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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

CDUA: HA-3847

SEP 25 2019

TO: Scott Glenn, Director
Office of Environmental Quality Control

FROM: Suzanne D. Case, Chairperson
Department of Land and Natural Resources

SUBJECT: Final Environmental Assessment (EA) for Conservation District Use Application (CDUA) for a Proposed Single-Family Residence, Subsistence Agriculture, and Landscaping Located at Pōpōkī, Puna, Hawai'i, Tax Map Key: (3) 1-5-010:031

The Department of Land and Natural Resources has reviewed the final EA for the subject project and has determined a Finding of No Significant Impact (FONSI). Please be advised, however, that this finding does not constitute approval of the proposal.

The draft EA was published in the July 23, 2019 edition of the Environmental Notice. Comments on the draft EA were sought from relevant agencies and the public, and were included in the final EA. The final EA has been prepared pursuant to Chapter 343, Hawai'i Revised Statutes and Chapter 11-200, Hawai'i Administrative Rules. Please publish this notice in OEQC's upcoming October 8, 2019 edition of the Environmental Notice.

We have enclosed one (1) hard copy of the final EA and the OEQC publication form, as well as one (1) CD with a pdf file of the Final EA and the OEQC publication form in word document format for publication purposes.

Please contact Tiger Mills of our Office of Conservation and Coastal Lands at 587-0382 should you have any questions.

Attachments: *FEA, OEQC Pub Form, 1 CD*

20-083

APPLICANT
PUBLICATION FORM

Project Name:	Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī
Project Short Name:	Moore Residence/Agroforestry at Pōpōkī
HRS §343-5 Trigger(s):	Use of Land in Conservation District
Island(s):	Hawai'i
Judicial District(s):	Puna
TMK(s):	1-5-010: 031
Permit(s)/Approval(s):	County of Hawai'i: Special Management Area Permit or Exemption Plan Approval and Grubbing, Grading, and Building Permits State of Hawai'i: Conservation District Use Permit Wastewater System Approval Water Well Permit
Approving Agency:	Hawai'i State Department of Land and Natural Resources
Contact Name, Email, Telephone, Address	K. Tiger Mills, Kimberly.mills@hawaii.gov, ph. (808) 587-0382 DLNR- Office of Conservation and Coastal Lands 1151 Punchbowl Street, Room 131 Honolulu HI 96813
Applicant:	
Contact Name, Email, Telephone, Address	Mike Moore (C/O James Leonard 808-896-3459; jmleonard.mac.com) 6215 Kanan Dume Road, Suite M1079 Malibu, CA 90265
Consultant:	
Contact Name, Email, Telephone, Address	Ron Terry, Geometrician Associates LLC 808-969-7090 rterry@hawaii.rr.com P.O. Box 396 Hilo, Hawai'i 96721

Status (select one)	**Submittal Requirements**
__ DEA-AFNSI	Submit 1) the approving agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEA, and 4) a searchable PDF of the DEA; a 30-day comment period follows from the date of publication in the Notice.
_x FEA-FONSI	Submit 1) the approving agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; no comment period follows from publication in the Notice.
____ FEA-EISPN	Submit 1) the approving agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; a 30-day comment period follows from the date of publication in the Notice.
____ Act 172-12 EISPN ("Direct to EIS")	Submit 1) the approving agency notice of determination letter on agency letterhead and 2) this completed OEQC publication form as a Word file; no EA is required and a 30-day comment period follows from the date of publication in the Notice.
____ DEIS	Submit 1) a transmittal letter to the OEQC and to the approving agency, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEIS, 4) a searchable PDF of the DEIS, and 5) a searchable PDF of the distribution list; a 45-day comment period follows from the date of publication in the Notice.
____ FEIS	Submit 1) a transmittal letter to the OEQC and to the approving agency, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEIS, 4) a searchable PDF of the FEIS, and 5) a searchable PDF of the distribution list; no comment period follows from publication in the Notice.

____ FEIS Acceptance Determination	The approving agency simultaneously transmits to both the OEQC and the applicant a letter of its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS; no comment period ensues upon publication in the Notice.
____ FEIS Statutory Acceptance	The approving agency simultaneously transmits to both the OEQC and the applicant a notice that it did not make a timely determination on the acceptance or nonacceptance of the applicant's FEIS under Section 343-5(c), HRS, and therefore the applicant's FEIS is deemed accepted as a matter of law.
____ Supplemental EIS Determination	The approving agency simultaneously transmits its notice to both the applicant and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is or is not required; no EA is required and no comment period ensues upon publication in the Notice.
____ Withdrawal	Identify the specific document(s) to withdraw and explain in the project summary section.
____ Other	Contact the OEQC if your action is not one of the above items.

Project Summary

Provide a description of the proposed action and purpose and need in 200 words or less.

Mike Moore plans to build a residence and conduct agroforestry using Polynesian and other crops on his 8.75-acre property in Puna. The a 1,950-square foot (sf), 2-bedroom 2-bath, single-story structure would have solar photovoltaic electricity, a water well, and an IWS. A 765-sf outbuilding will house farm equipment, tools and supplies and will shelter sheep and goats that will be tethered and/or fenced and utilized in vegetation maintenance. The vegetation was disturbed long ago and now is almost exclusively non-native plants. A strip of native shoreline vegetation will be left intact. Landclearing over less than an acre would produce short-term impacts to noise, air and water quality, and scenery, mitigated by Best Management Practices. No threatened or endangered plant species are present, and ilmpacts to the islandwide-ranging endangered Hawaiian hoary bat and Hawaiian hawk will be avoided through vegetation removal timing. An archaeological survey identified one agricultural site with walls, mounds and other features. Although not expected to require preservation, the features would be undisturbed or undergo agricultural re-use. No cultural sites or practices would be affected. The shoreline is used by local residents to fish and gather; Mr. Moore understands and supports the right to traverse and utilize the shoreline area.

Final Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

October 2019

TMK (3rd): 1-5-010: 031
Pōpōkī, Puna, County of Hawai‘i, State of Hawai‘i

APPLICANT:

Mike Moore
6215 Kanan Dume Road, Suite M1079
Malibu, CA 90265

DETERMINING AGENCY:

State of Hawai‘i
Department of Land and Natural Resources
Office of Conservation and Coastal Lands
1151 Punchbowl Street, Room 131
Honolulu, Hawai‘i 96813

CONSULTANT:

Geometrician Associates LLC
P.O. Box 396
Hilo, Hawai‘i 96721

Final Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

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1151 Punchbowl Street, Room 131
Honolulu, Hawai‘i 96813

CONSULTANT:

Geometrician Associates LLC
P.O. Box 396
Hilo, Hawai‘i 96721

CLASS OF ACTION:

Use of Land in Conservation District

This document is prepared pursuant to:
The Hawai‘i Environmental Protection Act,
Chapter 343, Hawai‘i Revised Statutes (HRS), and
Title 11, Chapter 200, Hawai‘i Department of Health Administrative Rules (HAR)

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APPENDIX 5 Coastal Erosion Study

SUMMARY OF PROJECT, ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Mike Moore (the applicant) seeks a Conservation District Use Permit (CDUP) to build a single-family residence and conduct agroforestry on his 8.75-acre property located *makai* of the Government Beach Road in the Conservation District between the Hawaiian Paradise Park and Hawaiian Shores subdivisions, in the Pōpōkī Ahupua‘a in the Lower Puna area of the Island of Hawai‘i.

The plan for the home consists of a 1,950-square foot (sf), 2-bedroom 2-bath, single-story structure with a loft and a covered lanai and surrounding walkway. The home will feature solar photovoltaic electricity, a water well, and an individual wastewater system meeting or exceeding all regulatory requirements. Supporting the agroforestry will be a 765-sf outbuilding that will be used to house farm equipment, tools and supplies, with a 15-foot wide eave on the back side to shelter sheep and goats that will be tethered and/or fenced and utilized in vegetation maintenance. In the area behind the home, Mr. Moore plans over time to remove invasive trees with chain saws and ecologically managed goat browsing, replacing these trees with crops typical of Polynesian agroforestry, such as ulu, banana, taro and coconut, as well as avocado, citrus and other crops introduced to Hawai‘i and adopted by Hawaiian farmers.

The vegetation of the property was apparently disturbed many decades ago and consists almost exclusively of non-native trees, shrubs, herbs, grasses and ferns. There is a narrow strip near the shoreline with naupaka and other native strand plants mixed with non-natives, and native puhala trees are clustered throughout the property. The locations of structures and the driveway have been planned to minimize disturbance of native vegetation. The proposed home site is separated from the Government Beach Road by 750 feet and would not be visible. With a proposed wide setback from the sea cliff to avoid coastal hazard and salt spray, and subtly placed amid vegetation, the home would not intrude upon the shoreline area. Mr. Moore plans to trim and/or remove some ironwood and other non-native trees to provide a sight line to the sea while preserving native vegetation in the shoreline area. As with most areas in Puna, the shoreline is used occasionally by local residents to fish and gather. Mr. Moore understands and supports the right to traverse and utilize the shoreline area.

Landclearing and construction activities would occur over less than an acre, with very minor short-term impacts to noise, air and water quality and scenery. These would be mitigated by Best Management Practices associated with the CDUP, grading permit and a Farm Management Plan. The applicant will ensure that all earthwork and grading conforms to applicable laws, regulations and standards. The site has been surveyed for threatened and endangered plants, and none are present. Impacts to the island wide-ranging endangered Hawaiian hoary bat and Hawaiian hawk will be avoided through timing of vegetation removal and/or hawk nest survey. No cultural sites or practices would be affected. An archaeological inventory survey identified several walls, mounds and other agricultural features. Although not expected to require preservation, the features would remain mostly undisturbed or undergo agricultural re-use. In the unlikely event that additional undocumented archaeological resources, including shell, bones, midden deposits, lava tubes, or similar finds, are encountered during construction within the project site, work in the immediate area of the discovery will be halted and the State Historic Preservation Division will be contacted to determine the appropriate actions.

PART 1: PROJECT DESCRIPTION AND E.A. PROCESS

1.1 Project Description and Location

Mike Moore (the applicant) seeks a Conservation District Use Permit (CDUP) to build a single-family residence and practice agroforestry on his 8.75-acre property located *makai* of the Government Beach Road in the Conservation District between the Hawaiian Paradise Park and Hawaiian Shores subdivisions, in the Pōpōkī ahupua‘a in the Lower Puna area of the Island of Hawai‘i.

The plan for the home consists of a 1,950-square foot (sf), 2-bedroom 2-bath, single-story structure with a loft, a 1,400-sf covered lanai and a 756-sf covered walkway area surrounding the structure. The home will feature solar photovoltaic electricity, a water well with a water tank and pump house, and an individual wastewater system meeting or exceeding all regulatory requirements. The total developed area per Conservation District Rules is 4,301 sf, which includes the combined areas for the residence, water tank, and pump house. The existing driveway that currently extends to proposed house site would be widened to 15 feet and improved with gravel but left unpaved. The driveway would also be expanded to include an improved but unpaved parking and turn-around area near the residence.

In addition to residential uses, Mr. Moore plans to conduct agroforestry with crops typical of Polynesian agroforestry, such as ulu, banana, taro and coconut, as well as avocado, citrus and other crops introduced to Hawai‘i and adopted by Hawaiian farmers, on a portion of the property, the details of which are discussed in the section below. The vegetation of the property was apparently disturbed many decades ago and consists almost exclusively of non-native trees, shrubs, herbs, grasses and ferns. There is a narrow strip near the shoreline with naupaka and other native strand plants mixed with non-natives. There are also native puhala trees clustered throughout the property. The location of structures has been planned to minimize disturbance of native vegetation. Landclearing and construction activities would occur over less than an acre.

The site has been surveyed for threatened and endangered plants, and none are present. An archaeological inventory survey identified several walls, mounds and other agricultural features. Although not expected to require preservation, the features would remain mostly undisturbed or be re-utilized in agroforestry.

The proposed home site is separated from the Government Beach Road by 750 feet and would not be visible from the road. With a proposed wide setback from the sea cliff to avoid coastal hazard and salt spray, and subtly placed amid vegetation, the home would not intrude upon the shoreline area. Mr. Moore plans to trim and/or remove some ironwood (*Casuarina equisetifolia*, an invasive tree) and other non-native trees to provide a sight line to the sea (as depicted in the Landscape Plan Sheet of Figure 3) but will preserve the native vegetation in the shoreline area. As with most areas in Puna, the shoreline is used occasionally by local residents to fish and gather. Mr. Moore understands and supports the right to traverse and utilize the shoreline area.

Figure 1 Project Location Map

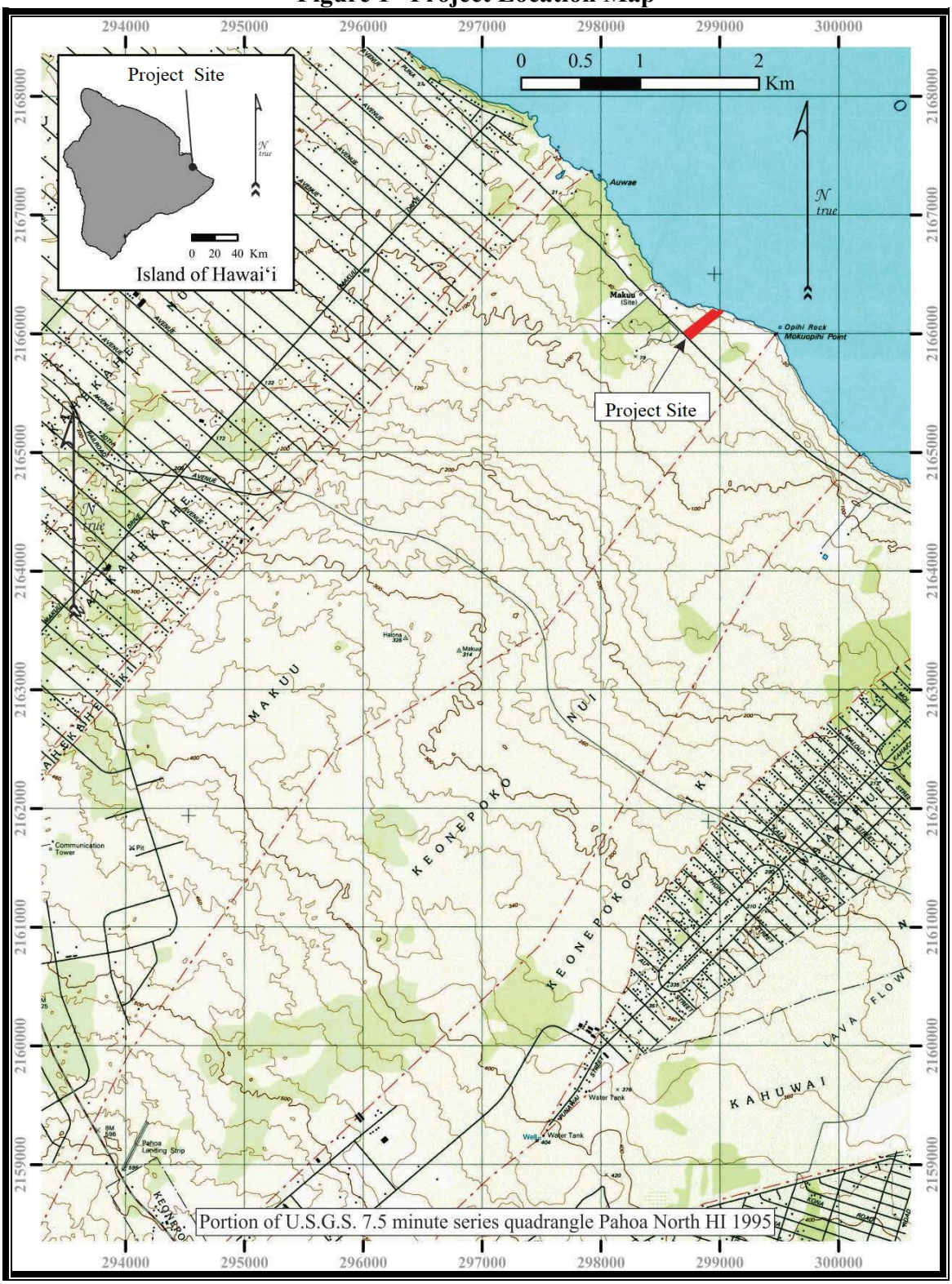
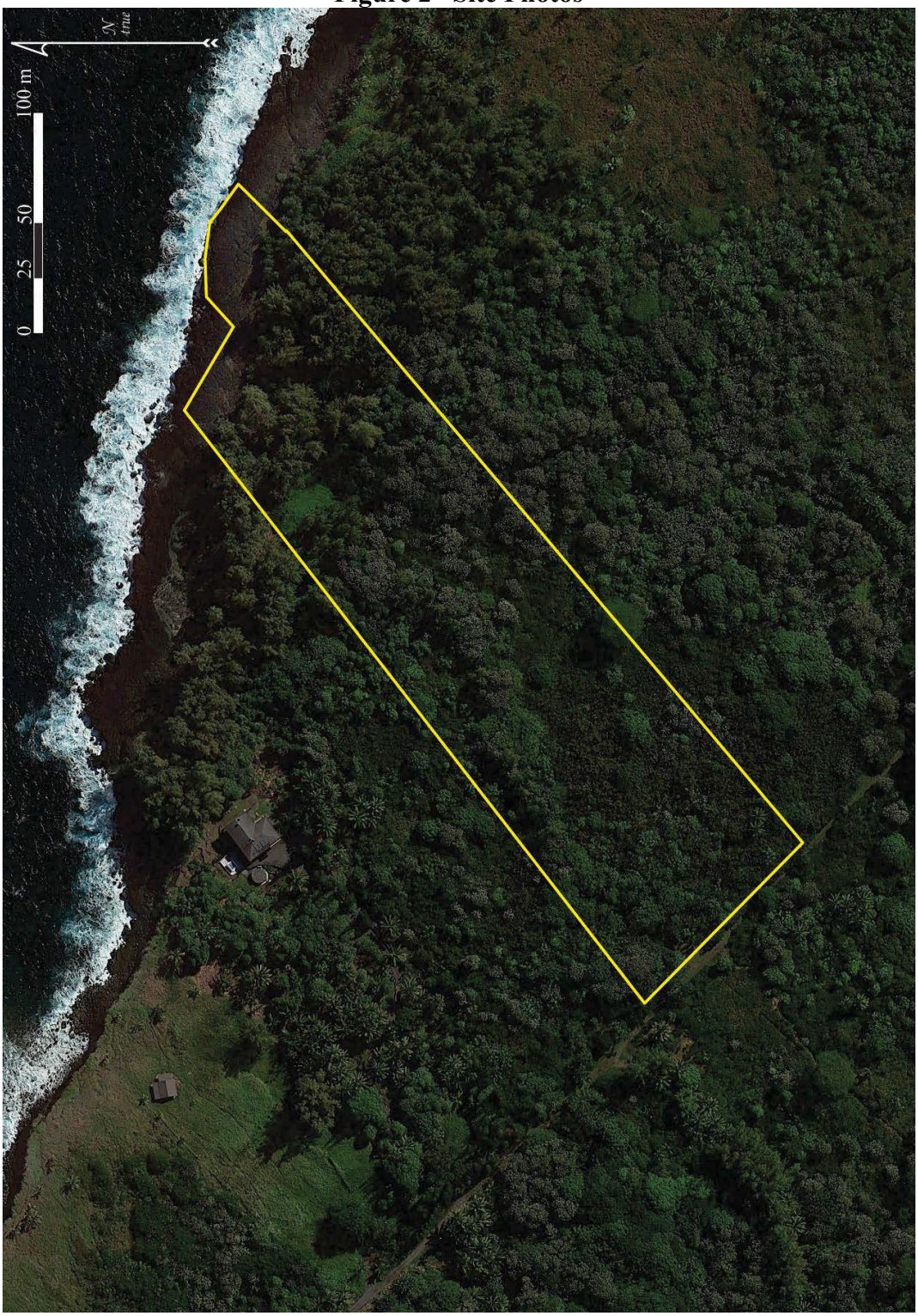


