cultivation. If *'uala* (sweet potato) pollen or starch grains are also found in these baseline samples, this may indicate that such micro-botanical remains do not necessarily derive from plants grown in situ, but could have originated elsewhere and been deposited by natural agencies such as the wind or water. A detailed Data Recovery Plan (mitigation plan) will need to be submitted to the State Historic Preservation Division for review and approval prior to the initiation of any data recovery investigations.

The Site 50-10-27-18511, Feature C burial lava tube has been recommended for Preservation as is due to the presence of human remains. This recommendation does not apply to the other remaining archaeological features identified within the Site 18511 complex (Features A, B, D, and E). A detailed Burial Treatment Plan (BTP) outlining how the Site 18511, Feature B burial lava tube will be protected is currently in preparation. Prior to initiation of any ground disturbing activities related to the development of the project area, the BTP will be submitted to the State Historic Preservation Division and Hawai'i Island Burial Council for their review and approval.

The status of the Site 50-10-27-30287 trail was taken under consideration by Nā Ala Hele, the Hawai'i State Trail and Access System. It determined that since the trail was not found on any maps prior to 1892, Nā Ala Hele would defer to the State Historic Preservation Divisions' recommendations regarding the trail.

The Site 50-10-27-30287 trail has been recommended for partial preservation and interpretation. It is proposed that one of the more visibly distinct segments of the trail be preserved with interpretive signage. This interpretive material would include a map showing the original course of the trail, as well as a written text describing the trail, indicating its relationship with the historic Māmalahoa Trail and the traditional shoreline trail, and explaining its importance to the residents of the nearby coastal settlements. Two potential preservation areas have been identified (Figure 94). The best preserved section of the trail is approximately six meters in length and located at its furthest western end. At this end, the trail is traceable for approximately 15 meters before it is cut by a line of bulldozer push. It is suggested that this entire 15 meter section be designated for preservation. The second most visible segment is closer to the center of the surviving trail segment. Here there are roughly 12 meters of clearly discernible trail, which could serve as an alternate preservation segment. It is recommended that one of these trail segments be selected for preservation and that interpretive signage be mounted adjacent to it.

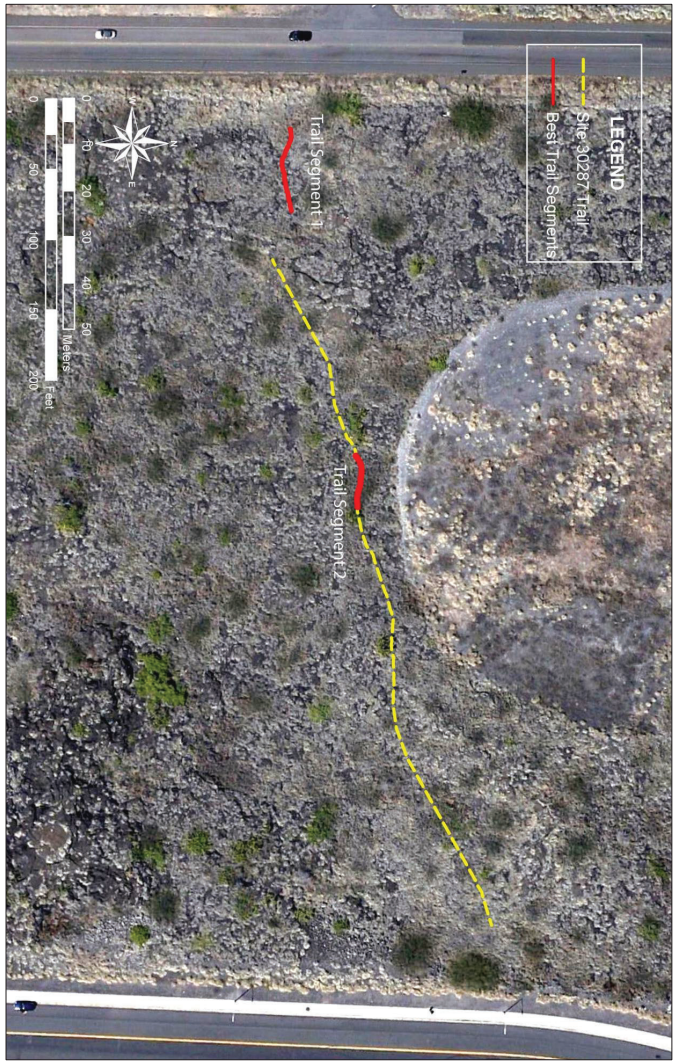


Figure 94. Location of the two most visible sections of the Site 50-10-27-30287 trail (base aerial from Google Earth accessed 2015).

10.0 SUMMARY AND DISCUSSION

The current Supplemental Archaeological Inventory Survey of the 110 acre Kona Commons project area identified a total of eleven archaeological sites containing 21 component features. Four of these sites had been documented by previous surveys. The remaining seven were newly discovered. Archaeological feature types encountered during the current survey included lava excavations, stone mounds, modified overhangs, small enclosures, a C-shaped wall and a C-shaped alignment, a modified depression, a petroglyph, a historic trail, and a lava tube containing human remains. These various structures appear to have served a range of functions including temporary habitation, crop cultivation, stone quarrying, visual marking, storage, communication, travel, and burial. While the sites encountered appear to be both pre-Contact and post-Contact in age, the majority are traditional in their appearance and construction style. One site, the Site 50-10-27-18502 modified depression, may represent a modern homeless campsite and/or trash dump. The style of the letters that form the Site 50-10-27-30211 petroglyph suggests that this image may date from the later historic period. Due to its direct association with the historic Māmalahoa Trail, the Site 50-10-27-30287 trail also appears to be historic in age. All of the remaining sites appear to date from the pre-Contact period.