Figure 2 Site Photos



2a, Above: Aerial Image with Property Boundary from Google Earth ©

Figure 2. Site Photos

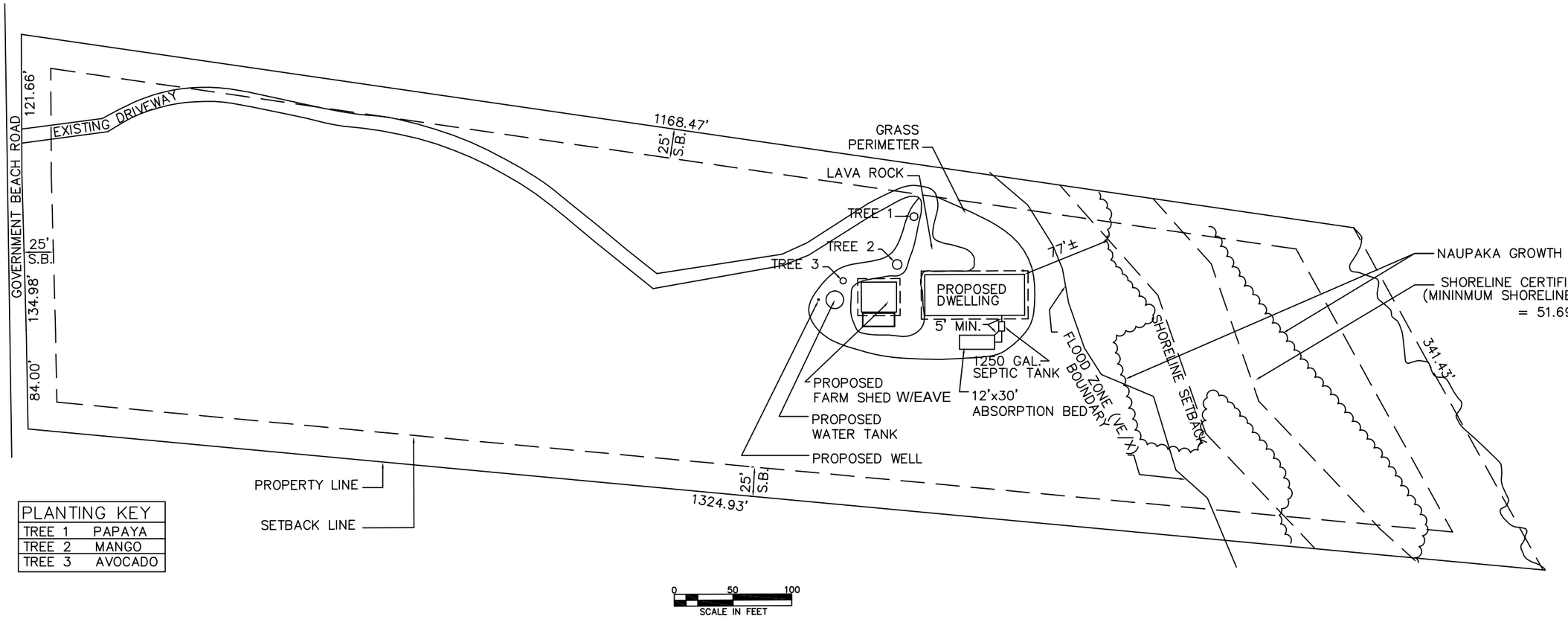
2b, Above: *Makai* end of driveway. 2c, Below: Pahoehoe shelf

Figure 2. Site Photos

2d, Above: Typical closed canopy non-native forest. 2e, Below: Hala cluster in interior

Figure 2. Site Photos

2f, Above: View *mauka* from proposed house site . 2f, Below: View *makai* from proposed house site.



PLANTING KEY	
TREE 1	PAPAYA
TREE 2	MANGO
TREE 3	AVOCADO

REVISIONS

DESCRIPTION	DATE

A NEW RESIDENCE FOR:

EQUITY TRUST CO FBO
M. S. MOORE, IRA
TMK. (3) 1-5-010 : 031

CONTENTS:

DATE: DECEMBER 2017

DRAWN BY: **Cole Custom Drafting**

SHEET NO.

DR. WILLIAM C. FOULK
LICENSED PROFESSIONAL ARCHITECT
No. AR9859
HAWAII U.S.A.

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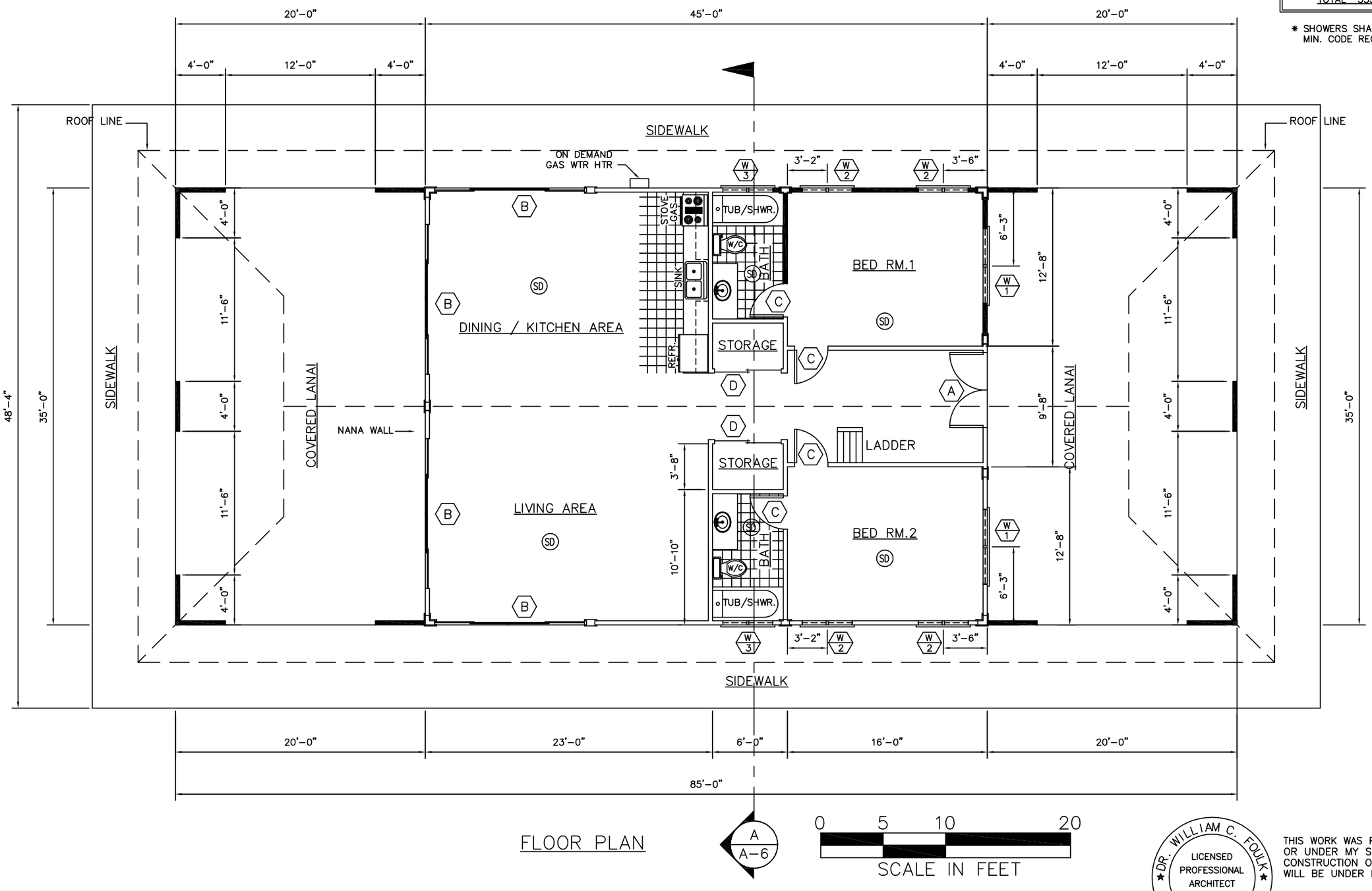
EXPIRES: 4/30/2020

RESIDENCE AREA TABULATION		
MAIN LIVING	1575	SQ.FT.
COVERED LANAI	1400	SQ.FT.
LOFT	375	SQ.FT.
TOTAL 3350 SQ.FT.		

* SHOWERS SHALL MEET MIN. CODE REQUIREMENTS



FLOOR PLAN

A / A-6

0 5 10 20

SCALE IN FEET

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EXPIRES: 4/30/2020

REVISIONS

DESCRIPTION	DATE

A NEW RESIDENCE FOR:

EQUITY TRUST CO FBO
M. S. MOORE, IRA
TMK. (3) 1-5-010 : 031

CONTENTS: FLOOR PLAN

DATE: DECEMBER 2017

DRAWN BY: LATAI LOA

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808/935-6307

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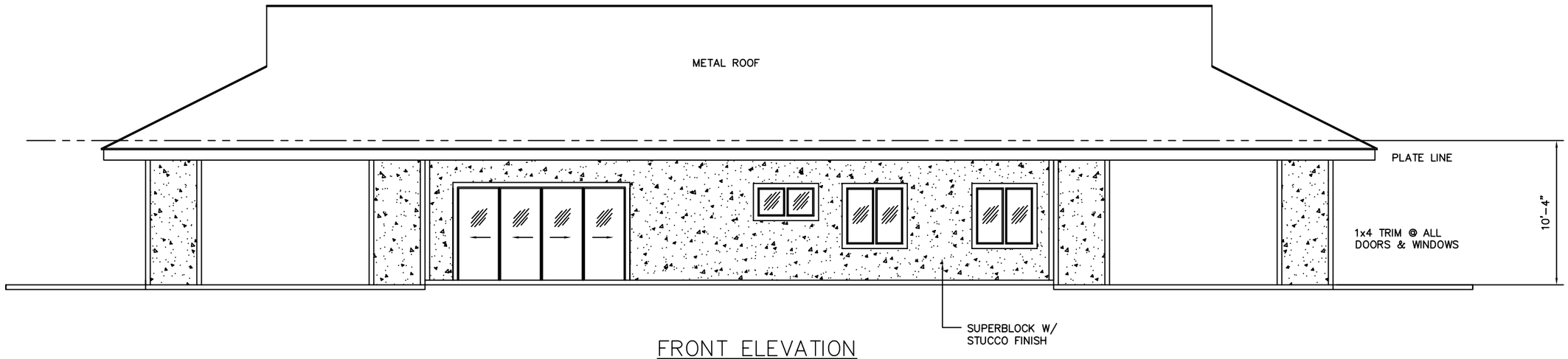
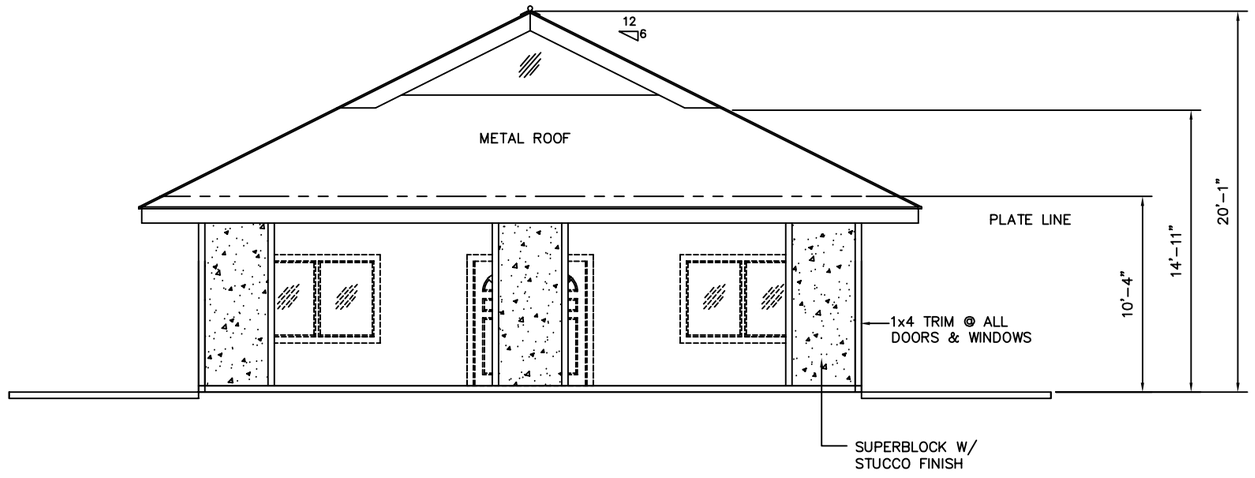
A-1



FRONT ELEVATION

SC: 1/8" = 1'



RIGHT ELEVATION

SC: 1/8" = 1'

SC: 1/8" = 1'

DR. WILLIAM C. FOULK
LICENSED
PROFESSIONAL
ARCHITECT
No. AR9859
HAWAII, U.S.A.

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EXPIRES: 4/30/2020

REVISIONS

DESCRIPTION	DATE

A NEW RESIDENCE FOR:

EQUITY TRUST CO FBO
M. S. MOORE, IRA
TMK. (3) 1-5-010 : 031

CONTENTS: FRONT ELEVATION
RIGHT ELEVATION

DATE: DECEMBER 2017

DRAWN BY: LATAI LOA

808/935-6307
Cole Custom Drafting

SHEET NO.

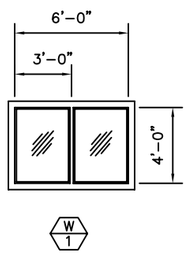
A—8

NOTE: –

1– WINDOW SIZES INDICATED ARE APPROXIMATE ONLY, AND MUST BE CONFIRMED ON SITE TO SUIT THE SELECTED MANUFACTURE'S STANDARD UNITS SIZES.
2– CO–ORDINATE EXACT WINDOW AND EXTERIOR DOOR LOCATIONS. MAINTAIN SPACING BETWEEN WINDOW, DOORS AND CORNERS TO ALLOW FOR EXTERIOR AND INTERIOR TRIMS.
3– ALL ANGLED WALLS TO BE 45 DEGREES UNLESS NOTED OTHERWISE.
4– BUILDER SHALL SATISFY HIMSELF THAT ALL DIMENSIONS, DATUM, AND INFORMATION SHOWN ARE CORRECT. VERIFY ALL DIMENSIONS ON SITE
5– CO–ORDINATE FLOOR FRAMING TO SUIT PLUMBING AND HEATING SYSTEMS
6– SEAL ALL PATIO / FOUNDATION WALL JOINTS WITH APPROVED SEALANT TO PREVENT MOISTURE AND INSECT PENETRATION.

CODE SEARCH – 2006 IBC HAWAII REVISED

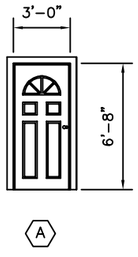
- FLOOR LIVE LOAD: ..... 40 psf
- ROOF LIVE LOAD: ..... 16 psf
- BASIC WIND SPEED: ..... 105 mph
- EFFECTIVE WIND SPEED: ..... 85 mph
- WIND EXPOSURE CATEGORY (ref. R301.2.1.4): ..... B
- HIGH WIND DESIGN CRITERIA (if applicable ref. 301.2.1.1): ..... Yes
- SEISMIC DESIGN CATEGORY (ref. Figure R301.2(2)): ..... E
- SEISMIC DESIGN CATEGORY PROVISIONS (where applicable ref. R301.2.2): ..... Yes
- NOTE EXTERIOR WALL LOCATION PER R302 (Table R302.1)
- GUARDS, WHERE REQUIRED FOR PORCHES, BALCONIES, RAMPS, OPEN SIDES OF STAIRS, OR RAISED FLOOR SURFACES GREATER THAN 30" ABOVE FLOOR OR GRADE, 34"–36" MIN. HEIGHT (ref. R312.1)



XO – SLIDERS

WINDOW SCHEDULE

SC: 1/8" = 1'

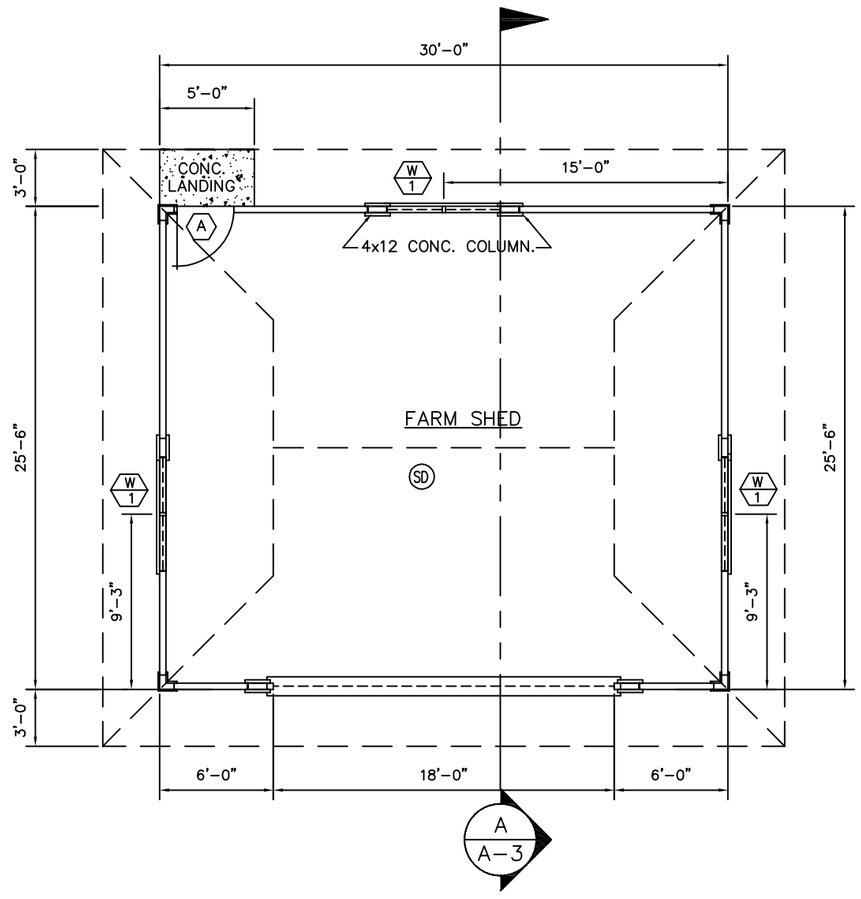


S.C. EXT DOOR.

DOOR SCHEDULE

SC: 1/8" = 1'

AREA TABULATION
BARN. 765 SQ.FT.
LANDING. 15 SQ.FT.
TOTAL..780. SQ.FT.



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DR. WILLIAM C. FOULK
LICENSED PROFESSIONAL ARCHITECT
No. AR9859
HAWAII, U.S.A.

EXPIRES: 4/30/2020

REVISIONS

DESCRIPTION	DATE

A NEW FARM SHED FOR:

EQUITY TRUST CO FBO
M. S. MOORE, IRA
TMK. (3) 1-5-010 : 031

CONTENTS:

FLOOR PLAN
DOOR SCHEDULE
WINDOW SCHEDULE
RESIDENTIAL DATA CODES

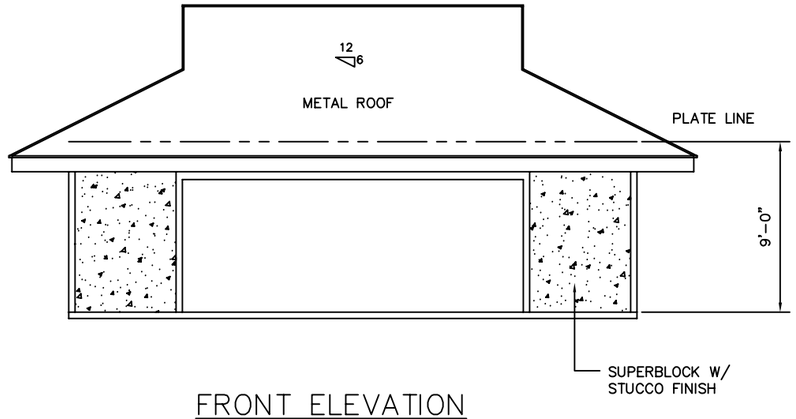
DATE: DECEMBER 2018

DRAWN BY: LATAI LOA

Cole Custom Drafting
808/935-6307

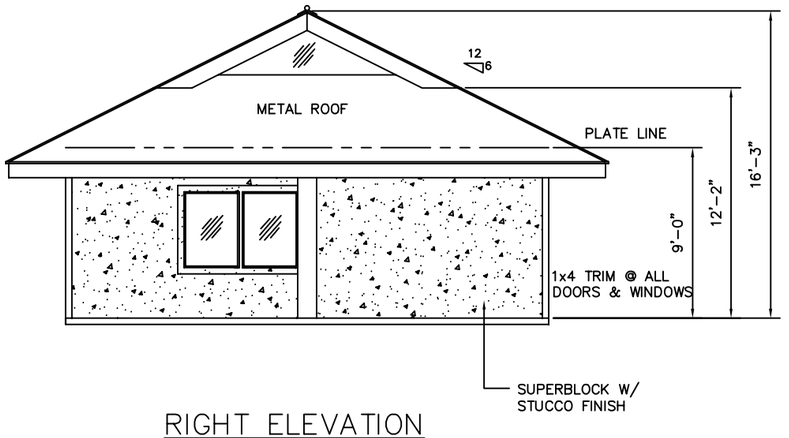
SHEET NO.

A–1



FRONT ELEVATION

SC: 1/8" = 1'



RIGHT ELEVATION

SC: 1/8" = 1'

SC: 1/8" = 1'

DR. WILLIAM C. FOULK
LICENSED
PROFESSIONAL
ARCHITECT
No. AR9859
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

EXPIRES: 4/30/2020

REVISIONS

DESCRIPTION	DATE

A NEW FARM SHED FOR:

EQUITY TRUST CO FBO
M. S. MOORE, IRA
TMK. (3) 1-5-010 : 031

CONTENTS: FRONT ELEVATION, RIGHT ELEVATION

DATE: DECEMBER 2018

DRAWN BY: LATAI LOA

Cole Custom Drafting
808/935-6307

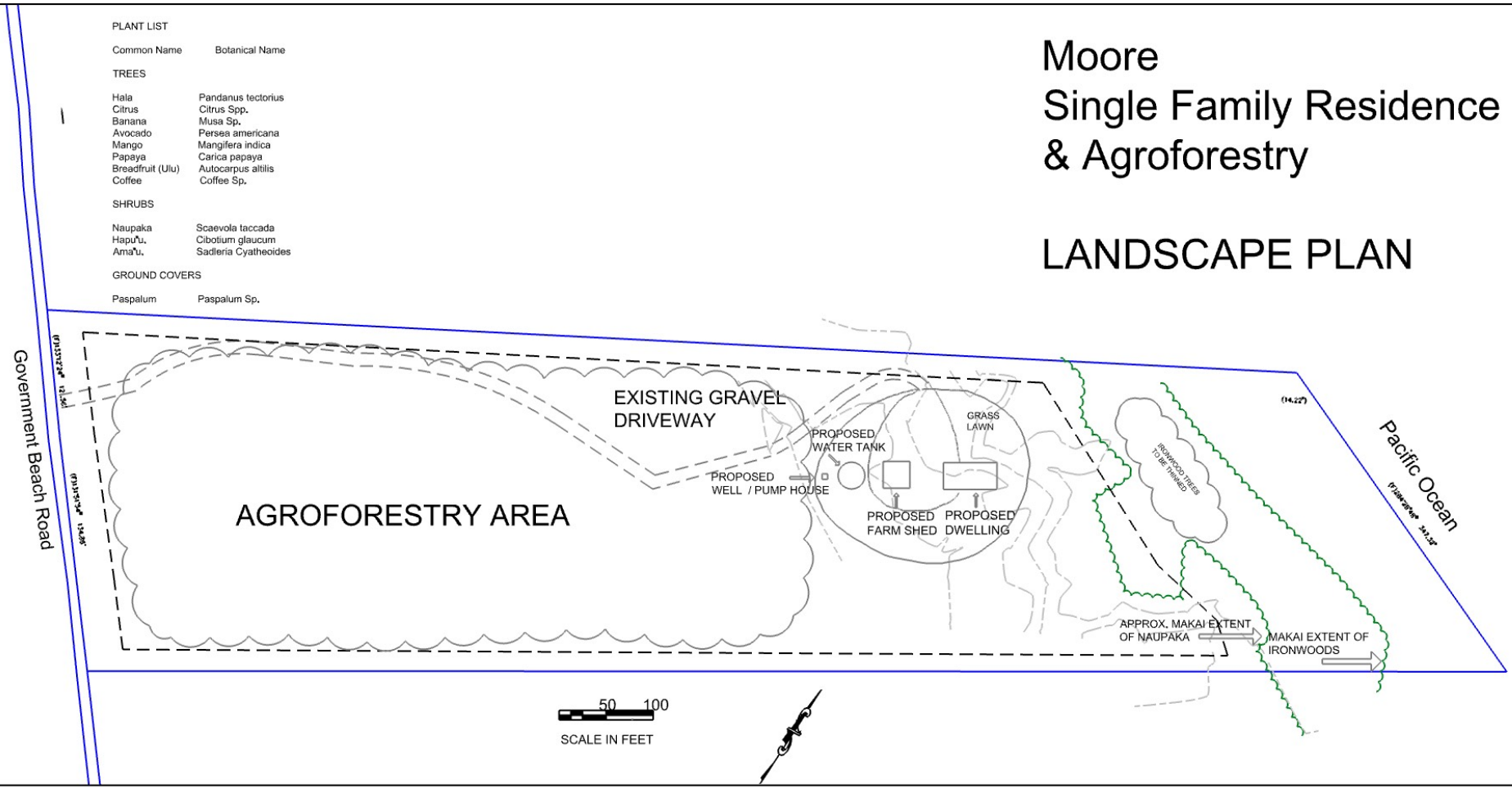
SHEET NO. A-5

Moore
Single Family Residence
& Agroforestry

LANDSCAPE PLAN

PLANT LIST

Common Name	Botanical Name
TREES	
Hala	Pandanus tectorius
Citrus	Citrus Spp.
Banana	Musa Sp.
Avocado	Persea americana
Mango	Mangifera indica
Papaya	Carica papaya
Breadfruit (Ulu)	Autocarpus altilis
Coffee	Coffee Sp.
SHRUBS	
Naupaka	Scaevola taccada
Hapu'u.	Cibotium glaucum
Ama'u.	Sadleria Cyatheoides
GROUND COVERS	
Paspalum	Paspalum Sp.



Agroforestry Practices

In addition to residential uses, Mr. Moore plans to implement agroforestry practices on a portion of the property. Supporting the operation will be a 765-sf outbuilding be used to house farm equipment, tools and supplies, with eaves on the back side to shelter sheep and goats that will be tethered and/or fenced and utilized in vegetation maintenance. Goats are relatively low-maintenance farm animals, and the owner is familiar and capable of their care. The goats will be cared for in accordance with normal husbandry practices and will be fed supplemental feed if required and provided veterinary care as appropriate.

Agroforestry is a modern term used to describe a practice that was integral to traditional Hawaiian farming. It refers simply to the practice of growing trees combined with crops and/or animals in a way that benefits from their interaction. Those farms where agroforestry is applied are sometimes referred to as "food-forests" where trees are grown together in a multi-layered forest-like planting that includes annual crops that are grown together with small livestock. Often, in the traditional Hawaiian context, ornamental, medicinal, and utilitarian plants, such as hala, kukui, coconut, ti, noni, and lei flowers, were included in the mix.

In a more modern context, the term agroforestry can apply to food-forests where compatible trees are used for shade-grown cropping, windbreaks, shading livestock, riparian or coastal protection, and many other practices. These integrated systems can increase productivity, tend to have less pest and disease problems, provide natural weed control and require less fertilizer and outside inputs compared with conventional agriculture. They also provide long-term benefits of soil and watershed protection, while maintaining a forest canopy that is important in sequestering carbon and reducing the build-up of greenhouse gases.

In the case of the Moore property, clues about the prior agricultural use of the property remain in the form of the many partially collapsed but still functional planting mounds and low rock-walls that were used to contain soil and protect the garden areas. Also, some of the trees traditionally found in association with the early Hawaiian farms in the area, such as the hala, kukui, mango, coconut, ti, and noni, are found interspersed among the invasive trees and vines that currently dominate the landscape.

The focus of the proposed Farm Plan is aimed at systematically removing the invasive trees and plants and working to protect and enhance the native and traditional Hawaiian plants currently found on the property or expected to be found in a typical 19th century Hawaiian farm of the area, including those mentioned above along with breadfruit, avocado, coffee, banana, papaya and citrus, as shown in the Landscape Plan Sheet of Figure 3.

The phased transition of the forest canopy will be achieved through the systematic hand-clearing of invasive trees and plants, in approximately 1 to 1.5-acre segments. Those trees being removed will be cut, chipped and used as mulch onsite, especially in the garden areas and around new tree plantings, to contribute to the soil development, and also for water retention and weed control. Tree stumps of the more persistent invasives, such as strawberry guava, gunpowder trees, and melochia, may require spot treatment with a chemical herbicide to effectively control these from re-sprouting or spreading. A spot treatment of the trees at the stump is recommended over a broadcast spray in order to enhance its

effectiveness and to limit the potential for environmental drift that could impact other desired trees and plants. This would be followed by a fencing of the selected area with a temporary electrical fencing used to contain grazing animals (principally goats) that will help maintain the cleared area from the reestablishment of the invasive or weedy plants. Any newly planted trees in those areas that have been cleared of the invasive trees and plants will be fenced to protect them during their grow-in period. Those areas with established natives, such as hala, will be also protected and enhanced as they are allowed to spread naturally into newly opened areas.

The specific fencing to be used is Timeless © electric fencing, which will be established around the perimeter of the property *mauka* of the house area. The Timeless Step In Post will be used to move the goats from area to area. It is generally recommended to use 3 to 4 full sized goats per acre to clear brush. The plan is to have 6 to 8 goats for the entire 9 acres, which will allow an initial period of steady, gradual clearing followed by long-term sustainable weed control and goat support. The entire process will be supervised by the owner and his family onsite. It is important to understand that the property, and all adjacent coastal property, is currently unfenced, and thus is subject to pig rooting and wallowing, along with most undeveloped parts of the rainforest in Puna. Fencing the goats in will also exclude pigs, which are much worse for water quality.

As with the residence, all agroforestry practices would be conducted on the portion of the property that is at least 160 feet from the shoreline, which itself is separated from the actual sea cliffs by a roughly 140-foot wide pāhoehoe lava shelf. Most new tree plantings would be associated with the designated garden areas, which are planned within the areas of the existing low rock wall enclosures. In this way, the remnant agricultural walls will be preserved and maintained and used in much the same way as in the past, as enclosures to retain the soil and protect crops from feral pigs that commonly forage in the area. They will also be used to protect against the potential for soil erosion, especially in the direction of the sea. However, given the topographic separation of the planned agroforestry activities from the ocean, combined with a significant vegetative buffer *makai* of the farming area, there is little or no potential threat of impact of soil erosion to the sea.

As noted above, the existing invasive and weedy trees within the farm area will be removed by hand and disposed of on-site by chipping and composting. Similarly, the weedy vines found among the invasive trees, including maile pilau and pothos, will be removed by hand and disposed of on site. Those trees to be planted would be placed in individual holes so as to result in minimal ground disturbance. All vegetative cuttings will be composted on site and, combined with the wood-chip, used as mulch around the tree plantings and in garden areas.

Some infrastructure is required to support the agroforestry, as shown in Figure 3. An 865-sf farm shed will be built just *mauka* of the residence to house the farm tools, equipment, animal feed, chemicals, fertilizers and soil supplements. It will provide an “in-field” work area for equipment and tool repair, as well as for mixing soils and soil supplements. A portion of the structure will also include an open shed area to house, feed, and tend animals, when necessary. Plans for the farm shed are shown in Figure 3. A water well and storage tank to be used for domestic and agroforestry practices will located just *mauka* of the farm shed, as shown on Figure 3. The water storage tank would be sized at 10,000 gallons and outfitted to serve both as a domestic and agricultural water sources and with sufficient reserve capacity and the appropriate fire apparatus fittings to provide fire-flow protection to both the residence and the farm shed.

A farm management plan (FMP) has been prepared for the CDUP application and is attached as Appendix 4. In summary, the FMP is meant to ensure that the environmental impacts of farming are minimized to the extent feasible, in keeping with the values of the Conservation District. To meet this goal, improvements to the property and farm operation and management will meet the following objectives:

- Siting improvements predominantly in previously disturbed areas, taking advantage of the existing topography so as to minimize the amount of grading required.
- Maintaining a protective buffer area in the coastal area aimed at the protection of the native coastal species in this area and to minimize potential impacts to the coastal environment from farm related activities;
- Implementing Best Management Practices (BMP's) for erosion and sedimentation control in conjunction with all construction or site improvements related to the Farm operation;
- Implementing a program for the systematic removal and control of the invasive and weedy species that cover much of the property and the long-term monitoring of affected areas aimed at evaluating the effectiveness of the control methods;
- Replanting in areas that are systematically cleared of the weedy species with native and Polynesian trees and plants that are traditionally found in the Hawaiian garden, in a manner and with the selection of species so as to be compatible with the planned agricultural activities in the area; and
- Implementing a program of Agricultural Best Management Practices, as described below, aimed at maximizing the food and resource production of the agroforestry while minimizing environmental/ health related impacts that could otherwise result from the agroforestry-related activities.

BMPs have been formulated through consultation of the University of Hawai'i-Manoa, College of Tropical Agriculture and Human Resource's *Best Management Practices to Manage Non-Point Pollution in Agriculture* (Abbas and Fares 2009). These include short-term practices meant to control erosion and sedimentation related to the relatively small amount of ground disturbing activities, which are extremely limited and associated primarily with clearing for the farm shed, water tank and well pad, because the agroforestry practices themselves involve no grading.

There will also be long-term practices related to soil management and other farm practices. These are discussed in detail in Appendix 4. The emphasis is placed on cultivation practices that minimize tillage, add organic material to the soils and establish ground covers. As proposed at the farm, these objectives would be achieved by creating holes for the tree plantings rather than grading or tilling the area for cultivation; maintaining the existing ground cover; and adding mulch from onsite composting and green-waste. Existing ground conditions in the farm are typically rocky with only a thin layer of organic soils. The lava rock substrate makes for well-draining soil conditions with low potential for ponding or soil erosion. Any soil that is present or added at the tree plantings will be retained in place by berming soil around individual plantings. Water will be managed through effective irrigation, also referred to as "right time-right amount" irrigation, to ensure that the specific crop water requirements are met, without overwatering and excessive soil, nutrient, or chemical movement. BMPs for nutrient management will monitor and regulate the application of nutrients to the soil according to the specific crop nutrient requirements. Nutrient management also includes selecting and using the appropriate organic manure amendments, which can help build and stabilize soils while reducing the need for chemical nutrients. Pests will be managed through integrated pest management stressing pest-resistant crops, biological control, removal and eradication of pests, and, only where necessary, safe and effective storage, handling and application of pesticides.

Finally, there will be regular and ongoing monitoring of the farm soil, water and plant conditions in order to identify potential environmental or biological threats early on; insure the effective use of available resources; and maintain optimum growing conditions for the selected crops. Mr. Moore expects to be fully capable of establishing and managing the farm in conformance with the Farm Management Plan.