The majority of the sites that had been previously recorded within the Kona Commons project area, either during the 1978 reconnaissance survey, the 1979 reconnaissance survey, the 1990 inventory survey, or the 1992 inventory survey, were not relocated during the present SAIS. These sites appear to have been destroyed by development and ground disturbing activities which have taken place in the project area over the last 36 years. The construction of the Kona Commons Shopping Center, the Target store, the International Marketplace and related retail properties, as well as the former Swing Zone facility resulted in the grading and landscaping of large portions of the project area. Bulldozing associated with these activities also appears to have extended somewhat outside the area of development.

Despite this level of destruction, it is still possible, using the data obtained during the current survey combined with that recorded by previous surveys, to make some interpretations as to the traditional cultural use of the project area. The archaeological features identified provide evidence of human activity in the survey area dating back into the pre-Contact period. Most, if not all, of this activity, however, appears to have short term in nature, conducted by individuals visiting or passing through the area rather than residing within it.

10.1 TRAILS

Ethnohistoric evidence (see Section 3.0) suggests that at least two trails crossed into and through the Kona Commons project area. The relative alignments of these trails, and their association to the sites documented during the current survey, are shown in (Figure 85).

The most substantial of these routes of travel was the historic Māmalahoa Trail, whose alignment once transected the northeastern corner of the survey area. Remnants of this historic

horse and cart path were identified during the 1992 PHRI survey and documented as part of Site 50-10-27-00002 (Figure 29). Though initially slated for preservation and interpretation, these trail remnants were later recommended for data recovery, and were subsequently destroyed during the construction of the present International Marketplace and HPM properties.

A trail that connects the historic Māmalahoa Trail with the traditional shoreline trail is shown on the 1924 United State Geological Survey (USGS) topographic map of the Keāhole Point Quadrangle (Figure 23). According to this map, the trail branches off of the Māmalahoa Trail just east of the project area and runs southwest to join the coastal trail just inland of the former settlement of Mākā'eo. As can be seen when the route of these trails is overlaid atop a contemporary USGS topographic map (Figure 24), the third trail would have crossed through the *makai* half of the Kona Commons project area.

A search was made along the alignment of this connector trail, as estimated by overlaying its course (as shown on the 1924 USGS map) atop a contemporary aerial photograph of the area (Figure 85). Field examination revealed faint traces of wear on portions of the *pāhoehoe* lava surface. The linear abrading of the lava surface was most likely caused by the passage of shod horses and mules along the bed of the trail. This ephemeral evidence of the trail was traceable for approximately 174 meters. It was cut at both ends by bulldozing associated with adjacent roads. What remains is a section of what would have originally been the central stretch of the trail.

It is not clear whether the Site 50-10-27-30287 trail existed during the pre-Contact period, or whether it was simply a post-Contact development resulting from the need to connect the historic Māmalahoa Trail with the traditional *ala kahakai* and the coastal settlements in the area now occupied by the Old Kona Airport Park. Given that the Māmalahoa Trail was a historic era construction that appears not to ave followed the course of an existing traditional trail, it is most likely that the more minor connector trail that runs through the Kona Commons project area is also of historic age.

10.2 HABITATION

No sites of long term habitation were discovered within the 110 acre project area, either during the current survey or during any of the previous surveys conducted. The only sites that appear to be residential in nature are temporary shelters. These features consist either of roughly constructed low walled windbreak shelters (enclosures and C-shaped walls/alignments) or natural features (overhangs and lava tubes) that have been modified. As has been mentioned (see Section 6.4.4), the small surface shelters are too small to have served as more that rough windbreaks. They appear to have been constructed as temporary windbreak shelters by individuals traveling across or working in the survey area. Their relatively small size and rough construction suggest that they were structures of convenience, built relatively quickly and occupied on a short term basis.

Natural feature also appear to have been utilized as a temporary shelters. Most of these consist of low lava overhangs that have been slightly modified by the addition of a facing wall. They may have served as temporary shelters where individuals traveling through the area could have taken temporary refuge from the wind and sun. Given their shallow overhangs and rough floors, it seems less likely that these sites were used as overnight shelters.

The largest of these modified natural shelters is the Site 50-10-27-18506 lava tube, which was documented during the 1992 PHRI survey but appears to have been destroyed (or at least buried) by subsequent development. The discovery, within the tube, of two fire hearths, a bone fishhook, a cowry octopus lure, and the recovery from within the excavated hearth of marine gastropods (*Nerita picea* and *Cypraea caputserpentis*), echinoid remains, and *kukui* (candlenut, *Aleurites moluccana*) nut shell fragments, suggests that it had served as an overnight camp for individuals fishing along the adjacent coastline (O'Hare and Rosendahl 1993:15). The presence of waterworn boulders and fragments of branch coral was taken by the AIS report to suggest that the lava tube may have also served a ceremonial use function (O'Hare and Rosendahl 1993:A-8). The PHRI report also mentions the presence of "coconut husk fragments," though it is not clear if these fragments consisted simply of the fibrous husk (which could have served as tinder for lighting fires) or included both the husk and portions of the shell (which could be used as crude cups for catching or holding liquid). These "coconut husk fragments" were interpreted as evidence that the lava tube was also utilized as a water catchment feature. "The cave is wet, with water dripping continually from the ceiling. The presence of coconut husk halves placed around the floor of the cave is probably evidence for water catchment" (O'Hare and Rosendahl 1993:A-8). The Site 18506 lava tube and its associated features promised to yield a substantial amount of information concerning the traditional use of the project area. Regretfully, it appears to have been destroyed prior to any further data recovery being attempted.