1.2 Environmental Assessment Process

This Environmental Assessment (EA) process is being conducted in accordance with Chapter 343 of the Hawai‘i Revised Statutes (HRS). This law, along with its implementing regulations, Title 11, Chapter 200, of the Hawai‘i Administrative Rules (HAR), is the basis for the environmental impact assessment process in the State of Hawai‘i. According to Chapter 343, an EA is prepared to determine impacts associated with an action, to develop mitigation measures for adverse impacts, and to determine whether any of the impacts are significant according to thirteen specific criteria. Part 4 of this document states the anticipated finding that no significant impacts are expected to occur, based on the preliminary findings for each criterion made by the consultant in consultation with the Hawai‘i State Department of Land and Natural Resources, the determining agency. If, after considering comments to the Draft EA, DLNR concludes that, as anticipated, no significant impacts would be expected to occur, then the agency will issue a Finding of No Significant Impact (FONSI), and the action will be permitted to proceed to other necessary permits. If the agency concludes that significant impacts are expected to occur as a result of the proposed action, then an Environmental Impact Statement (EIS) will be prepared.

1.3 Public Involvement and Agency Coordination

The following agencies, organizations and individuals have been consulted during the Environmental Assessment Process:

County:

Planning Department	County Council	Civil Defense Agency
Fire Department	Department of Public Works	Police Department

State:

Department of Health, Environmental Planning Office
Department of Land and Natural Resource (DLNR), Land Division and OCCL
Office of Hawaiian Affairs

Private:

Sierra Club Malama O Puna
Five Adjacent Property Owners: Fielding, Gross, Zimmerer, Phillips and Ketler

Copies of communications received during early consultation are contained in Appendix 1a. Notice of the availability of the Draft EA was published in the July 23, 2019 *OEQC Environmental Notice*. Appendix1b contains written comments on the Draft EA and the responses to these comments. Various places in the EA have been modified to reflect input received in the comment letters; additional or modified non-procedural text is denoted by double underlines, as in this paragraph.

PART 2: ALTERNATIVES

2.1 Proposed Project, Alternative House Sites and Alternative Uses

The proposed project and its location are described in Section 1.1 above and illustrated in Figures 1-3. The location of the home site, at a minimum of about 300 feet from the sea cliff and 160 feet from the certified shoreline, was chosen in order to enjoy coastal breezes and views on the property and avoid mosquitos. In its inland section, the property is heavily vegetated with non-native trees that will be gradually enhanced with trees representative of Polynesian agroforestry crops.

A number of other locations on the property could also serve as the site for a residence, but none have the advantages of the proposed site in terms of breezes and views, while both avoiding mosquitos and impacts to native shoreline vegetation (which is restricted to about 200 feet inland of the sea cliff) and offering a location for the tree crops. There is no known environmental or other reason for seriously considering other sites on the property.

No other alternative uses for the property that are identified in the Conservation District Rules, such as a commercial tourist nature park, are desired by the applicant, and thus none are addressed in this EA.

2.2 No Action

Under the No Action Alternative, the residence would not be built and the farm would not be established. The lot would remain unused, except for temporary camping and picnicking by the owner. This EA considers the No Action Alternative as the baseline by which to compare environmental effects from the project.

PART 3: ENVIRONMENTAL SETTING, IMPACTS AND MITIGATION

The 8.75-acre property is located between the Government Beach Road on the south side and the shoreline of the Pacific Ocean on the north side, flanked by similarly sized private parcels that currently have no active land uses (see Fig. 1). The shoreline in this area is neatly defined by the edge of a 15-foot plus high sea cliff, in front of which is a pahoehoe shelf that is bare near the cliff but has grass and ironwood trees more inland, with scattered boulders throughout. The certified shoreline is located about 140 feet *mauka* of the cliff on this elevated pahoehoe shelf, where high waves from seasonally high surf have left a debris line (see Figure 3, Site Plan). *Mauka* of the shoreline the elevation gradually rises and partly native shoreline vegetation gives way to mostly weedy vegetation typical of disturbed areas of Puna (see photos in Figure 2 for each of these zones). U.S. Geological Survey maps and Google Earth images indicate that elevations on the property vary from about 10 to 50 feet above sea level, with the chosen residential site lying at about 20 feet.

3.1 Physical Environment

3.1.1 Climate, Geology, Soils and Geologic Hazards

Environmental Setting

The property is located on the flank of Kilauea, an active volcano. This area receives an average of about 120 inches of rain annually, with a mean annual temperature of approximately 75 degrees Fahrenheit (Giambelluca et al. 2014; UH Hilo-Geography 1998:57). Guidance to federal agencies for addressing climate change issues in environmental reviews was released in August 2016 by the Council on Environmental Quality (US CEQ 2016). The guidance urged that when addressing climate change, agencies should consider: 1) the potential effects of a proposed action on climate change as indicated by assessing greenhouse gas emissions in a qualitative, or if reasonable, quantitative way; and, 2) the effects of climate change on a proposed action and its environmental impacts. It recommends that agencies consider the short- and long-term effects and benefits in the alternatives and mitigation analysis in terms of climate change effects and resiliency to the effects of a changing climate. Although this guidance has since been withdrawn for political reasons, the State of Hawai‘i in Hawai‘i Revised Statutes §226-109 encourages a similar analysis. It is possible, and even likely, that larger and more frequent tropical storms and even hurricanes will affect the Hawaiian Islands in the future. In addition, as discussed in Section 3.1.2, accelerating sea level rise is expected.

The two lava flows that underlie the project site both erupted sometime between 200 and 750 years ago, according to the general geology map of Kilauea by Moore and Trusdell (1991). Field and photo inspection by geologist Dr. Jack Lockwood (see Appendix 5) indicates that the younger flow, which does not reach the sea cliff, originated about 335 bp (before present) on Kilauea’s East Rift Zone, 16 to 17 miles upslope of the coast. The lava flow forming the coastline fronting the property is older – according to Moore and Trusdell, in the range of 400-700 years bp.

Soil in the area is classified as Opihikao highly decomposed plant material. This well-drained, thin organic soil develops over pahoehoe bedrock. It is found from sea level to 1,000 feet in elevation and is

rapidly permeable, with slow run-off and a slight erosion hazard. This soil is within subclass VIIs, which means it has limitations that make it unsuitable for cultivation and restrict its use to pasture, range, woodland or wildlife (U.S. Soil Conservation Service 1973).

The entire Island of Hawai‘i is subject to geologic hazards, especially lava flows and earthquakes. Volcanic hazard as assessed by the U.S. Geological Survey in this area of Puna is zone 3 on a scale of ascending risk 9 to 1 (Heliker 1990:23). The relatively high hazard risk is because Kilauea is an active volcano. Zone 3 includes areas less hazardous than zone 2, which is adjacent to the summit and East Rift Zone (ERZ), because of greater distance from recently active vents and (or) because of topography. One to five percent of zone 3 has been covered since 1800, and 15 to 75 percent has been covered within the past 750 years. The property is within the higher-risk margin of zone 3, only about two miles from the loosely-defined boundary of zone 2. As noted above, the younger lava flow on the property was estimated by geologists to have been emplaced in the early 18th century. The next lava flow to reach the coastline in this area (2.5 miles to the southeast) was in June 1840. For 150 years no lava flows threatened this area, until 2014, when a lava flow from Kilauea's ERZ entered Pahoa and almost crossed the Kea‘au-Pahoa Highway. The flow stopped six miles upslope from the property, but the coastal area between Hawaiian Paradise Park and Hawaiian Acres could have been impacted had the eruption continued. On May 4, 2018, a 6.9 magnitude earthquake that occurred initiated one of the largest eruptive events in the last 150 years on the Island of Hawai‘i. By May 27, 2018, 24 fissures had erupted lava in the area between Leilani Estates and Noni Farms Road in the Puna District. In the three months that followed about two thousand residents were evacuated and seven hundred homes were destroyed or made uninhabitable. Businesses ranging from vacation rentals, farms and ranches, and tour operations were destroyed or precluded from operating. Also lost were the Kua O Ka La Public Charter School, Ahalanui Beach Park, a portion of Isaac Hale Beach Park, and the Wai ‘opae Marine Life Conservation District. Loss of access and subsequent lava damage caused the shutdown of Puna Geothermal Venture, which provided a substantial portion of the County's electricity. Altogether, 13.7 square miles of land had been covered by the time the eruption had stopped spreading, and 845 acres of land had been added to the island.

Moore and Trusdell's map depicts eleven lava flows that have traveled northeast from the ERZ over the past 1,500 years; seven of these have reached the ocean – a total which now is eight. Radiometric dating and detailed mapping is inadequate to define quantitative recurrence intervals for eruptive activity on the ERZ, but that limited data does suggest that "on average", lava flows travel northeast from that rift zone once every 140 years or so; flows have reached the coastline about every 200 years. Lava flows that have reached the coast are, however, relatively narrow, so that the odds that the Moore property will be overrun by lava within the next few centuries are relatively low over the expected functional lifetime of the structure.

The Island of Hawai‘i experiences high seismic activity and is at risk from earthquake damage (USGS 2000), especially to structures that are poorly designed or built, as the 6.7-magnitude quake of October 2006 and the 6.9-magnitude quake of May 2018 demonstrated. The portion of the property site proposed for improvement is flat to low-sloping. There are appropriate setbacks to surrounding steeper slopes, with a minimum of about 300 feet to the 15-foot-plus high sea cliff. There does not appear to be a substantial risk at the site from subsidence, landslides or other forms of mass wasting.

Impacts and Mitigation Measures

In order to deal with the potential for larger and more frequent tropical storms that could be part of a changing climate, the home has been designed to withstand hurricane force winds, and trees with the potential to be fall on the home are planned for removal (particularly the invasive ironwood). The implications of climate change for the shoreline setting are dealt with in the next section. In general, geologic conditions do not impose undue constraints on the proposed action, as much of the Puna District faces similar volcanic and seismic hazard and yet continues to be the fastest growing region of the State. The applicant understands that there are hazards associated with homes in this geologic setting and has made the decision that a residence is not imprudent to construct or inhabit.

3.1.2 Flood Zones and Shoreline Setting

Floodplain Environmental Setting, Impacts and Mitigation Measures

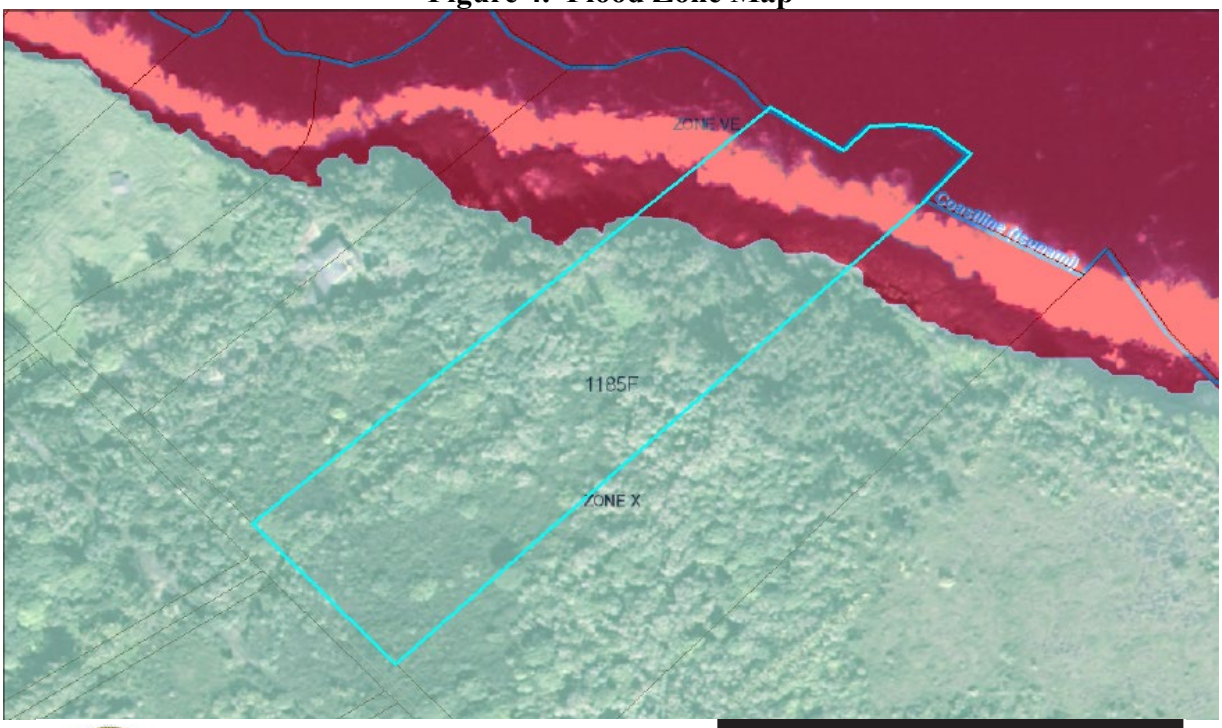
Floodplain status for many areas of the island of Hawai‘i has been determined by the Federal Emergency Management Agency (FEMA), which produces the National Flood Insurance Program's Flood Insurance Rate Maps (FIRM). The flood zones for this region were recently mapped, and digital maps are available from the Department of Land and Natural Resources at http://gis.hawaiinfip.org/fhat/ (Figure 4). Unfortunately, a systematic error of approximately 135 feet in the registration of the TMK layer and the Google Earth © layer (clearly visible by examining the offset of the Government Road) affects direct interpretation of the map. In any case, the residence building site is classified in Flood Zone X, areas with minimal flood hazards, including tsunami inundation.

The home site would be located about 20 feet above sea level, about 300 feet back from the top of the 15-foot plus high sea cliff, and 160 feet from the certified shoreline, in an area that is clearly out of the flood zone. The proposed site for the residence is also *mauka* of the area affected by high waves. There is no evidence of tsunami inundation in this location, although storm waves of the magnitude generated by Tropical Storm Iselle, which hit the Puna coastline on August 8, 2014, have clearly affected the pahoehoe platform *makai* of the shoreline. Other than mega-tsunami of the type that would inundate all of Hilo and Honolulu, the home site is not at risk of tsunami. Mr. Moore has chosen to locate the home about 300 feet from the cliff in order to completely avoid wave damage and minimize spray from waves. Furthermore, the very conservative siting of the home in this position at 20 feet above sea level ensures that even when sea level rises five or more feet above its current level, the home will likely remain out of the effective flood zone. Extremely large rises in sea level of the type that would essentially require the relocation of much of downtown Hilo and Honolulu may similarly necessitate moving the home back further on the property, which could be done with relative ease because of the 800-foot lot depth.

Coastal Erosion Issues: Background

Property near the shoreline is subject to natural coastal processes including erosion and accretion, which can be affected by human actions such as removal of sand or shoreline hardening. Erosion may adversely

Figure 4. Flood Zone Map



Flood Hazard Assessment Report

www.hawaiinfip.org

Property Information

COUNTY:	HAWAII
TMK NO:	(3) 1-5-010:031
WATERSHED:	KAAHAKINI
PARCEL ADDRESS:	15-2259 GOVERNMENT BEACH ROAD KEAAU, HI 96749

Notes:

Flood Hazard Information

FIRM INDEX DATE:	SEPTEMBER 29, 2017
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL:	1551661185F
PANEL EFFECTIVE DATE:	SEPTEMBER 29, 2017

THIS PROPERTY IS WITHIN A TSUNAMI EVACUTION ZONE: YES
FOR MORE INFO, VISIT: http://www.scd.hawaii.gov/

THIS PROPERTY IS WITHIN A DAM EVACUATION ZONE: NO
FOR MORE INFO, VISIT: http://dlnreng.hawaii.gov/dam/

0 200 400 ft

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

If this map has been identified as 'PRELIMINARY', please note that it is being provided for informational purposes and is not to be used for flood insurance rating. Contact your county floodplain manager for flood zone determinations to be used for compliance with local floodplain management regulations.

FLOOD HAZARD ASSESSMENT TOOL LAYER LEGEND
(Note: legend does not correspond with NFHL)

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD - The 1% annual chance flood (100-year), also know as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. SFHAs include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

- **Zone A**: No BFE determined.
- **Zone AE**: BFE determined.
- **Zone AH**: Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
- **Zone AO**: Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
- **Zone V**: Coastal flood zone with velocity hazard (wave action); no BFE determined.
- **Zone VE**: Coastal flood zone with velocity hazard (wave action); BFE determined.
- **Zone AEF**: Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

NON-SPECIAL FLOOD HAZARD AREA - An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

- **Zone XS (X shaded)**: Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- **Zone X**: Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

- **Zone D**: Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase apply, but coverage is available in participating communities.

Source: Hawai‘i DLNR: http://gis.hawaiinfip.org/fhat/

affect not only a lot owner's improvements but also State land and waters, along with the recreational and ecosystem values they support.

Single Family Residential permitting in Conservation Districts in the State of Hawai‘i is regulated by State of Hawai'i Administrative Rules governing Conservation Districts (Title 13, Subtitle 1 Chapter 5, adopted August 12, 2011). Applications to permit shoreline residential construction in the Conservation Districts must consider rates of coastal erosion. The State DLNR requires an estimate of annual erosion rate in the form of a "Coastal Erosion Study". for any property for which construction is proposed. Such a study integrates on-site quantitative measurements by a credentialed specialist or specialists, inspection of available aerial and satellite imagery taken over a period of time, and a review of relevant geological literature.
A Coastal Erosion Study that also considered other coastal hazards was prepared for the property by Geohazards Consultants International, Inc. The full report is attached as Appendix 5 and summarized below. The reader is referred to the report for additional detailed description, maps and photos.

Sea Level Rise

Because the proposed use of a single-family residence on this coastal property has an expected useful lifetime of 40 to 70 years, it is important to first examine the potential for future sea level rise. Sea level rise also factors into future rates of coastal retreat and erosion.

There is a scientific consensus that the earth is warming due to manmade increases in greenhouse gases in the atmosphere, according to the United Nations' Intergovernmental Panel on Climate Change (UH Manoa Sea Grant 2014). Global mean air temperatures are projected to increase by at least 2.7°F by the end of the century. This will be accompanied by the warming of ocean waters, expected to be highest in tropical and subtropical seas of the Northern Hemisphere. Wet and dry season contrasts will increase, and wet tropical areas in particular are likely to experience more frequent and extreme precipitation. For Hawai‘i, where warming air temperatures are already quite apparent, not only is the equable climate at risk but also agriculture, ecosystems, the visitor industry and public health.

An overall global rise in sea level of 3.3 feet by the end of the 21st century was proposed by Fletcher (2010) and others. More recent scientific assessments (e.g., Rahmstorf et al. 2012) posit 4 feet as a reasonable upper bound. Some recent research that concentrates on the potential for Antarctic melting to contribute more to sea level than generally modeled envisions as much as an additional meter (3.3 feet) of sea level rise (DeConto and Pollard 2016). Not only the magnitude of sea level rise but also the timing is the subject of debate . According to the Hawai‘i Climate Change Mitigation and Adaptation Commission (HCCMAC) (2017:v):

> While the IPCC's "business as usual" scenario, where GHG emissions continue at the current rate of increase, predicts up to 3.2 feet of global sea level rise by year 2100 (IPCC 2014), recent observations and projections suggest that this magnitude of sea level rise could occur as early as year 2060 under more recently published highest-end scenarios...

The HCCMAC report goes on to state that the Island of Hawaii is in many senses the least vulnerable of the main Hawaiian Islands to the impacts of sea level rise, but that certain areas – particularly Kona, Puakō, Kapoho and Hilo Bay ".....face serious threats. It is estimated that at least 130 existing structures would experience chronic flooding if there were 3.2 feet of sea level rise."

Relative sea-level rise, of course, is a result of the combined eustatic water rise and land subsidence. In some locations, the effects of eustatic sea level rise can be magnified substantially. The 1975 Kalapana earthquake on Kilauea's rift caused land in Kapoho to drop 0.8 feet (based on Hawaiian Volcano Observatory (USGS) data in Hwang et al. (2007:6). This episodic, seismic-induced subsistence is difficult to estimate over human-scale time periods. On the basis of InSAR (Synthetic Aperture Radar Interferometry) remote sensing data, Hwang et al. (ibid.) state that the coastline at Kapoho may be subsiding at a continuous rate of between 0.31-0.67 in/yr. Rates of subsidence at the Moore property are certainly much lower as a result of its distance from Kilauea's tectonically active rift zone, as well as its position on the west side of the rift zone, where land is supported by the bulk of Mauna Loa. A rate in the middle of this estimate, or a little less than 0.5 in/yr., is probably conservative. A highly conservative estimate of overall sea level change by the year 2100, accounting for a eustatic rise of 5 feet and local tectonic sinking of about 3 feet, is 8 feet. The greatest rate of SLR will take place during the second half of this century according to recent modelling (e.g., Cazenave and Le Cozannet 2014).

Coastal Erosion: Physical Setting

As discussed in Section 3.1.1, two lava flows dated between 200 and 750 years bp underlie the property, but only one reaches the shoreline (Moore and Trusdell 1991). The entire shoreline frontage of the property is bounded by a broad, flat pahoehoe lava shelf extending from the rugged coastline inland 80 to 100 feet (Figure 5a). This coastal shelf is exposed to strong eastern and northern swells that can overtop the coastal sea cliff and scour the shelf clear of vegetation, except for ephemeral grasses. The shelf surface consists of horizontal pahoehoe lavas with less than two feet of relief, cut in places by narrow cracks near the sea cliff. These appear to have formed due to tensional stresses associated with cliff erosion. The sea cliff is near vertical and 15-feet plus high, consisting of the massive interior of a single very thick pahoehoe flow. The base of the cliff is marked by large subangular boulders length that have fallen from the cliffs above. These blocks are usually too large (up to six feet in diameter) to be mobilized by the incoming waves and form energy dispersing barriers to incoming surf.

In places the pahoehoe shelf is marked by anomalous areas of frothy, vesicle rich, glassy material, a typical result of interaction with voluminous seawater. This suggests that when the flow was originally emplaced and still molten it was deluged with crashing surf in places, indicating that the presently exposed flow was located close to the original coastline. The proximity of this thick pahoehoe flow to the original coastline is also suggested by the presence of a large included block of glassy, partly oxidized "littoral breccia" that was apparently thrown inland by waves and incorporated in the massive pahoehoe lava pond. The geologists hypothesize that when the massive pahoehoe flow reached the ocean some 750 years ago, littoral explosions built up a coastal berm of spatter that formed a barrier behind which especially thick molten pahoehoe ponded. The impact of waves on this littoral berm tore loose fragments that were thrown back into the dammed molten pahoehoe pond. This situation is analogous to the

ponding of thick pahoehoe that has been observed to form inland from littoral cones and spatter deposits along the Kalapana coastline during recent eruptions of Kilauea. The fragmental deposits that appear to have formed the original coastline during emplacement of this flow were quickly eroded away hundreds of years ago, but active erosion ceased once the fragmental material was eroded away and the solid, massive pahoehoe formed inland from the berm was exposed.

Other evidence supports the existence of a large pond of molten lava inland of the now eroded-away coastal berm. The flat-lying coastal pahoehoe shelf is bordered on its *mauka* edge, 80 to 100 feet inland from the coastline, by an anomalous downward tilting of the originally horizontal surface (Figure 5b). This tilting was evidently caused by the lateral draining of a large volume of molten lava from beneath the crust in this area to lower areas (perhaps though gaps in the coastal berm). This caused the crust to subside, forming an elongate 3 to 5-foot deep depression inland of the pahoehoe shelf. This depression extends across the entire shoreline frontage of the property. It has now largely been infilled by the sand deposits thrown up from large waves that crash against the cliff and splash water onto the shelf. Large cracks formed on the pahoehoe shelf surface along the zone where tilting of the surface crust occurred as molten lava drained away from beneath the crust. A geologic cross-section of this area (Figure 5c) shows the accumulation of sand deposits in this down-dropped area.

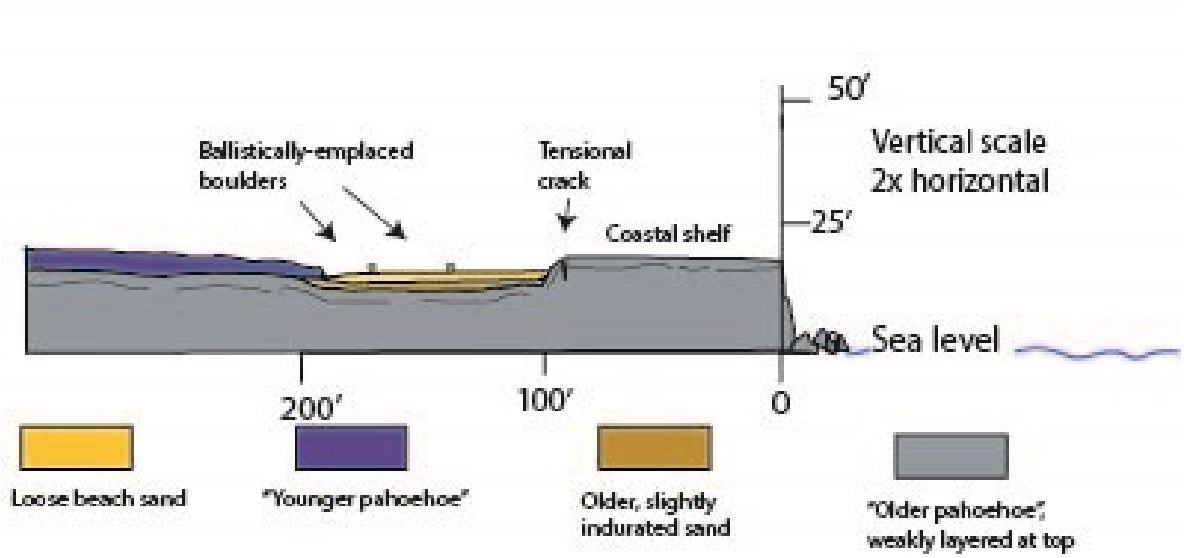
The coast of this part of the Puna District faces the open ocean with no barrier of offshore reefs or bars. The submarine slope is approximately 1,300 feet/mile for a distance of roughly 6 miles, descending into the deepwater Puna Canyon. Large waves reaching the coast are predominantly related to trade wind conditions, though the shoreline is also somewhat exposed to North Pacific swells. Field observations of the coastline were taken at various tide levels on the three inspection days in 2017 ranging from +0.75 to -.0.1 feet above the tidal datum (tidal datum for Hilo, Hilo Bay, and Kuhio Bay, HI -http://tidesand currents.noaa.gov). The ocean was characterized by moderate swells (3-4 feet) in August, with higher swells (to 6-7 feet) on 7 September, which generated light surf that prevented detailed observation of coastal lavas along the sea cliff. At no time during these visits did incoming waves overtop the sea cliff.

The shoreline is legally defined in Hawai‘i as “the upper reaches of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves, ...” (HAR §13-5-2). At the time when the coastal erosion study was conducted, an official shoreline position has not been surveyed or certified, although it was presumed that it would roughly coincide with the *makai* edge of ironwood tree growth. Grasses extend *makai* of the ironwood trees but there is no established woody vegetation. Because of the pending certified shoreline location, the horizontal datum used to discuss coastal hazards in the report was the sea cliff. Since that time, the shoreline has been certified at about 140 feet from the sea cliff, because during times of high surf, waves overtop the cliff and run a considerable degree inland to where the slope begins to rise (see Figure 4d).

Figure 5. Coastal Erosion Study and Shoreline Figures

5a, Above: Pahoehoe shelf behind sea cliff. 5b, Below: Sand-filled subsidence area. Note tilting of pahoehoe shelf at margin of flat shelf.

Figure 5. Coastal Erosion Study and Shoreline Figures



5c, Above: Cross-section across shoreline area of property. 5d, Below: Approximate position of certified shoreline in orange marker, with house site 160 feet to left and sea cliff 140 feet to right

Coastal Erosion Rate

Most shoreline studies in Hawai‘i and elsewhere focus on erosion of “soft” coasts, for the obvious reasons that erosion rates are faster (sometimes over 3 feet per year) and thus more observable and consequential for human occupation. Andriati and Walsh (2007) studied the erosion of carbonate (limestone and low-grade marble) hard coast near Bari, Italy, and documented that the finer the crystallinity of the rock, the slower the rate of retreat. They established shoreline shift rates of 0.03-0.3 feet/year – as much as 4 inches/year. Although the conditions of the Moore property are considerably different in terms of the relative crystallinity of the rock, but its degree of fracturing, marine dynamics, climate, and other factors, the work in Italy reinforces the observation that hard coasts are significantly more resistant to erosion.

As discussed above, the property shoreline is massively rocky and “hard” as opposed to unconsolidated and “soft”, and by nature it resists erosion far more effectively than Hawai‘i’s beaches and bars. Several key processes are at work contributing to erosion of this and all typical hard coasts. Wave energy impacting the cliff loosens masses of rock by compressing air within fractures, while the drag of moving water abrasively grinds smaller fragments at the shore. There is no way to definitively quantify the relative contributions of these processes, though it is reasonable to say that the energy released by wave action is probably the main cause of shoreline retreat at this locality.

Inspection of airphotos of the property from 1954, 1965, 1977 and 2014 show no measurable change in position of the overall coastal sea cliff or of the vegetation line since the earliest 1954 photo. The large scale (limited resolution) of the airphotos makes quantitative analyses of fine-scale morphological changes of the sea cliff or vegetation positions impossible, and it is doubtful that horizontal changes of less than 10 feet could be detected. As an approximation of the erosion rate at this property is not statistically feasible using the methods outlined by Hwang (2005), any shoreline determinations must rely upon alternative indicators – primarily observation of active erosion such as freshly cut cliff faces or presence of angular erosional debris.

Since there is no visible indication that the coastline has changed over the 58-year period since the first airphoto record began, it thus appears that the maximum amount of coastal erosion fronting the property over this period is less than 10 feet – for a maximum rate of 0.17 feet (2 in.)/yr. since 1954. There is no sign of recent erosion of the cliff line (as evidenced by the presence of well-established algae on cliff faces and absence of any indication of fresh rockfall scars). For this reason, and because of the solid, erosion-resistant nature of the pahoehoe interior rock that forms the cliff face, the geologists who prepared the coastal erosion study believe that any mechanical erosion that is taking place must be much less than the 2-in./yr. maximum that could have occurred.

The combined effects of land subsidence and rising sea levels may cause an overall (relative) drop in the coastline elevation of up to 8 feet over the next eighty years, if sea levels rise and the Puna coast subsides at relatively fast rates. The durability and height of the sea cliff (higher than 15 feet at even the highest tides) ensures that combined sea level change and land subsidence will not cause any major coastline transgression in this area, at least until the later quarter of the 21st century.

Ballistically Emplaced Storm Boulders ("Pōhaku Lele")

Perhaps the greatest geologic hazard that affects the coastal shelf of the property is related to exceptionally high storm waves that can tear off blocks from the upper parts of the sea cliff and propel them large distances inland. Such blocks are initially transported by high waves over the sea cliff, but because of their greater density than seawater and thus great inertia, they may leave the waves behind and be propelled through the air as ballistically-emplaced storm boulders. For the coastal erosion report the geologist chose to utilize the term "*pōhaku lele*" (flying rocks) to describe them (the reader is referred to Figure 12 of Appendix 5 for more information, photos and maps concerning these rocks). This is a relatively infrequent phenomenon, but over time they may accumulate. More than 100 of these blocks were observed on the property, with over a dozen of them in excess of two feet in diameter, some weighing up to three tons (several are visible in Figure 5b). Most landed in the sandy area filling the "inshore subsided area", but one was noted 205 feet from the sea cliff, about 60 feet *mauka* of the sandy infilled area and the certified shoreline, on the eastern half of the property. Almost all of the *pōhaku lele* have freshly broken surfaces, with no development of lichen. The geologists suspect that most of them were emplaced during the August 2014 impact of the near-hurricane strength storm Iselle, which was the strongest tropical cyclone to make landfall on the Island of Hawai'i in recorded history (https://en.wikipedia.org/wiki/Hurricane_Iselle), and which was focused on the Puna coastline. One of the storm boulders appears to have been emplaced much earlier – indicating that *pōhaku lele* emplacement has occurred in the past and likely will occur in the future during major storms or tsunami.

Fletcher et al. 2002 Coastal Hazard Assessment of Property

Hwang (2005) recommended that all hazards facing coastal areas should be considered when planning for land-use zoning in Hawai'i, and not just erosion. In a USGS-sponsored study, Fletcher et al. (2002) portrayed generalized hazards assessments for long sections of Hawai'i's coastlines; the ratings of the specific hazards for the section of Puna coastline including the property are shown in Table 1. They considered overall hazards along this stretch of coastline as "high", but the geologist evaluated some of these scores and re-rated them for the particular property, rather than the section as a whole, and evaluated overall coastal hazards here as "low to medium".

Table 1. Natural Hazards Impacting the Coastline Fronting Property

Hazard Type	**Relative Threat**	**Fletcher et al. Rating (1-4)**	**Property Rating by Geologist**
Tsunami	Medium-high	3	3
Stream Flooding	Medium-high	3	1
High Waves	Medium-high	3	3
Storms	Medium-high	3	4
Erosion	Low	2	1
Sea Level Change	Medium-high	3	1
Volcanic/Seismic	High	4	4
Overall Hazard Assessment	High	6 (on scale of 1-7)	2-3

After Fletcher et al. 2002, p.150).

Overall Assessment of Coastal Hazard: Impacts and Mitigation Measures

Although actual erosion of the sea cliff fronting the property has been minimal throughout the last 60 years (with an absolute maximum of less than 10 feet, and an actual value that is likely far less), several factors dictate a more conservative approach to location of the proposed residence with relationship to the sea cliff. First, global sea levels are rising, and the island is slowly subsiding, and if this proceeds relatively rapidly, within 80 years the current 15-foot plus tall sea cliffs may be only 7 feet or so in height. Furthermore, the frequency and severity of tropical storms is likely to increase due to warming oceans and climate change. These factors may increase the erosion "work" of the ocean and accelerate cliff retreat. More importantly, they will cause waves to overtop the cliff more frequently, with wash extending further back, causing the "shoreline" – the most *mauka* line of the annual wash of the waves – to retreat as well. It would likely move the *pōhaku lele* zone inland as well.

For these reasons, Mr. Moore has chosen to locate the home about 20 feet above sea level, about 300 feet back from the top of the sea cliff, 160 feet *mauka* of the certified shoreline, outside the flood zone, 100 to 150 feet *mauka* of the most *mauka pōhaku lele*. This will situate the residence and agroforestry support structures in a zone that should be safe for many decades, if not a century, under most future scenarios.

Although a scenario of modest sea level rise and tropical storm activity would likely not substantially affect the integrity or use of the proposed residence and the agroforestry practices, worst-case increases, particularly in a case of sudden onset, could have some impact. If so, the Moore property would be among thousands, or perhaps tens of thousands, of impacted properties in what would be the largest disaster to affect the Hawaiian Islands since human settlement. As sea level rise is gradual, there would probably be an opportunity for the owner to consider relocating or scrapping all structures for re-use of their valuable materials should sea level rise sufficiently to endanger the structure.

In order to ensure that the public interest in avoiding shoreline modification is safeguarded, the owner would agree to a CDUP and/or deed condition that would prevent any future request for shoreline hardening to protect the residence, regardless of hardship, and a condition requiring moving or dismantling the home if sea level rise eventually threatens the integrity of the structure.

3.1.3 Water Quality

The house would be set back a minimum of about 300 feet from the sea cliff and 160 feet from the certified shoreline, and no grading activities would occur *makai* of this area. No natural water features such as streams, springs, or anchialine ponds are found on or near the property.

Land clearing and construction activities would occur on an area of less than an acre. The grading work would be limited to the home site its related spaces for driveway/parking, septic system, water well and construction staging area. The only grading required for the agroforestry practices is for the shed directly *mauka* of the home. No grubbing or grading is planned in the primarily non-native forest that would be utilized in agroforestry practices. Trees and other crops will be planted in individual holes to minimize the need for ground disturbance. Grading will be planned and conducted to balance cut and fill material for

the graded area in order to avoid the need to import or export of soils from the site. Related to the trenching required for the septic system, extracted materials (spoils) will be used to refill the trenched areas and to blend the areas with the surrounding topography.

A County grading permit will be required. After actual grading plans are developed, the applicant and engineer will determine whether the area of disturbance is sufficiently large to require a National Pollutant Discharge Elimination System permit. Grading for the driveway and house lot will include practices to minimize the potential for sedimentation, erosion and pollution of coastal waters. The applicant will ensure that their contractor shall perform all earthwork and grading in conformance with:

(a) "Storm Drainage Standards," County of Hawai'i, October, 1970, and as revised.
(b) Applicable standards and regulations of Chapter 27, "Flood Control," of the Hawai'i County Code.
(c) Applicable standards and regulations of the Federal Emergency Management Agency (FEMA).
(d) Applicable standards and regulations of Chapter 10, "Erosion and Sedimentation Control," of the Hawai'i County Code.
(e) Conditions of an NPDES permit, if required, and any additional best management practices required by the Board of Land and Natural Resources.