No concrete evidence of permanent habitation structures was encountered within the survey area. Such residences were most likely located along the shoreline. We know, from the work of Reinecke and other early archaeologists, that a small settlement was located in the area of Mākāʻeo, which was destroyed by construction of the Old Kona Airport.

11.0 MANAGEMENT OF CULTURAL RESOURCES

One of the purposes of this report is to serve as a planning document to assist Queen Liliʻuokalani Trust in managing the archaeological resources present within its Keahuolū lands. The report provides detailed information on the location, character and relative significance of the archaeological remains present within the 110 acre Kona Commons parcel. It should not, however, be considered an exhaustive document. The present program of site recording and test excavations was undertaken to gather information about the sites, not to mitigate any adverse impacts to these archaeological remains.

Prior to the initiation of any development within the Kona Commons parcel, various preservation/mitigation plans will need to be prepared so as to best anticipate and mitigate the adverse impacts of any such development upon the archaeological resources present. It has been recommended (see Section 9.2) that additional data recovery investigations are undertaken at the Site 50-10-27-30210, Feature B lava excavation. In this case, data recovery will involve excavation of the interior of the excavation to recover a sample of the soil present. This investigation is likely to uncover additional information (pollen and phytolith) not documented during the present inventory survey. Prior to the initiation of these data recovery investigations, a detailed Data Recovery Plan will need to be prepared and submitted to the State Historic Preservation Division [SHPD] for review and approval. This plan would be prepared in accordance with the requirements of Hawaiʻi Administrative Rules Title 13, Subtitle 13, Chapter 278 (Rules Governing Standards for Archaeological Data Recovery Studies and Reports).

Due to the presence of a known burial at Site 50-10-27-18511, Feature C, a Burial Treatment Plan is currently being prepared detailing the proposed treatment of the site and its remains. This Burial Treatment Plan will need to comply with all necessary requirements as set forth in Hawaiʻi Administrative Rules, Title 13, Subtitle 13, Chapter 300 (Rules of Practice and Procedure Relating to Burial Sites and Human Remains). The Plan will be submitted to both the SHPD and the Hawaiʻi Island Burial Council [HIBC] for review and determination.

A Historic Preservation Plan will need to be prepared for the Site 50-10-27-30287 historic trail. This Plan will need to satisfy the requirements of Hawaiʻi Administrative Rules Chapter 13-277 (HAR §13-277, Rules Governing Requirements for Archaeological Site Preservation and Development). The Preservation Plan will describe the site to be preserved, identify the type of preservation intended, and address in detail the interim and long term protective measures to be put in place to protect it. In this case, the plan would identify the portion of the trail to be preserved and the mitigation measures to be employed to protect it during construction activities. It will also address in detail the placement and wording of the interpretive signage mounted adjacent to it. The Plan will be submitted to the SHPD for review and approval prior to the start of ground disturbing activities.

Following the acceptance of the results of data recovery investigations, as well as the Burial Treatment and Historic Preservation Plans, an Archaeological Monitoring Plan will need to be

prepared. The purpose of this Archaeological Monitoring Plan is to recommend the most appropriate methods to insure that construction activities do not adversely affect the historic property (the Site 50-10-27-18511, Feature C, burial) presently recommended for preservation. The plan will discuss interim protection measures, such as the erection of orange construction fencing around the preservation site, as well as the requirements for archaeological and cultural monitoring. The components of this Monitoring Plan will need to meet the standards outlined in Hawai'i Administrative Rules Title 13 Chapter 279 (Rules Governing Standards for Archaeological Monitoring Studies and Reports). It will also need to be approved by the SHPD prior to the start of any construction activities.

Recommendations for the preservation or data recovery of specific sites within the Kona Commons survey areas have been addressed in Section 9. The current survey also noted the presence of small subsurface lava tubes within the southwestern corner of the project area, adjacent to the former Swing Zone driving range. None of the tubes investigated was found to contain any cultural material. The 1992 PHRI survey identified a modified lava tube (Site 50-10-27-18506), containing two fire hearths, as well as surface artifacts and marine shell midden, in this area. Site 18506 was not relocated during the current survey, despite a thourogh examination of its likely location (based upon the 1992 site distribution map). Although it is most probable that the tube was destroyed during the construction of the Swing Zone, given the amount of landscaping which has taken place in that area, the possibility exists that the tube entrance may have been blocked by bulldozed stones or fill, and that a section of the tube remains buried and could potentially be uncovered during ground disturbing activities. For this reason, it is recommended that any mitigation/monitoring plan that is prepared in association with the development of the Kona Commons area should call for archaeological monitoring to take place during any ground disturbing activities conducted in the vicinity of the former Swing Zone.

The complex of archaeological sites present within the *ahupua'a* of Keahuolū have the potential to serve as a rich educational resource for the people of Hawai'i. They provide a glimpse into the life of the residents of this part of Kona during the pre-Contact and early historic periods, and serve as a tangible testament to their skill and ability in adapting to what many would see today as a barren and inhospitable environment. The information gathered during the present supplementary archaeological inventory investigations, as well as during future data recovery excavations conducted within the Kona Commons survey areas, can help add to our already extensive knowledge of the history of Keahuolū. This history is already being made accessible through the educational activities associated with the 25 acre Keahuolū Historic Preserve Area and the Kepo'okalani Interpretive Center. It is hoped that the information contained in this report will further contribute to our understanding of the way of life practiced by *ka po'e kāhiko o* Keahuolū.

12.0 REFERENCES

Apple, Russell A.
1965 *Trails: From Stepping Stones to Kerbstones*. Bernice P. Bishop Museum Special Publication 53. Bishop Museum Press, Honolulu.