In addition, as part of construction, the applicant will be implementing Best Management Practices as part of the Farm Management Plan (see Appendix 4). The applicant will require that the construction contractor implement the following practices:

- Minimizing the total amount of land disturbance required, which will be delineated to the construction contractor prior to the commencement of any onsite work.
- Construction activities with the potential to produce potential stormwater run-off will not be allowed during periods of unusually heavy rains or storm conditions.
- Prior to the start of construction, contractors will implement erosion and dust control measures to prevent any sediment from leaving the construction areas, especially towards the ocean.
- Graded areas will be replanted or otherwise stabilized as soon as possible following grading activity.

The general shoreline area from Hawaiian Paradise Park to the Papaya Farms area already supports hundreds of homes several homes and is utilized by residents and property owners to park vehicles and fish, and there are no reported water quality problems from these uses. Upon their completion, the home and agroforestry area would be similar to the homes, gardens and orchards on shoreline lots in the area, and they would be not expected to contribute to sedimentation, erosion, and pollution of coastal waters.

3.1.4 Flora and Fauna

Environmental Setting: Flora

Prior to the advent of commercial agriculture, ranching, and lot subdivision, the natural vegetation of this part of the Puna shoreline, with its substrate of geologically recent lava, was mostly coastal forest and strand vegetation. It was dominated by naupaka (*Scaevola taccada*), hala (*Pandanus tectorius*), ʻōhiʻa (*Metrosideros polymorpha*), nanea (*Vigna marina*) and various ferns, sedges and grasses (Gagne and Cuddihy 1990).

The entire Moore property was systematically inspected for plants by Dr. Ron Terry in July and October 2017. Although there is some disturbance from heavy equipment that roughed in a driveway, presumably many decades ago, the ground surface of the property is mostly undisturbed. Strand vegetation in the form of naupaka, mauʻu ʻakiʻaki (*Fimbristylis cymosa*) and akulikuli (*Sesuvium portulacastrum*) is still present, although heavily invaded by wedelia (*Sphagneticola triloba*), ironwood and other weedy herbs, shrubs and trees (see Figure 2). Interestingly, however, there is almost no trace of the original forest. No ʻōhiʻa is present, and the individual hala trees and small clusters of hala scattered throughout the property could all easily have grown in the last twenty years and do not necessarily represent a remnant of the original forest. The site is dominated by a dozen or so non-native trees (most of them invasive), including ironwood, strawberry guava (*Psidium cattleianum*), common guava (*Psidium guajava*), octopus tree (*Schefflera actinophylla*), cecropia (*Cecropia obtusifolia*), autograph tree (*Clusia rosea*), macaranga (*Macaranga mappa*), albizia (*Falcataria moluccana*), gunpowder tree (*Trema orientalis*), mango (*Mangifera indica*), rose apple (*Syzygium jambos*), and false kamani (*Terminalia catappa*) (see Figure 2). Non-native pilau maile (*Paederia foetida*), five-leaf yam (*Dioscorea pentaphylla*) and lilikoi (*Passiflora edulis*) vines heavily festoon the trees.

As mentioned above, the native hala tree is scattered throughout the property, with the largest concentration just *mauka* of the area planned for the residence. Several Polynesian introductions are present, including scattered coconut trees (*Cocos nucifera*), noni (*Morinda citrifolia*), and ʻawapuhi (*Zingiber zerumbet*). These natives and Polynesian introductions represent a "head-start" on the planned agroforestry practices. A list of species detected on the property itself is found in Table 2. All native plants found on the property are very common in the region, on the island, and throughout the Hawaiian Islands.

Environmental Setting: Fauna

During several visits in 2017, we observed Japanese white-eyes (*Zosterops japonicus*) – by far the most abundant bird on the property – as well as common mynas (*Acridotheres tristis*), northern cardinals (*Cardinalis cardinalis*), spotted doves (*Streptopelia chinensis*), striped doves (*Geopilia striata*), and house finches (*Carpodacus mexicanus*). No native birds were identified, and it is unlikely that many native forest birds would be expected to use the project site due to its low elevation, alien vegetation and lack of adequate forest resources. However, it is not inconceivable that Hawai'i ʻamakihi (*Hemignathus virens*) are sometimes present, as some populations of this native honeycreeper appear to have adapted to

Table 2. Plant Species Observed on Property

Scientific Name	Family	Common Name	Life Form	Status*
Ageratum houstonianum	Asteraceae	Ageratum	Herb	A
Casuarina equisetifolia	Casuarinaceae	Ironwood	Tree	A
Cecropia obtusifolia	Cecropiaceae	Cecropia	Tree	A
Centella asiatica	Apiaceae	Asiatic Pennywort	Herb	A
Chamaecrista nictitans	Fabaceae	Partridge Pea	Herb	A
Citrus spp.	Rutaceae	Citrus	Shrub	A
Clidemia hirta	Melastomataceae	Koster's Curse	Herb	A
Clusia rosea	Clusiaceae	Autograph Tree	Tree	A
Coccoloba uvifera	Polygonaceae	Sea Grape	Tree	A
Cocos nucifera	Arecaceae	Coconut	Tree	PI
Cordyline fruticosa	Agavaceae	Ti	Shrub	PI
Crassocephalum crepidioides	Asteraceae	Crassocephalum	Herb	A
Crotalaria sp.	Fabaceae	Crotalaria	Herb	A
Cyclosorus cyatheoides	Thelypteridaceae	Kikawaio	Fern	E
Cyclosorus dentata	Thelypteridaceae	Downy Wood Fern	Fern	A
Cyperus compressus	Cyperaceae	Cyperus	Sedge	A
Cyperus polystachyos	Cyperaceae	Pycreus	Herb	I
Desmodium incanum	Fabaceae	Spanish Clover	Herb	A
Desmodium triflorum	Fabaceae	Tick Clover	Herb	A
Digitaria ciliaris	Poaceae	Digitaria	Herb	A
Digitaria sp.	Poaceae	Digitaria	Herb	A
Dioscorea pentaphylla	Dioscoreaceae	Five-Leaf Yam	Vine	PI
Drymaria cordata	Caryophyllaceae	Drymaria	Herb	A
Emilia fosbergii	Asteraceae	Lilac Pualele	Herb	A
Euphorbia hirta	Euphorbiaceae	Garden Spurge	Herb	A
Falcataria moluccana	Fabaceae	Albizia	Tree	A
Fimbristylis cymosa	Cyperaceae	Mauʻu ʻAkiʻaki	Herb	I
Kyllinga brevifolia	Cyperaceae	Kyllinga	Herb	A
Lygodium japonicum	Schizaeaceae	Japanese Climbing Fern	Fern	A
Macaranga mappa	Euphorbiaceae	Macaranga	Shrub	A
Mangifera indica	Anacardiaceae	Mango	Tree	A
Megathyrsus maximus	Poaceae	Guinea Grass	Grass	A
Melochia umbellata	Sterculiaceae	Melochia	Tree	A
Mimosa pudica	Fabaceae	Sleeping Grass	Herb	A
Morinda citrifolia	Rubiaceae	Noni	Shrub	PI
Nephrolepis exaltata	Nephrolepidaceae	Sword Fern	Fern	I
Nephrolepis multiflora	Nephrolepidaceae	Sword Fern	Fern	A
Oplismenus hirtellus	Poaceae	Basketgrass	Herb	A
Oxalis corniculata	Oxalidaceae	Yellow Wood Sorrel	Herb	I?
Paederia scandens	Rubiaceae	Maile Pilau	Vine	A
Pandanus tectorius	Pandanaceae	Hala	Tree	I
Paspalum conjugatum	Poaceae	Hilo Grass	Herb	A

Table 2, continued				
Scientific Name	**Family**	**Common Name**	**Life Form**	**Status***
Paspalum sp.	Poaceae	Paspalum	Herb	A
Paspalum urvillei	Poaceae	Paspalum	Herb	A
Passiflora edulis	Passifloraceae	Passion Fruit	Vine	A
Phyllanthus debilis	Euphorbiaceae	Niruri	Herb	A
Phymatosorus grossus	Polypodiaceae	Maile Scented Fern	Fern	A
Pilea microphylla	Urticaceae	Artillery Plant	Herb	A
Pluchea carolinensis	Asteraceae	Sourbush	Shrub	A
Polygala paniculata	Polygalaceae	Milkwort	Herb	A
Portulaca oleracea	Portulacaceae	Pigweed	Herb	A
Psidium cattleianum	Myrtaceae	Strawberry Guava	Tree	A
Psidium guajava	Myrtaceae	Guava	Tree	A
Pterolepis glomerata	Melastomataceae	Pterolepis	Herb	A
Sacciolepis indica	Poaceae	Glenwood Grass	Herb	A
Pterolepis glomerata	Melastomataceae	Pterolepis	Herb	A
Scaevola taccada	Goodeniaceae	Beach Naupaka	Shrub	I
Schefflera actinophylla	Araliaceae	Octopus Tree	Tree	A
Sesuvium portulacastrum	Aizoaceae	Akulikuli	Herb	I
Setaria palmifolia	Poaceae	Palmgrass	Herb	A
Solanum lycopersicum	Solanaceae	Tomato	Herb	A
Spathoglottis plicata	Orchidaceae	Philippine Ground Orchid	Herb	A
Spermacoce sp.	Rubiaceae	Spermacoce	Herb	A
Stachytarpheta jamaicensis	Verbenaceae	Stachytarpheta	Herb	A
Syzygium jambos	Myrtaceae	Rose-Apple	Tree	A
Terminalia catappa	Combretaceae	False Kamani	Tree	A
Tournefortia argentea	Boraginaceae	Tree Heliotrope	Tree	A
Trema orientalis	Ulmaceae	Gunpowder Tree	Tree	A
Wedelia trilobata	Asteraceae	Wedelia	Herb	A
Zingiber zerumbet	Zingiberaceae	ʻAwapuhi	Herb	PI

A=Alien E=Endemic I=Indigenous PI Polynesian Introduction END=Federal and State Listed Endangered

the mosquito borne diseases of the Hawaiian lowlands. Common shorebirds such as Pacific golden-plover (*Pluvialis fulva*), ruddy turnstone (*Arenaria interpres*), and wandering tattler (*Heteroscelus incanus*) are often seen on the Puna coastline feeding on shoreline resources. Of these, only the Pacific golden-plover was observed during the site visits. The seabird black noddy (*Anous minutus melanogenys*) was observed flying near the cliffs and over the nearshore waters, as it frequently does in cliffed coasts of the main Hawaiian Islands. It nests in crevices and caves in lava (especially pahoehoe) sea cliffs; no black noddy nests were observed on the cliffs in front of the property.

As with all of East Hawaiʻi, several endangered native terrestrial vertebrates may be present in the general area and may overfly, roost, nest, or utilize resources of the property. These include the endangered Hawaiian hawk (*Buteo solitarius*), the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), the endangered Hawaiian petrel (*Pterodroma sandwichensis*), the endangered band-rumped storm petrel

(*Oceanodroma castro*), and the threatened Newell's shearwater (*Puffinus auricularis newelli*). Other mammals in the project area are all introduced species, including feral cats (*Felis catus*), feral pigs (*Sus scrofa*), small Indian mongooses (*Herpestes a. auropunctatus*) and various species of rats (*Rattus* spp.). Several species of non-native reptiles and amphibians may also be present. None are of conservation concern and all are deleterious to native flora and fauna.

The coastal and marine fauna and flora are typical of the high-energy coasts of Puna, which are young ecosystems with limited coral growth but a variety of algae, fish and invertebrates. Marine mammals and reptiles, some of them endangered, also visit the Puna coastal waters.

Impacts and Mitigation Measures

No rare, threatened or endangered plant species are present. The project site is dominated by alien vegetation, with the only semi-sensitive ecosystem on the property being the shoreline vegetation, where several common native strand plants are present mixed with non-natives such as ironwood. Development avoids the shoreline area, but a number of ironwoods will be removed and others will be trimmed. Although a few naupaka shrubs are found up to 300 feet inland, including slightly into the home site, no adverse impact upon coastal vegetation should occur. Because of the location and nature of the project relative to sensitive vegetation and species, construction and use of the single-family residence as well as agroforestry practices are not likely to cause adverse biological impacts. The removal of some of the existing ironwood in the coastal area may allow some native species to re-establish, reclaiming the area from domination by this invasive tree.

The precautions for preventing effects to water quality during construction listed above in Sections 3.1.1 and 3.1.6 will reduce adverse impact on aquatic biological resources in coastal waters to negligible levels.

In order to avoid impacts to the endangered but regionally widespread terrestrial vertebrates listed above, the applicant will commit to conditions that are proposed for the CDUP. Specifically, construction will refrain from activities that disturb or remove shrubs or trees taller than 15 feet between June 1 and September 15, when Hawaiian hoary bats may be sensitive to disturbance. Furthermore, barbed wire will not be used in order to avoid bat entanglement. If landclearing occurs between the months of March and September, inclusive, a pre-construction hawk nest search by a qualified ornithologist using standard methods will be conducted. If Hawaiian hawk nests are present, no land clearing will be allowed until October, when hawk nestlings will have fledged. Finally, the applicant agrees to shield any exterior lighting from shining upward, in conformance with Hawai‘i County Code § 14 – 50 et seq., to minimize the potential for disorientation of seabirds.

3.1.5 Air Quality, Noise, and Scenic Resources

Environmental Setting

Air quality in the area is generally excellent, due to its rural nature and minimal degree of human activity, although vog from Kilauea volcano is occasionally blown into this part of Puna when this volcano is

erupting, which it currently is not. Noise on the site is low and is derived from natural sources (such as surf, birds and wind) due to the very rural nature of the area.

The area shares the quality of scenic beauty along with most of the Puna coastline. The County of Hawai‘i General Plan contains Goals, Policies and Standards intended to preserve areas of natural beauty and scenic vistas from encroachment. The General Plan discusses the black sand beaches and tidal ponds as noted features of natural beauty in Puna, but among specific examples of natural beauty does not identify any features or views in the *ahupua‘a* of Pōpōkī, in Plat 1-5-010, or any other location near the project site. Shoreline views from the Government Beach Road are completely blocked by over 1,000 feet of heavy vegetation.

Impacts and Mitigation Measures

The project would not affect air quality or noise levels in any substantial ways. Brief and minor adverse effects would occur during construction. However, there are virtually no sensitive noise receptors in the vicinity – with no houses or other structures within 300 feet of the property boundary, and 600 feet of the proposed home site. Given the small scale and short duration of any noise impacts, coupled with the lack of sensitive receptors, noise mitigation would not be necessary.

Because all grading and construction would occur, at the closest, about 300 feet from the sea cliff, and 750 feet from the *mauka* edge of the property, with dense intervening vegetation on all sides, construction and occupation of the single-family home would have virtually no visual impacts. The agroforestry practices would involve trees and other crops that could be visible from the road but would result in a landscape in harmony with the rural landscape of Puna.

3.1.6 Hazardous Substances, Toxic Waste and Hazardous Conditions

Based on onsite inspection and the lack of any known former and current uses on the property, it appears that the site contains no hazardous or toxic substances and exhibits no other hazardous conditions. In addition to the measures related to water quality detailed in Section 3.1.3, in order to ensure to minimize the possibility for spills of hazardous materials, the applicant proposes the following:

- Unused materials and excess fill will be disposed of at an authorized waste disposal site.
- During construction, emergency spill treatment, storage, and disposal of all hazardous materials, will be explicitly required to meet all State and County requirements, and the contractor will adhere to “Good Housekeeping” for all appropriate substances, with the following instructions:
    - Onsite storage of the minimum practical quantity of hazardous materials necessary to complete the job;
    - Fuel storage and use will be conducted to prevent leaks, spills or fires;
    - Products will be kept in their original containers unless unresealable, and original labels and safety data will be retained;
    - Disposal of surplus will follow manufacturer’s recommendation and all regulations;
    - Manufacturers’ instructions for proper use and disposal will be strictly followed;

- Regular inspection by contractor to ensure proper use and disposal;
- Onsite vehicles and machinery will be monitored for leaks and receive regular maintenance to minimize leakage;
- Construction materials, petroleum products, wastes, debris, and landscaping substances (herbicides, pesticides, and fertilizers) will be prevented from blowing, falling, flowing, washing or leaching into the ocean; and
- All spills will be cleaned up immediately after discovery, using proper materials that will be properly disposed of.

3.2 Socioeconomic and Cultural

3.2.1 Land Use, Socioeconomic Characteristics and Recreation

Existing Environment

Because of the gradual occupation of lots developed during widespread land subdivision about sixty years ago, the Puna District has been the Big Island's fastest-growing district over the last thirty years. Population as measured in the 2010 U.S. Census was 45,326, a 66 percent increase over the 2000 count of 27,232. Despite the lava hazards and a lack of basic infrastructure such as paved roads and water in most subdivisions, the relatively inexpensive lots, which typically range in size from one to three acres, have attracted residents from the U.S. mainland and other parts of the State of Hawai‘i who seek affordable property. The basis of the economy of Puna has evolved from cattle ranching and sugar to diversified agriculture, various services for the growing populations, commuting to Hilo, and tourism, which has been stimulated by being home to Kilauea, one of the world's most active volcanoes.

Some Puna subdivisions between Pahoa and Hilo (including Hawaiian Beaches and Hawaiian Shores, both near the project site), are now partially bedroom communities for Hilo's workforce, as evidenced by the heavy flow of Hilo-bound traffic during the AM rush hour.

The Moore property is bordered by the shoreline to the north, by the Government Beach Road to the south, and by vacant lots to the east and west. Across and along the Government Beach Road are various farms, cattle pastures and single-family homes.

Puna experiences a high demand for coastal recreation, especially in calmer shorelines areas near populations centers. Despite the long coastline, there are few beaches in Puna, and none in the vicinity of the project site. In most location in Puna, ocean recreation consists primarily of fishing from the cliffs. There is relatively little use of the rough and irregular shoreline in this area. Maps of public accesses produced by the County of Hawai‘i do not indicate any nearby official *mauka-makai* shoreline public accesses from the Government Beach Road (http://www.hawaiicounty.gov/pl-shoreline-access-big-island). However, from informal access trails on the east and west that connect the road to the shoreline, fisherman and *opihi* pickers access fishing and gathering spots all along the coast. The project site does not have an official or unofficial shoreline trail either above or below the sea cliff. The area below the cliff is topographically difficult and no continuous access is possible. The pahoehoe shelf *mauka* of the

sea cliff is easily walkable and is occasionally used by fishermen who are traversing the coast looking for ulua fishing sites or opihi gathering areas (see photos in Figure 5).