Award Book
The adjudicated claims and lands awarded during the Māhele 'Āina were recorded in the *Award Books*. This book comprises one of five bound volumes which, together with the *Mahele Book*, constitute the principle documentation resulting from the Māhele. These volumes are preserved in the Hawaii State Archives and are accessible on microfilm.

Barrera, William
1971 *Anaehoomalu: a Hawaiian Oasis: Preliminary Report of Salvage Research in South Kohala, Hawaii*. Pacific Anthropological Records Series. Dept. of Anthropology, Bernice P. Bishop Museum, Honolulu.

Belt Collins Hawai'i
1993 Letter dated 24 November 1993 from Belt Collins Hawai'i, Ltd. to the Hawai'i State Historic Preservation Division requesting approval of the mitigation plan for the Queen Lili'uokalani Trust lands in Keahuolū.

2008 *Final Environmental Assessment and Finding of No Significant Impact for the Proposed Kona Commons Project Keahuolū, North Kona District, Kailua-Kona, Hawai'i TMK: portion of (3) 7-4-08:02; (3) 7-4-015: portion of 15 and 22; (3) 7-4-10*. Belt Collins Hawai'i, Ltd. Submitted to Queen Lili'uokalani Trust.

Bevacqua, R. F.
1972 *Archaeological Reconnaissance Survey of a Portion of Keahuolū, Kona, Hawai'i Island*. Letter Report, Dept. of Anthropology, Bernice P. Bishop Museum.

Boundary Commission
Boundary Commission Books: five volumes of statements and testimony regarding land boundaries presented before the Board of Commissioners for Boundaries are preserved on microfilm in the Archives of the State of Hawaii.

Carter, Laura
1986 *An Archaeological Reconnaissance of the Makai Parcel of Ka'ūpūlehu Ahupua'a, North Kona, Hawai'i Island*. Included in the *Kaupulehu Resort: Kaupulehu North Kona Final Environmental Impact Statement*. Bernice P. Bishop Museum Department of Anthropology. Submitted to Barnwell Industries, Inc.

Clark, John
1985 *Beaches of the Big Island*. University of Hawai'i Press, Honolulu.

Cleghorn, P.L. and J.D. McIntosh
2013 *Supplement to the Archaeological Inventory Survey for the Nanea Wells Project, Kaʻūpūlehu, North Kona District, Island of Hawaiʻi [TMK: (3) 7-2-003:003 POR. and 012 POR.].* Pacific Legacy, Inc. Submitted to Sunetric. A copy of this report is on file at the State Historic Preservation Division library in Kapolei.

Cordy, Ross
2000 *Exalted Sits the Chief: The Ancient History of Hawai'i Island*. Mutual Publishing, Honolulu.

Cordy, Ross, Joseph Tainter, Robert Renger, and Robert Hitchcock
1991 *An Ahupuaʻa Study: The 1971 Archaeological Work at Kaloko Ahupuaʻa, North Kona, Hawaiʻi: Archaeology at Kaloko-Honokōhau National Historic Park*. Western Archaeological and Conservation Center Publications in Anthropology No. 58, National Park Service, U. S. Department of the Interior.

Donham, Theresa K.
1986 *Full Archaeological Reconnaissance Survey, Kohana-Iki Development Project Area. Land of Kohana-Iki, North Kona, Island of Hawaiʻi (TMK: 3-7-3-09:3, 14)*. PHRI Report 216-040286. Submitted to Helber, Hastert, Van Horn & Kimura.

1990 *Archaeological Inventory Survey Queen Liliʻuokalani Trust Property, Land of Keahuolū, North Kona District, Island of Hawaiʻi*. Ms. 596-021290, Paul H. Rosendahl, Ph.D., Inc. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

Dye, Tom
2002 *Archaeological Data Resources in the Barren Zone, Manini'owali and Kuki'o 2nd Ahupua'a, Kona, Hawai'i*. T. S. Dye & Colleagues Archaeologists, Inc. Submitted to W/B Maniniʻowale. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

Ellis, William
1917 *Narrative of a Tour of Hawaii, or Owhyhee; with Remarks on the History, Traditions, Manners, Customs and Language of the Inhabitants of the Sandwich Islands*. The Advertiser Historical Series, No. 2. Hawaiian Gazette Co., Ltd., Honolulu.

Emerson, Joseph Swift
1882 Letter to W. D. Alexander, Surveyor General, May 21, 1882. Housed in the Hawaiʻi State Archives – DAGS 6, Box 1.

Emory, Kenneth Pike
1970 Inventory of Archaeological and Historical Sites in the Districts of Kona and Kaʻū and in Anaehoomalu, South Kohala, Island of Hawaiʻi. Departmental Report Series 70-12 ed. Vol. 61-1. Honolulu: Department of Anthropology, B.P. Bishop Museum.

Emory, Kenneth, J. Halley Cox, William Bonk, Yosihiko Sinoto, and Dorothy Barrère
1959 Natural and Cultural History Report on the Kalapana Extension of Hawaii National Park. Report prepared by the Department of Anthropology, Bernice P. Bishop Museum.

Foreign Testimony
1846-62 Testimony on land claims, chiefly in English, of both native and foreign-born residents made during the Māhele ʻĀina. The books of Foreign Testimony are preserved in the Hawaiʻi State Archives where they are accessible on microfilm, and can also be found online at http://www.avakonohiki.org/hawaii-land-documents.html or http://www.papakilodatabase.com.

Fornander, Abraham
1916-1920 *Fornander Collection of Hawaiian Antiquities and Folklore*. Memoirs of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History. Vols. IV (1916-1917), V (1918-1919), VI (1919-1920). Bishop Museum Press, Honolulu.

Giambelluca, T.W., M.A. Nullet and T.A. Schroeder
1986 Hawaiʻi Rainfall Atlas, Report R76, Hawaiʻi Division of Water and Land Development, Department of Land and Natural Resources, Honolulu.

Hammatt, H. H., D. W. Shidler, and D. Borthwick
1987 *Archaeological Survey and Test Excavations of a 15-acre Parcel, Kealakehe, Kona, Hawaiʻi*. Cultural Surveys Hawaiʻi. Submitted to Mauna Lani Resort. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

Handy, E. S. Craighill, Elizabeth Handy and Mary Kawena Pukui
1972 *Native Planters in Old Hawaii: Their Life, Lore and Environment*. Bernice P. Bishop Museum Bulletin 223, Bishop Museum Press, Honolulu.

Hawaiʻi Biodiversity and Mapping Program
2006 Geographic Information System data indicating the boundaries of the historic (traditional) *ahupua'a* land division boundaries for the Island of Hawaiʻi, provided by the Hawaiʻi Biodiversity and Mapping Program, University of Hawaiʻi at Mānoa, Honolulu, Hawaiʻi.

Hillebrand, William
1981 *Flora of the Hawaiian Islands: A Description of their Phanerograms and Vascular Cryptogams*. Lubrecht & Cramer, New York. Originally published in 1888.

ʻĪʻī, John Papa
1959 *Fragments of Hawaiian History*. Bishop Museum Press, Honolulu.

Indices of Awards
1929 *Indices of Awards Made by the Board of Land Commissioners to Quiet Land Titles in the Hawaiian Islands*. Territory of Hawaiʻi, Star Bulletin Press, Honolulu.

Jensen, P.M., Theresa Donham and Paul H. Rosendahl
1992 Archaeological Mitigation Program, Queen Lili'uokalani Trust Property, Phase I, Mitigation Plan for Data Recovery, Interim Site Preservation and Monitoring, Land of Keahuolū, N. Kona, Island of Hawai'i. Paul H. Rosendahl, Ph.D., Inc. Submitted to Belt Collins Hawai'i, Ltd. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

Kalākaua, David
1869 Letter dated July 8, 1869 to his sister Lili'uokalani describing the lands in the *ahupua'a* of Keahuolū. The original is housed in the Hawai'i State Archives.

Kamakau, Samuel Manaiakalani
1961 *Ruling Chiefs of Hawaii*. Kamehameha Schools Press, Honolulu.

Kelly, Marion
1983 *Nā Mala O Kona: Gardens of Kona. A History of Land Use in Kona, Hawai'i.* Departmental Report Series 83-2. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.

Ladefoged, T., G. Somer and M. Lane Hamasaki
1987 A Settlement Pattern Analysis of a Portion of Hawai'i Volcanoes National Park. *Western Archaeological and Conservation Center Publications in Anthropology*, No. 44.

Land Commission Awards
1836-55 The Land Commission Awards are individual *kuleana* claims awarded during the Māhele 'Āina. They are preserved in the Hawai'i State Archives, where they are accessible on microfilm, and can also be found online at http://www.avakonohiki.org/hawaii-land-documents.html or http://www.papakilodatabase.com.

Māhele Book
1848 The *Buke Kakau Paa no ka mahele aina i Hooholoia i waena o Kamehameha III a me Na Lii a me na Konohiki ana*, commonly referred to as the Māhele Book, records the division of lands that commenced on January 28, 1848 and ended on March 7, 1848 between Kamehameha III, the chiefs, and the konohiki. The Māhele Book is preserved in the Hawai'i State Archives where it is accessible on microfilm. It is also available online at http://www.avakonohiki.org/hawaii-land-documents.html.

Maly, Kepā
ms. Kaao Hooniua Puuwai no Ka-Miki (The Heart Stirring Story of Kamiki). Translation of a traditional account of people and places of the island of Hawai'i. Published in the Hawaiian language newspaper *Ka Hoku o Hawaii*; January 8, 1914 – December 6, 1917. A copy of this manuscript is on file in the library of the University of Hawai'i, Hilo.

1994 Historical Documentary Research, Appendix A in *Archaeological Inventory Survey, Sites 19762 and 19763, Queen Liliuokalani Trust, Keahuolu Lands, Land of Keahuolu, North Kona District, Island of Hawai'i*. Prepared by Paul H. Rosendahl, Ph.D., Inc. for the Queen Lili'uokalani Trust. Copies of this report are on file at the State Historic Preservation Division Libraries in Hilo and Kapolei.

Maly, Kepā and Onaona Maly
2007 *Makalawena: Ma Kekaha Wai 'Ole O Nā Kona, Hawai'i: A Collection of Traditions and Historical Accounts of Makalawena in the Kekaha Region of Kona, Hawai'i*. Kumu Pono Associates. Submitted to Belt Collins Hawai'i and the Kamehameha Schools.

Maly, Kepā and Paul H. Rosendahl
1993 *Burial Treatment Plan, Archaeological Mitigation Program Queen Lili'uokalani Trust Keahuolū Lands, Land of Keahuolū, North Kona District, Island of Hawai'i*. Paul H. Rosendahl, Ph.D., Inc. Submitted to Belt Collins Hawai'i, Ltd. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

Moore, K. and R. Bevaqua
1972 Archaeological Survey of Portions of Waikoloa, South Kohala District, Island of Hawai'i. *Departmental Report Series*, No. 72-4. Department of Anthropology, Bernice Pauahi Bishop Museum, Honolulu.

Nakamura, M., K. Sherry and L. Tamini
1998 "Foraging for Food? Prehistoric Pit Features at Pohakuloa, Hawaii." Published in the Rapa Nui Journal, Volume 12 (4) December 1998.