Impacts and Mitigation Measures

No adverse socioeconomic impacts are expected to result from the project. The project will have a very small positive economic impact for the County of Hawai‘i. The residence and associated improvements will not adversely affect recreation, as access along the shoreline will not be affected. The proposed residential and farming uses will not interfere with this continuing use. Mr. Moore has been informed of the rights of the public to utilize these areas and the cultural and subsistence importance of these practices and expects that conditions ensuring continued public access along the front of the property will be codified within the Conservation District Use Permit to make the access situation explicit.

3.2.2 Cultural and Historic Resources

An archaeological inventory survey and a cultural impact assessment were prepared for the property and are attached as Appendices 2 and 3, respectively. Research for this report included primary fieldwork, consultation of archaeological and ethnographical studies and primary documents including maps and Mahele testimony, and consultation of informants. In the interest of readability, the summary below does not include all scholarly references; readers interested in extended discussion and sources may consult these appendices. Separately, the Office of Hawaiian Affairs, the Lower Puna Councilperson, the Sierra Club, Malama O Puna and five neighbors were also consulted as part of the EA to determine whether they had any information on natural or cultural resources that might be present or affected, and additional research on cultural resources and impacts was conducted.

Historical and Cultural Background

The first inhabitants of Hawai‘i were believed to be settlers who had undertaken difficult voyages across the open ocean. For many years, researchers have proposed that early Polynesian settlement voyages between Kahiki (the ancestral homelands of the Hawaiian gods and people) and Hawai‘i were underway by A. D. 300, although recent work suggests that Polynesians may not have arrived in Hawai‘i until at least A. D. 1000 (Kirch 2012).

The initial inhabitants of Hawai‘i are believed to have come from the southern Marquesas Islands and settled initially on the windward side, eventually expanding to leeward areas. Early Hawaiian farmers developed new strategies and tools for their new environment (Kirch 2012; Pogue 1978). Societal order was maintained by their traditional philosophies and by the conical clan principle of genealogical seniority (Kirch 2012). Universal Polynesian customs brought from their homeland included the observance of major gods *Kane*, *Ku*, and *Lono*; the *kapu* system of law and order; cities of refuge, various beliefs, and the concepts of *mana* and the *‘aumakua* (Fornander 1969).

The Development Period, believed under Kirch’s new concept to have occurred from A. D. 1100 to 1350, brought an evolution of traditional tools, including a variation of the adze (*ko‘i*), and some new Hawaiian

inventions such as the two-piece fishhook and the octopus-lure breadloaf sinker. That was followed by the Expansion Period (A. D. 1350 to 1650) which saw greater social stratification, intensive land modification, and population growth. This period was also the setting for the second major migration to Hawai‘i, this time from Tahiti. Also established during this period was the *ahupua‘a*, a land-use concept that incorporated all of the eco-zones from the mountains to the shore and beyond. The usually wedge-shaped *ahupua‘a* provided a diverse subsistence resource base (Hommon 1986) and added another component to what was already becoming a well-stratified society (Kirch 2012).

As population grew during the following centuries so did the reach of inland cultivation in the upland environmental zones and consequent political and social stresses. During the Proto-Historic Period (A. D. 1650-1795), wars reflective of a complex and competitive social environment are evidenced by *heiau* building. During this period, sometime during the reign of Kalaniopu‘u (A. D. 1736-1758), Kamehameha I was born in North Kohala.

Ahupua‘a were ruled by *ali‘i ‘ai ahupua‘a* or lesser chiefs and managed by a *konohiki*. *Ali‘i* and *maka‘ainana*, or commoners, were not confined to the boundaries of *ahupua‘a* as resources were shared when a need was identified. *Ahupua‘a* were further divided into smaller sections such as *‘ili, mo‘o‘aina, pauku‘aina, kihapai, koele, hakuone* and *kuakua*. The chiefs of these land units have their allegiance to a territorial chief or *mo‘i* (literally translated as king) (Hommon 1986). The Moore property is located within the *ahupua‘a* of Pōpōkī, which translates literally as “ti leaf bundle” (Pūku‘i et al. 1974), in the traditional *moku-o-loko* or district of Puna, which comprises some fifty *ahupua‘a* on the eastern/ windward shores of Hawai‘i Island. As Pōpōkī encompasses *mauka* agricultural and forest resources and *makai* fisheries, residents were once able to procure nearly all that they needed to sustain their families and contribute to the larger community from within the land division.

The Pre-Western contact population of the Puna District lived in small settlements along the coast where they subsisted on marine resources and agricultural products. As McGregor stated in reference to the lava flows that periodically alter the district, “Puna is where new land is created and new growth and new life sprout. The new land is sacred, fresh, clean, and untouched. After vegetation begins to grow upon it, it is ready for human use.” (2007:145). The villages of Puna, McEldowney notes, were similar to those of the Hilo District, and they:

> …comprised the same complex of huts, gardens, windbreaking shrubs, and utilized groves, although the form and overall size of each appear to differ. The major differences between this portion of the coast and Hilo occurred in the type of agriculture practiced and structural forms reflecting the uneven nature of the young terrain. Platforms and walls were built to include and abut outcrops, crevices were filled and paved for burials, and the large numbers of loose surface stones were arranged into terraces. To supplement the limited and often spotty deposits of soil, mounds were built of gathered soil, mulch, sorted sizes of stones, and in many circumstances, from burnt brush and surrounding the gardens. Although all major cultigens appear to have been present in these gardens, sweet potatoes, ti (*Cordyline terminalis*), *noni (Morinda citrifolia*), and gourds (*Lagenaria siceraria*) seem to have been more conspicuous. Breadfruit, pandanus, and

> mountain apple (*Eugenia malaccensis*) were the more significant components of the groves that grew in more disjunct patterns than those in Hilo Bay. (McEldowney 1979:17)

Located along the coast, the property is within the Coastal Settlement Zone (Zone I) as modeled by McEldowney (1979:15-18), where families often lived clustered around sheltered bays (McEldowney 1979). In their refinement of the model as it applies to Puna, Burtchard and Moblo (1994) elaborate on McEldowney's concept of the Coastal Settlement Zone:

> As with her model, [the Coastal Settlement Zone] includes coastal terrain to about one half mile inland. This is the zone expected to have the greatest density and variety of prehistoric surface features in the general study area. Primary settlements are expected in places where agriculturally productive sediments (principally well-weathered *ʻaʻā* flows) co-occur with sheltered embayments and productive fisheries. Settlements within this zone are expected to be logistically linked to inland agricultural and forest exploitation zones accessed through a network of upslope-downslope (*Mauka-makai*) trails. Larger settlements and resource acquisition areas may have been connected by cross-terrain trail networks (1994:26).

In addition to the agricultural resources listed above, the barrenness of surrounding lava flows was not a limiting factor for the cultivation of sweet-potato or *ʻuala*, which requires practically no soil to flourish. Its propagation is discussed in detail by many nineteenth and early twentieth century visitors to the district, who described seeing the *ʻuala* growing from mounds of lava stones. In the following passage, published under the title "Hawaii-Nei" in *Harper's Magazine*, Charles Nordhoff (1873a:382-402) described the vegetation of Puna and mention early commercial coffee production in the district. Nordhoff also provided observations of the narrow coastal trail "across unceasing beds of lava" that "was actually hammered down to make it smooth enough for travel" in some places (1873a:401). According to Nordhoff, "most of the lava is probably very ancient, though some is quite recent, and ferns and guava bushes and other scanty herbage grow through it" (ibid.). Nordhoff's narrative continued:

> ...after a descent to the sea-shore, you are rewarded with the pleasant sight of groves of cocoa-nuts and umbrageous arbors of pandanus, and occasionally with a patch of green. Almost the whole of the Puna coast is waterless...
>
> It will surprise you to find people living among the lava, making potato patches in it, planting coffee and some fruit trees in it, fencing in their small holdings, even, with lava blocks. Very little soil is needed to give vegetation a chance in a rainy season, and the decomposed lava makes a rich earth. But, except the cocoa-nut, which grows on the beach, and seems to draw its sustenance from the waves, and the sweet-potato, which does very well among the lava, nothing seems really to thrive. (ibid.).

In another installment titled "Hawaii-Nei-II", Nordhoff (1873b:544-559) wrote of the lack of fresh water in Puna and how Dr. Coan had told him about how Native Hawaiians collected freshwater for his use during his missionary tour "from the drippings of dew in caves" (1873b:550). For, "wells are here out of the question, for there is no soil except a little decomposed lava, and the lava lets through all the water

which comes from rains" compounded by the lack of mountain streams (ibid.). Nordhoff also presented the following observations of the communities in Puna as well as traditional sweet potato planting methods:

> There are no fields, according to our meaning of the word. Yet formerly the people in this district were numbered by thousands: even yet there is a considerable population, not unprosperous by any means. Churches and schools are as frequent as in the best part of New England. Yet when I asked a native to show me his sweet-potato patch he took me to the most curious and barren-looking collection of lava you can imagine, surrounded too, by a very formidable wall made of lava, and explained to me that by digging holes in the lava where it was a little decayed, carrying a handful of earth to each of these holes, and planting there in a wet season, he got a very satisfactory crop. Not only that, but being desirous of something more than a bare living, this man had planted a little coffee in the same way, and had just sold 1600 pounds, his last crop. (ibid.)

Although *ʻuala* was cultivated widely, Handy et al. said that it did not appear to have been a staple food of Puna, a district "most famous for its breadfruit" (1991:190). Handy opined:

> . . . Despite the fact that sweet potatoes were planted almost universally and many patches are still maintained, the Puna natives seem to regard this vegetable with little interest, probably because Puna people prided themselves upon and relished their breadfruit, and also because potato was nowhere and at no time the staple for this rainswept district. (1940:165)

Breadfruit (*ʻulu*) was a *kinolau* (physical manifestation) of the goddess Haumea, the "patron of childbirth," and the principal staple food of Puna, where it was most famous (Beckwith 1970:283; Handy et al. 1991). Careful and gentle propagation was required, which entailed the removal and replanting of the root sucker cutting while ensuring it remained within its original, undisturbed soil casing. With respect to *ʻulu* as a sustainable food source, Handy et al. explained that, "except in Puna, Hawaii, breadfruit was wholly secondary to taro and sweet potato as a staple. I am told that in Puna in a good year, breadfruit may be eaten for 8 months of the year, beginning with May "(1991:152).

Although *ʻulu* appears to have been the preferred source of sustenance for residents of Puna, taro (*kalo*) rivaled it as a staple food source. Puna's lack of flowing streams made growing wetland *kalo* impossible. Despite this freshwater stream deficit, Puna received plentiful rainfall throughout the year, which made the cultivation of dryland *kalo* possible, even along the coast as far north as Hilo (Handy 1940). Handy et al. related that, "the wet and sometimes marshy pandanus forests from Kapoho through Poho-iki to ʻOpihikao used to be planted with taro in places" (1991:541). The method of planting dryland taro in the lowland forests of Puna is described by Handy et al. as the "*pa-hala* (pandanus clearing) method" (1991:104) and was advantageous for it did not require the constant weeding necessitated in better soils. The Pa-hala planting process is as follows:

> Make holes in the *ʻaʻa* (broken lava) by taking out some of the stones. Be sure that the place chosen is in a *pu hala* grove, to save the labor of hauling *hala* branches into the patch later on. Fill the hole with whatever weeds can be found and leave them there for six weeks or more. The

> weeds will rot and make soil. When the weeds have rotted away, the taro *huli* are wrapped in *lau hala* (*hala* leaves) to keep them moist and are planted. When there or four leaves have appeared on each *huli*, then that is the time to cut down the *pu hala* to let in the sun. The branches of the *hala* are cut off and the patch covered with them until this is not a trace of the taro to be seen. This is left until sufficiently dry to set on fire. The fire does not hurt the taro much as the *huli* are already well rooted. The *hala* reduced to ashes, give the taro the needed nourishment and they grow so tall that a man can be hidden under their leaves (Handy et al. 1991:104–105).

Hala was valued for its fragrance and harvested for more utilitarian purposes. The inhabitants of Puna were recognized for their skilled *lauhala* (*hala* leaf) weaving. The dried leaves were used to plait *lauhala* mats for thatching onto house rafters and walls in a method typically employed in Puna and the neighboring district of Hilo in the absence of *pili* grass. Plaited *lauhala* was also used for pillows, fans, floor coverings, canoe sails, baskets, and occasionally as clothing (Handy et al. 1991). According to Fornander (1918-1919), two styles of *lauhala* mats were associated with Puna; the *makali'i*, a braided, small-stranded mat, and the *puahala* or *hīnano*, made from the male pandanus blossom. The latter was highly valued, and "...is only made in Puna where the hala tree is very abundant. It is a regular article of trade among the natives who greatly prize it as a choice mat to sleep on" (Summers 1999:17). *Hala* had many other significant uses and came to be identified with the people of Puna.

In addition to *hala*, *kalo*, *'ulu*, and *ti* mentioned above, other crops such as coconut (*niu*) and *'awa* were cultivated in Puna. *Niu* thrived in coastal Puna and is frequently mentioned in historical accounts. With respect to varieties, Handy et al. (1991) list only two: the *niu hiwa* (particularly used for ceremony, medicine, and cooking), and the *niu lelo* (used primarily for nonreligious purposes). Water from the *niu* was palatable and flavorful. It could also be utilized on a spiritual level by priests practicing divination. The raw meat was edible, and could be scraped out of the shell with a large *'opihi* to be eaten as is or incorporated into the preparation of various sweets including *haupia* (*haukō*), *kūlolo, and pi'epi'e 'ulu*. Besides being utilized for human consumption, coconut meat could also be used to feed animals.

Puna was a region famed in legendary history for its associations with the goddess Pele and god Kāne. Because of the relatively young geological history and persistent volcanic activity, the region has a strong association with Pele. However, the connection to Kāne is perhaps more ancient. Kāne, ancestor to both chiefs and commoners, is the god of sunlight, fresh water, verdant growth, and forests. It is said that before Pele migrated to Hawai'i from Kahiki, Puna was esteemed the most beautiful place in the islands by many. Contributing to that beauty were the groves of fragrant hala and forests of *'ōhi'a lehua* for which Puna was famous. The inhabitants of Puna were likewise famous for their expertise and skill in *lauhala* weaving.

Many *'ōlelo no'eau* (traditional sayings) speak of Puna, and most mention the land – which could at any time be covered in inky lava left in Pele's furious wake – and the air, which was sweetly scented with the heavenly fragrances of *hala*, *maile*, and *lehua* blossoms. The following *'ōlelo no'eau* are from Mary Kawena Pūku'i (1983):

> *Ka makani hali ʻala o Puna.*
> The fragrance-bearing wind of Puna
> Puna, Hawaiʻi, was famed for the fragrance of *maile*, *lehua*, and *hala*. It was said that when the wind blew from the land, fishermen at sea could smell the fragrance of these leaves and flowers. (p. 158)
>
> *Ke one lauʻena a Kāne.*
> The rich, fertile land of Kāne.
> Puna, Hawaiʻi, was said to have been a beautiful, fertile land loved by the god Kāne. Pele came from Kahiki and changed it into a land of lava beds, cinder, and rock. (p.191)

The fragrant breezes of Puna were also celebrated in Hawaiian *mele* (songs). One such mele, *Ke Haʻa Lā Puna i ka Makani*, accompanied the very first recorded *hula* of the Pele and Hiʻiaka saga (Kanahele and Wise 1989). A tale of jealousy and spite is recounted in the legend *Hopoe the Dancing Stone*, published by Westervelt (1916). Pele called upon each of her sisters to fetch her dream lover Lohiʻau from Kauaʻi. Knowing Pele's tempestuous temper, each feared possible repercussions and refused to go. After being denied by all but one sister, Pele rumbled her home, the volcano, sending out burning smoke and vapors, impatiently beckoning her very last option. Hiʻiaka did so, leaving behind her dear friend Hōpoe, a skilled and graceful hula dancer who and had spent much time teaching Hiʻiaka old Hawaiian hula. Before Hiʻiaka could return, Pele's impatient fury caused her to shake the earth with great ferocity and heaved her lava in a torrent of devastation, annihilating Hiʻiaka's *ʻōhiʻa lehua* forest, obliterating all of Puna, and finally cornering Hōpoe as she lingered by the sea:

> Hopoe was the last object of Pele's anger at her younger sister, but there was no escape. The slow torrent of lava surrounded the beach where Hopoe waited death. She placed the garlands Hiiaka had loved over her head and shoulders. She wore the finest skirt she had woven from lauhala leaves. She looked out over the death-dealing seas into which she could not flee, and then began the dance of death. (Westervelt 1916:94)

In her death, Hōpoe was transformed. She was reborn as a stone, carefully balanced alongside the sea where she could continue her graceful dance throughout the centuries when touched by the soft breeze or the rumbling of the earth. And Hiʻiaka, her heart bitter with her sister's betrayal, brought Lohiʻau back to Pele, faithfully as she swore she would.

Many other stories, chants and songs deal with legendary events in Puna that still bring meaning to the landscape today. Some of them dealt with *ʻaumakua*, which are certain animals, trees, flowers, insects, and natural phenomena who were half god and half human and communicated through mediums, possessed by their spirits. Of special significance are *ʻaumakua manō* (shark deities) who are frequently worshipped in Hawaiʻi.

A traditional *moʻolelo* (story), "The Heart Stirring Story of Ka-Miki" (*Kaao Hooniua Puuwai no Ka-Miki*), originally appeared in *Ka Hoku o Hawaiʻi* (a Hawaiian language newspaper) between 1914 and 1917. The story tells of two supernatural brothers, Ka-Miki and Maka-ʻiole, who were skilled *ʻōlohe*

(competitors/fighters) and their travels around Hawai‘i Island by way of the ancient trails and paths (*ala loa* and *ala hele*), seeking competition with other *‘ōlohe*. Among several tales involving Puna, during an expedition through the uplands, Ka-Miki and Maka-‘iole encountered a man named Pōhakuloa who was intensely working on a large *koa* log. They were headed to Kea‘au but had lost their way. They stopped and asked Pōhakuloa for directions, but he was startled by the unexpected appearance of the brothers and replied impolitely. Taunts were exchanged between the two parties, which led to a physical altercation. It was at this point, that Pōhakuloa realized that these two men were extraordinarily skilled as well as spiritually protected, and he admitted his defeat. Pōhakuloa wished to prepare a meal and drink of *‘awa* with his newfound friends, and solicited the help of his brother in law, an *‘ōlohe* chief named Kapu‘euhi. However, Kapu‘euhi had plans of his own. He intended to compete with and conquer the brothers but was defeated by them instead. Kapu‘euhi was infuriated by his defeat, and by Pōhakuloa’s refusal to aid in retaliation against Ka-Miki and Maka-‘iole.