National Resources Conservation Service (NRCS)
1995 Soil Survey Geographic Data Base. This Geographic Information System data layer was prepared by the U. S. Department of Agriculture National Resources Conservation Service National Soil Survey Center. It is accessible through the Hawai'i State Office of Planning's Hawai'i Statewide GIS Program at http://planning.hawaii.gov/gis/download-gis-data/

Neller, Earl
1980 *An Archaeological Reconnaissance at the Old Kona Airport Beach Park, Keahuolū and Lanihau, Kona, Hawai'i*. Historic Sites Section, Division of State Parks, Department of Land & Natural Resources.

O'Hare, C. and S.T. Goodfellow
1994 *Phased Archaeological Mitigation Program, Kealakehe Planned Community, Phase II, Archaeological Data Recovery, Land of Kealakehe, North Kona District, Island of Hawai'i*. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

O'Hare, Constance R. and Paul H. Rosendahl
1993 *Archaeological Inventory Survey Queen Liliʻuokalani Trust 100-Acre KIS Expansion Site, Land of Keahuolū, North Kona District, Island of Hawaiʻi (TMK: 3-7-4-008:Por.2)*. Paul H. Rosendahl, Ph.D. Inc. Submitted to Belt Collins Hawaiʻi. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

PHRI (Paul H. Rosendahl, Ph.D. Inc.)
1993 Letter dated 23 November 1993 from Paul H. Rosendahl, Ph.D. Inc. to the Hawaiʻi State Historic Preservation Division requesting the amendment of the mitigation plan for the Queen Liliʻuokalani Trust lands in Keahuolū to include the 100 acre KIS Expansion Site parcel.

Pukui, Mary Kawena, Samuel Elbert
1971 *Hawaiian Dictionary*. University of Hawaiʻi Press. Honolulu.

Pukui, Mary Kawena, Samuel Elbert, and Esther Mookini
1976 *Place Names of Hawaii*. University of Hawaiʻi Press. Honolulu.

Reeve, Rowland B., Paul L. Cleghorn, and Elizabeth L. Kahahane
2015 in review *Archaeological Inventory Survey of Urban Phase I and Urban Phase II Parcels, Queen Liliʻuokalani Trust Lands, in Keahuolū, North Kona, Island of Hawaiʻi [TMK: (3) 7-4-020:009-015, 020, 022, 026]*. Pacify Legacy, Inc. Submitted to Queen Liliʻuokalani Trust.

Reeve, Rowland B., Paul L. Cleghorn, Tanya Lizama, and Reid Yamasato
In prep *Archaeological Inventory Survey of Urban Phase III Parcel, Queen Liliʻuokalani Trust Lands, in Keahuolū, North Kona, Island of Hawaiʻi [TMK: (3) 7-4-008:002]*. Pacify Legacy, Inc. Submitted to Queen Liliʻuokalani Trust.

Reeve, R. B., P. L. Cleghorn, J. D. McIntosh, K. M. Mooney, and E. L. Kahahane
2012 *Archaeological Inventory Survey of 628 Acres of Queen Liliʻuokalani Trust Lands in Keahuolū, North Kona, Island of Hawaiʻi [TMK: (3) 7-4-008:002]*. Pacify Legacy, Inc. Submitted to Queen Liliʻuokalani Trust. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

Reeve, Rowland, Paul Cleghorn, and Kimberly Mooney
2011 in review *Archaeological Data Recovery at the Southern End of the Proposed Ane Keohokālole Highway, Keahuolū, North Kona, Hawaiʻi, [TMK: (3) 7-4-20-010]*. Pacify Legacy, Inc. Submitted to County of Hawaiʻi. Report under review at the State Historic Preservation Division.

Reinecke, John E.
1930 Survey of Sites on West Hawaiʻi. Survey of Hawaiian Sites: From Kailua, Kona, to Kalāhuipuaʻa, Kohala. Unpublished typescript on file at the Department of Anthropology, B.P. Bishop Museum, 1930.

Rosendahl, Paul H.
1979 *Archaeological Reconnaissance Survey of Certain Liliʻuokalani Trust Properties, (TMK:3-7-4-008: Por. 1, Por. 2, Por. 12), Kailua-Kona, Island of Hawaiʻi*. Paul H. Rosendahl, Ph.D. Inc. Submitted to Belt Collins Hawaiʻi, Ltd. A copy of this report is on file at the State Historic Preservation Division libraries in Kapolei and Hilo.

Sato, H. H., W. Ikeda, R. Paeth, R. Smythe, M. M. Takehiro, Jr.
1973 *Soil Survey of the Island of Hawaiʻi*. U.S. Department of Agriculture Soil Conservation Service. Washington D.C. Government Printing Office.

Schilt, Rose
1984 *Subsistence and Conflict in Kona, Hawaiʻi: An archaeological Study of the Kuakini Highway Realignment Corridor*. Department of Anthropology, Bernice Pauahi Bishop Museum, Report 84-1.

Schmitt, Robert C.
1968 *Demographic Statistics of Hawaii: 1778-1965*. University of Hawaiʻi Press, Honolulu.

SHPD (Hawaiʻi State Historic Preservation Division)
1993 Letter dated 27 July 1993 (Log No. 8975, Doc. No. 9307RC36) from SHPD to Belt Collins Hawaii, Ltd. regarding data recovery and preservation recommendations for the 100 acre KIS Expansion Site.

Sinoto, Akihito
1975 *Archaeological Reconnaissance Survey of a Proposed Access Road Corridor at Keahuolū, Island of Hawaiʻi*. Ms. 060575. Department of Anthropology, B.P. Bishop Museum. Prepared for Belt, Collins & Associates.

Stokes, John
1991 *Heiau of the Island of Hawai'i: A Historic Survey of Native Hawaiian Temple Sites* (edited by Tom Dye). Bernice Pauahi Bishop Museum Bulletin in Anthropology 2. Bishop Museum Press, Honolulu.

Tangaro, Taupouri, Kuʻulei Higashi Kanahele and William Mahealani Pai.
2006 Kona Kai Ola Project: Kealakehe and Keahuolu Ahupuaʻa: Cultural Impact Assessment.

Walsh, Patrick O. and Hallett H. Hammatt
1995 *An Archaeological Inventory Survey of the New Queen Kaahumanu Highway Right-Of-Way Between Palani Road and Keāhole Airport*. Cultural Surveys Hawaiʻi. Submitted to R.M. Towell Corporation. A copy of this report is on file at the Hawaiʻi State Historic Preservation Division library in Kapolei.

Wong Smith, Helen
1990 Historical Documentary Research. In Donham Archaeological Inventory Survey, Queen Lili'uokalani Trust Property: Land of Keahuolū, North Kona District, Island of Hawai'i. Paul H. Rosendahl, Inc. On file at the State Historic Preservation Division Library in Kapolei, O'ahu.

Maps

Awana, T. Y.
1952 Hawaii Territorial Survey, T. Y. Awana Surveyor, Kailua Section, North Kona, Hawaii, Surveyed and Mapped by J. S. Emerson, Traced from Reg. Map 1280 by Herman K. Aki – Aug. 1952. A copy of this map is on file at the Hawaii State Survey Office, Registered Map No. 1280.

Brown, J. F.
1875 "Ahupuaa Keahuolu in N. Kona Hawaii Area 4071 Acres J. F. Brown Sur. 1875." A copy of this map is on file at the Hawaii State Survey Office, Register No. J12, Drawer 4, Number 2.

Emerson, Joseph Swift
1880s "Kona Hawaii, Kailua Section." A copy of this map is on file at the Hawaii State Survey Office. Registered Map No. 1443.

United State Geological Survey
1924a "Keahole Point Quad." United State Geological Survey topographic map for 1924.

1924b "Kailua Quad." United State Geological Survey topographic map for 1924.

Wolfe, E. W. and J. Morris
1996 Geologic Map of the Island of Hawai'i. United States Geological Service Miscellaneous Investigations Series. Department of the Interior, Washington, D.C.

APPENDIX A

Site Attributes

SITE ATTRIBUTES

SIHP No.	Feature	Site / Feature Type	Artifacts	Secondary Artifact	Midden	Human Skeletal Remains	Condition*	Possible Age	Possible Function
50-10-27-18502		Modified Depression	Modern	None Observed	None Observed	None Observed	Fair	Modern	Habitation
50-10-27-18508		Modified Overhang	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Habitation
50-10-27-18509	A	Stone Mound	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Marker
	B	Filled Depression	None Observed	None Observed	None Observed	None Observed	Fair	Natural	Uncertain
	C	Stone Mound	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Marker
	D	Lava Excavation	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Agriculture
50-10-27-18511	A	Modified Overhang	Modern	None Observed	None Observed	None Observed	Fair	Pre-Contact	Habitation
	B	Lava Excavation	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Agriculture
	C	Modified Lava Tube	None Observed	None Observed	None Observed	Present	Fair	Pre-Contact	Burial
	D	Lava Excavation	Traditional	None Observed	None Observed	None Observed	Fair	Pre-Contact	Quarry
	E	Lava Excavation	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Quarry
50-10-27-30207		Lava Excavation	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Uncertain
50-10-27-30208		Stone Mound	None Observed	None Observed	None Observed	None Observed	Poor	Pre-Contact	Marker
50-10-27-30209		Enclosure	None Observed	None Observed	None Observed	None Observed	Poor	Pre-Contact	Habitation
50-10-27-30210	A	Modified Overhang	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Storage
	B	Lava Excavation	None Observed	None Observed	None Observed	None Observed	Good	Pre-Contact	Uncertain
	C	C-shaped Wall	None Observed	None Observed	None Observed	None Observed	Poor	Pre-Contact	Habitation
	D	Enclosure	None Observed	None Observed	None Observed	None Observed	Poor	Pre-Contact	Habitation
50-10-27-30211		Petroglyph	None Observed	None Observed	None Observed	None Observed	Fair	Historic	Communication
50-10-27-30212		C-shaped Alignment	None Observed	None Observed	None Observed	None Observed	Fair	Pre-Contact	Habitation
50-10-27-30287		Trail	None Observed	None Observed	None Observed	None Observed	Fair	Historic	Trsavel

*Condition = Destroyed, Poor, Fair, Good, Excellent

APPENDIX B

Site Coordinates

Pacific Legacy Historic Preservation

SITE COORDINATES

SIHP No.	Feature	Site / Feature Type	Condition*	Possible Age	Possible Function	GPS Point Location	Easting	Northing
50-10-27-18502		Modified Depression	Fair	Modern	Habitation	Southwest Corner	184849.142	2174806.068
50-10-27-18508		Modified Overhang	Fair	Pre-Contact	Habitation	Northwest End of Wall	184753.346	2175014.539
50-10-27-18509	A	Stone Mound	Fair	Pre-Contact	Marker	Center	184773.765	2175149.119
	B	Filled Depression	Fair	Natural	None	East End	184780.995	2175155.698
	C	Stone Mound	Fair	Pre-Contact	Marker	Center	184784.738	2175159.342
	D	Lava Excavation	Fair	Pre-Contact	Agriculture	Center	184775.772	2175163.723
50-10-27-18511	A	Modified Overhang	Fair	Pre-Contact	Habitation	Center	184984.34	2175124.083
	B	Lava Excavation	Fair	Pre-Contact	Agriculture	Center	185007.037	2175134.106
	C	Modified Lava Tube	Fair	Pre-Contact	Burial	Center of Entrance	185008.977	2175142.708
	D	Lava Excavation	Fair	Pre-Contact	Quarry	Center	185027.372	2175135.174
	E	Lava Excavation	Fair	Pre-Contact	Quarry	Center	185019.291	2175138.029
50-10-27-30207		Lava Excavation	Fair	Pre-Contact	Uncertain	Center	184936.551	2174756.684
50-10-27-30208		Stone Mound	Poor	Pre-Contact	Marker	Center	184970.855	2174805.903
50-10-27-30209		Enclosure	Poor	Pre-Contact	Habitation	Northwest Corner	184851.449	2175035.333
50-10-27-30210	A	Modified Overhang	Fair	Pre-Contact	Storage	Southwest End	184763.547	2175027.14
	B	Lava Excavation	Good	Pre-Contact	Uncertain	Center	184765.409	2175016.333
	C	C-shaped Wall	Poor	Pre-Contact	Habitation	Northwest End	184765.558	2175014.266
	D	Enclosure	Poor	Pre-Contact	Habitation	East Corner	184770.111	2175012.115
50-10-27-30211		Petroglyph	Fair	Historic	Communication	Center	185009.069	2174822.964
50-10-27-30212		C-shaped Alignment	Fair	Pre-Contact	Habitation	Southwest End	184970.569	2174768.554
50-10-27-30287		Trail	Fair	Historic	Travel	West End	184848.673	2174928.849

*Condition = Destroyed, Poor, Fair, Good, Excellent

SHPD ACCEPTANCE LETTER FOR SUPPLEMENTAL ARCHAEOLOGICAL INVENTORY SURVEY, DATED AUGUST 11, 2015

APPENDIX

D-1

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555

August 11, 2015

Dr. Paul L. Cleghorn, Senior Archaeologist
Pacific Basin Division, Pacific Legacy, Inc.
30 Aulike Street, Suite 301
Kailua, Hawaii 96734

LOG NO: 2015.02142
DOC NO: 1508MV17
Archaeology

Subject: **HRS Chapter 6E-42 Historic Preservation Review -**
Supplemental Archaeological Inventory Survey of the 110 Acre
Queen Liliuokalani Trust Kona Commons Parcel
Keahuolu Ahupua'a, North Nona District, Island of Hawai'i
TMK: (3) 7-4-008:002 Por; (3) 7-4-025:001, :002, :003, :005, :007, :010, through :022

Thank you for the opportunity to review the revised draft report titled: *Supplemental Archaeological Inventory Survey of the 110 Acre Kona Commons Parcel of Queen Liliuokalani Trust Lands in Keahuolu, North Kona, Island of Hawai'i TMK: (3) 7-4-008:002 Por; (3) 7-4-025:001, :002, :003, :005, :007, :010, through :022* (J. McIntosh, T. Lizama, R. Reeve, J. Cleghorn and P. Cleghorn May 2015). This document was received by our office on June 1, 2015. This survey was undertaken in order to supplement the previous archaeological survey undertaken Rosendahl (1992). The survey utilized a 100% pedestrian survey with transects spaced at 10-15 meters. In addition, excavation in the form of test borings was conducted in five locations. The archaeological survey documented a total of 11 archaeological sites comprised of 20 component features in the project area. Four of these historic properties a modified depression (SIHP 50-10-27-18502), a modified overhang (SIHP 18508), a complex (SIHP 18509), and a complex that contains a burial feature (SIHP 18511) were previously recorded during the Rosendahl (1992) archaeological survey. However, it is important to note that previously unrecorded features of SIHP 18509 (feature D) and 18511 (features D and E) were newly identified during the current supplemental inventory survey. In addition to these features, the supplemental AIS identified and recorded 6 previously unrecorded historic properties. The newly recorded historic properties include: a lava excavation (SIHP 30207), a stone mound (SIHP 30208), an enclosure (SIHP 30209), a complex (SIHP 30210), a petroglyph (SIHP 30211), a C-shaped alignment (SIHP 30212) and a trail (SIHP 30287). With the exception of the burial feature (SIHP 18511fea. C) that is assessed as significant under criteria D and E, all of these sites have been assessed as significant under criteria D only. The report indicates that SIHP 18511fea. C and SIHP 30287 have been recommended for preservation, SIHP 30210 fea. B has been recommended for Data Recovery and the remaining sites are recommended for no further work. SHPD agrees with the significance assessments and treatment recommendations presented in this report. We believe that the entire trail (SIHP 30287) should be preserved until it can be confirmed with Na Ala Hele whether or not this trail is eligible for inclusion as a state trail. However it is possible that the trail may be breached in accordance with an approved preservation plan. The changes that were made to the report are the result of the SHPD review of a previous draft (Log No. 2015.04866, Doc No. 1503MV20). The report has been revised in response to the SHPD review of a previous draft of this report (Log 2012.3111, Doc. 1210MV40). The revisions and explanations have adequately addressed our concerns. This report meets the requirements of Hawaii Administrative Rule (HAR) §13-276 and is accepted. Please send one hardcopy of the document, clearly marked **FINAL**, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office. Please contact Mike Vitousek at (808) 692-8029 or Michael.Vitousek@hawaii.gov for any questions or concerns relating to this letter.

Aloha,

Mike Vitousek

Michael Vitousek,
Lead Archaeologist Hawaii Island Section
Historic Preservation Division