Kapu‘euhi invited the brothers back to his house to partake in a meal and a particularly potent type of *‘awa*, scheming to get them drunk. Unbeknownst to Ka-Miki and Maka-‘iole, this was common practice for Kapu‘euhi, who often housed weary travelers, intoxicated them with *‘awa*, then killed them and stole their belongings. Kapu‘euhi waged a bet with the brothers; if they couldn’t drink five cups of the *‘awa*, then he would throw them out and they would be at the mercy of the Puna forest. Ka-Miki and Maka-‘iole agreed and counteracted his bet with one of their own; if they were able to drink five cups, they would throw Kapu‘euhi out of his own house. The brothers prayed and chanted to their ancestral goddess and were able to consume the entire quantity of *‘awa* without getting drunk. As agreed upon, Kapu‘euhi was thrown out. Stunned, and angered that he was thwarted once again, Kapu‘euhi requested assistance from Kaniahiku (a much feared Puna *‘ōlohe* and forest guardian) and her grandson Keahialaka. “At that time, Keahialaka was under the guardianship of Pānau and Kaimū, and he enjoyed the ocean waters from Nānāwale to Kaunaloa, Puna” (*Ka Hoku o Hawai‘i* October 28, 1915; translated by Maly 1998:20), which Maly suggests is symbolic of controlling those regions.

Together, Kapu‘euhi and Kaniahiku conspired to lead the brothers deep into the Puna forest, where Kaniahiku would be able to murder them, all the while maintaining the façade that they were taking them to the *‘awa* grove of Mauānuikananuha. Once Ka-Miki and Ka-‘iole were well within the domain of Kaniahiku, she created a dark and murky environment, spreading gloomy mists and an overgrowth of twisted vegetation intended to ensnare the brothers. Ka-Miki and Maka‘iole were overcome, and left for dead by Kapu‘euhi, who made his way back to safety, led by Kaniahiku’s sister. They prayed to their ancestor, Ka-uluhe-nui-hihi-kolo-i-uka for help. All at once, her presence became apparent, and the brothers were able to continue on to the ‘awa grove. Another attempt by Kaniahiku to kill the brothers was made, but Ka-uluhe’s protection over them was too strong, and she failed (Maly 1998).

The subject *ahupua‘a* of Pōpōkī is specifically mentioned in the *Legend of Halemano*, the tale of a romance between Halemano of O‘ahu and the beautiful and forbidden princess Kamalālāwalu (Kama) of Puna (Fornander 1918-1919:234). Kama lived under a strict *kapu* that kept her from leaving her home or having visitors and companionless except for her brother Kumukahi. Her parents had promised her as the wife of either the Hilo or the Puna King upon reaching maturity. Instead, Kama became untied with a

young man from O‘ahu named Halemano through his learning of her in his dreams and sailing a canoe across to Puna with gifts for her and her brother, Kumukahi, who could act as an intermediary.

> After these different things were ready they set out for Puna, Hawaii. Upon their arrival off of Makuu and Popoki, two small pieces of lands next to Puna, the kite was put up. When the people on the shore saw this flying object they all shouted with joy (ibid.)

Their shouting drew Kumukahi out onto the beach where he became enthralled by the gifts he saw there, according to plan. Since Kama could not refuse her dear brother’s wishes, she agreed to come down to the beach and eventually onto Halemano’s canoe, and the pair were paddled off to O‘ahu.

Traditional life in Hawai‘i’ took a sharp turn on January 18, 1778 with the arrival of British Capt. James Cook in the islands. On a return trip to Hawai‘i ten months later, Kamehameha visited Cook aboard his ship the *Resolution* off the east coast of Maui and helped Cook navigate his way to Hawai‘i Island. Cook exchanged gifts with Kalaniopu‘u at Kealakekua Bay the following January, and Cook left Hawai‘i in February. However, Cook’s ship then sustained damage to a mast in a severe storm off Kohala and returned to Kealakekua, setting the stage for his death on the shores of the bay.

During the Proto-Historic Period there was a continuation of the trend toward intensification of agriculture, *ali‘i*-controlled aquaculture, settling of upland areas and development of traditional oral history. The *Ku* cult, *luakini heiau* and the *kapu* system were at their peaks, but the influence of western civilization was being felt in the introduction of trade for profit and a market-system economy. By 1810, the sandalwood trade established by Europeans and Americans twenty years earlier was flourishing. That contributed to the breakdown of the traditional subsidence system, as farmers and fishermen were required to toil at logging, which resulted in food shortages and a decline in population.

The rampant sandalwood trade resulted in the first Hawaiian national debt, as promissory notes and levies granted by American traders were enforced by American warships. The assimilation of western ways continued with the short-lived whaling industry to the production of sugarcane, which was more lucrative but carried a heavy environmental price.

Following the death of Kamehameha I in 1819, the customary relaxing of *kapu* took place. But with the introduction of Christianity shortly thereafter, his successor, Kamehameha II, renounced the traditional religion and ordered that *heiau* structures either be destroyed or left to deteriorate. The family worship of *‘aumakua* images was allowed to continue.

In 1823, British missionary William Ellis and members of the American Board of Commissioners for Foreign Missions (ABCFM) toured the island of Hawai‘i scouting communities in which to establish church centers for the growing Calvinist mission. Ellis recorded observations made during this tour in a journal (Ellis 1963). His writings contain descriptions of residences and practices elsewhere in Puna that are applicable to the general study area:

> The population in this part of Puna, though somewhat numerous, did not appear to possess the means of subsistence in any great variety or abundance; and we have often been surprised to find desolate coasts more thickly inhabited than some of the fertile tracts in the interior; a circumstance we can only account for, by supposing that the facilities which the former afford for fishing, induce the natives to prefer them as places of abode; for they find that where the coast is low, the adjacent water is usually shallow.
>
> We saw several fowls and a few hogs here, but a tolerable number of dogs, and quantities of dried salt fish, principally albacores and bonitos. This latter article, with their *poë* [*poi*] and sweet potatoes, constitutes nearly the entire support of the inhabitants, not only in this vicinity, but on the sea coasts of the north and south parts of the island.
>
> Besides what is reserved for their own subsistence, they cure large quantities as an article of commerce, which they exchange for the vegetable productions of Hilo and Mamakua [Hāmākua], or the mamake and other tapas of Ora [ʻŌlaʻa] and the more fertile districts of Hawaii.

Ellis and the ABCFM missionaries travelled along the coast of Kauwai, Waʻawaʻa, and Nānāwale Ahupuaʻa and then turned *mauka* toward a village in Honolulu Ahupuaʻa (Ellis 2004:294). On August 8, 1823, the Ellis and the missionaries left Honolulu and visited the village of Waiakahiula to the southeast of the project site. Ellis' journal provides a brief first-hand description of the village's location relative to the coast:

> We arose early on the 8th, and Mr. Thurston held morning worship with the friendly people of the place [Honolulu]. Although I had been much indisposed through the night, we left Honoruru soon after six a.m. and, travelling slowly towards the sea-shore, reached Waiakeheula about eight, where I was obliged to stop, and lie down under the shade of a canoe-house near the shore. Messrs. Thurston and Bishop walked up to the settlement about half a mile inland, where the former preached to the people… (Ellis 2004:295).

After preaching, Bishop continued on alone toward Waiakea, while Thurston returned to fetch Ellis from the canoe shed. Upon reaching the village, Ellis found its residences to be interspersed among the agricultural fields rather than in a single, nucleated settlement:

> The country was populous, but the houses stood singly, or in small clusters, generally on the plantations, which were scattered over the whole country. Grass and herbage were abundant, vegetation in many places luxuriant, and the soil, though shallow, was light and fertile. (Ellis 2004:296)

A year after Ellis' visit, in 1824, the ABCFM established a base church in Hilo. From that church (Haili), the missionaries traveled to the more remote areas of the Hilo and Puna Districts. David Lyman, who came to Hawaiʻi in 1832, and Titus Coan, who arrived in 1835, were two of the most influential Congregational missionaries in Puna and Hilo. As part of their duties they conducted a census of the areas

within their missions. In 1835, 4,800 individuals were recorded as residing in the district of Puna; the smallest total district population on the island of Hawai‘i. In 1841, Titus Coan stated that most of the 4,371 recorded residents of Puna lived near the shore, though hundreds also lived inland.

In 1835, the United States Exploring Expedition under the direction of Commander Charles Wilkes toured Hawai‘i Island and travelled through the Puna District. Wilkes produced a map of Puna, which illustrates the coastal trail but shows only a large “Pandanus Forest” covering the lands *mauka* of the Moore property (see Figure 5 of Appendix 3). Wilkes described the trail between Hilo and Nānāwale (Nanavalie) 5 as follows:

> In some places they have taken great pains to secure a good road or walking path; thus, there is a part of the road from Nanavalie to Hilo which is built of pieces of lava, about four feet high and three feet wide on the top; but not withstanding this, the road is exceedingly fatiguing to the stranger, as the lumps are so arranged that he is obliged to take a long and short step alternately; but this the natives do not seem to mind, and they pass over the road with great facility, even when heavy laden…(Wilkes 1856, Vol. IV:188-193).

The *Mahele ‘Aina* took place in 1848, placing all land in Hawai‘i into three categories: Crown Lands, Government Lands and Konohiki Lands. Ownership rights were “subject to the rights of the native tenants,” or those individuals who lived on the land and worked it for their subsistence and for their chiefs. As a result of the *Māhele*, Pōpōkī, along with the immediately adjacent *ahupua‘a* of Maku‘u and Hālona, were retained as Government Lands in their entirety (Charvet-Pond and Rosendahl 1993:C-2). In addition, the Commissioners of Boundaries (Boundary Commission) never certified the boundaries of Pōpōkī Ahupua‘a, which is why it is so often grouped with the neighboring *ahupua‘a* of Maku‘u and Hālona. These three *ahupua‘a* were not depicted individually on any of the cartographic resources reviewed for the cultural impact assessment; in literature, all three are commonly referenced together as a single unit called Maku‘u. Very few *kuleana* claims were made during the Māhele for Puna, mostly owing to rapid depopulation from disease and migration, and none were made for *kuleana* within Pōpōkī Ahupua‘a (Waihona ‘Āina database).

In conjunction with the Māhele ‘Āina of 1848, the King authorized the issuance of Royal Patent Grants to applicants for tracts of land, larger than those generally available through the Land Commission. The process for applications was clarified by the “Enabling Act,” which was ratified on August 6, 1850. The Act resolved that portions of the Government Lands established during the Māhele should be set aside and sold as grants. The stated goal of this program was to enable native tenants, many of whom were not awarded *kuleana* parcels during the Māhele, to purchase lands of their own. Despite this goal, many of the Government Lands were eventually sold or leased to foreigners. Between 1852 and 1855, coastal portions of Pōpōkī, Maku‘u and Hālona *ahupua‘a* were divided and sold as fee simple Land Grants (see Figure 6 of Appendix 3). Grant 1013 was sold to D. Maiau in 1852; Grant 1014 to Kea in 1852; and Grant 1537 to Kapohano(a) in 1855. The Moore property is situated within the southern coastal portion of Grant 1537, which comprises 171 acres and is crossed by the *alanui aupuni* or government road (Maly 1999:67). Around the time that Grant 1537 was sold, Puna’s population had suffered a sharp decline. Within a quarter of a century, Puna’s population deteriorated by more than half, from 4,800 in 1835 to 2,158 in

1860 (Anderson 1865). In 1868 volcanic activity emanating from Mauna Loa volcano devastated Hawai‘i Island with lava flows, earthquakes and a tsunami. This transformed the landscape of the southern part of island forever, and further contributed to the depopulation in Puna. Even with this disaster, however, transportation infrastructure in the project area continued to improve in order to serve the growing commercial sugar, timber and coffee operations in Puna. The Puna District population fell further to a mere 1,043 in 1878 and reached an unsurpassed low of 944 persons by 1884 (Thrum 1885 and 1886).

Post-Māhele historical accounts of Puna were generally authored by visitors to the Hawaiian Islands and mostly take the form of travelogues. These writings demonstrate a considerable transformation from the almost exclusive traditional native subsistence strategies discussed in earlier chronicles to a new way of life. As discussed in Appendix 3, such accounts include those of the famous travelers Mark Twain and Isabella Bird, as well as lesser known authors such as Henry Whitney, George Chaney and John Roy Musick. Many mention the Government Beach Road, which evolved from earlier trail routes and was under construction as a true road by the 1840s. The road remained the preferred route of travel between Hilo and the outlying areas of Puna until 1895, when the Kea‘au-Pāhoa Road (now Highway 130) was established to access the growing inland population centers and agricultural areas (Maly 1999:6). A small settlement at Maku‘u reached after traveling through miles of hala groves is frequently mentioned.

By 1900 Puna was on the verge of major economic growth, spurred by the sugar and lumber industries. The rise and fall of these industries can be traced along the rusted railroad tracks that litter the landscape *mauka* of the property. In 1899, the ‘Ōla‘a Sugar Company began operating around Kea‘au. The directors of the company realized early that the lack of cargo transportation facilities would hinder their success. As a result, they organized the Hilo Railroad Company and, on April 8, 1899, were granted a 50-year charter (Best 1978). The railroad’s infrastructure developed quickly. Rail service to ‘Ōla‘a (Kea‘au) from Hilo began on June 18, 1900. Puna Sugar Company, located near the village of Kapoho, had been organized within the Puna District earlier that same year. Puna Sugar had cane fields scattered all over lower Puna from Kapoho to Pāhoa Town itself. Coastal Pōpōkī’s thin, sticky, acidic soils, however, did not allow sugar cane cultivation. The scattered geography of suitable agricultural lands in Puna also hindered the growth of the sugar industry. As with ‘Ōla‘a Sugar’s early Kea‘au operations, the lack of a reliable transportation system made it expensive to collect and transport the cane from the scattered fields to the mill. So, when Hilo Railroad proposed to lay four miles of track from Kapoho to Pāhoa, the Puna Sugar Company paid for half the cost. By March 1, 1902, the Hilo Railroad was making regular stops at the ‘Ōla‘a Sugar Mill, the town of Pāhoa, and in lower Puna. By 1905 the harvests of the Puna Sugar Co. were being ground at the ‘Ōla‘a Mill, and the Puna Sugar Co. was operating as a division of the ‘Ōla‘a Sugar Co. (Dorrance and Morgan 2000). The railroad in this area lasted until 1948.

The route of the railroad across Pōpōkī ca. 1903, *mauka* of the Moore property, appears on Hawai‘i Registered Map No. 2258 (see Figure 7 of Appendix 3). Also visible on Registered Map No. 2258 is a single structure within the boundaries of Grant 1537, located near the coast, *mauka* of a small hill and survey station labeled Opunaha. It is also of note that on the map, the numbered survey transit stations along the coast were given names of presumed local significance. A former resident of Maku‘u who resided on Grant 1013, Mrs. Mary Ann Kamahele, recalled that Opunaha was a canoe landing spot, and that Kula (the name given to Transit Station 14) was a *ko‘a* (a fishing ground) where *āholehole* were

caught (Ewart and Luscomb 1974). As seen on the map (see Figure 7 of Appendix 3), Transit Station 13, which approximates the southeastern corner of the Moore property, is labeled Kahuanui, perhaps a reference to the coastal *pāhoehoe* flat that dominates the area. A coconut grove is also depicted directly across the Government Road from the property.

An unmarked *mauka*/*makai* trail extends just outside and parallel to the southern boundary of the Moore property and bisects the Government Road and proceeds to the southwest with a branch that veers back down to the ocean. The main alignment of the trail continues south, extending through Keonepoko Iki Ahupua‘a, crossing the Hilo Railroad and terminating just to the west of the "Section House" buildings. An "old trail" is also visible on the map to the west of the current study area within the northern portion of Grant 1537, immediately *mauka* of the Government Road. This trail extends *mauka* and terminates after it crosses the Hilo Railroad. The government road is labelled as "6-feet wide" on the 1903 map, the same alignment is labeled "Puna Trail" in a 1924 topographic map (see Figure 8 of Appendix 3). Thus, the same alignment was referred to as Puna Trail, *alanui aupuni*, and Government Road interchangeably.

Several important land use actions occurred in Pōpōkī Ahupua‘a near the Moore property during the first third of the 20th century. The *makai* lands of Pōpōkī and neighboring Government Lands became part of Shipman Ranch. Hawai‘i Territory Survey Plat Map No. 811 (prepared in 1915) shows that W.H. Shipman, Ltd. held a lease for pasture land of roughly 14,000 acres of Maku‘u, Pōpōkī, and Hālona (General Lease No. 854) at an annual rental of $251.00. The lease, which began on November 25, 1914 and expired on November 25, 1929, excluded the 171-acre Grant No. 1537 to Kapohano, within which the Moore property is located. On June 17, 1929, a 500-acre portion of what is referred to as the Ka‘ohe-Maku‘u Government Tract was set aside as Parcel B for the Hawaiian Homes Commission, explicitly excluding Grants 1013, 1014, and 1537.

During the mid-1960s, the lands to the southeast and northwest of the project site were subdivided into the Hawaiian Beaches, Hawaiian Parks, and Hawaiian Shores subdivisions. In recent years several residences have been constructed along the coast in the Maku‘u area within the subdivided parcels of the former grant properties.

As documented in Appendix 3, a number of cultural impact assessments conducted primarily for other single-family residences in the area found that a constant through all these eras of history is that the well-developed Hawaiian traditions of fishing and collecting food from the ocean continue to be practiced. This orientation to the shoreline and the traditional practices developed in Hawai‘i are still passed down from generation to generation. Many fishermen catch *pūhi* to fish for *‘ulua* along the cliffs of Puna. Whether they use a hand-line or rod and reel, they use knowledge and techniques of past fishermen to select fishing locations, proper bait, and technique. Fishermen throw net, fish by rod and reel, or spear fish at different locations along the shoreline including the Maku‘u area to catch specific fish such as *āholehole*, *‘āweoweo*, *kala*, *kole*, *kūmū*, *manini*, *mamo*, *moana* and many other types of fish. In addition, the traditional collection of *‘ōpihi*, *‘a‘ama*, and *limu* along the rocky shoreline is still practiced. Others fish by boat out of Hilo or Pohoiki for *akule*, *kawele‘ā*, *mahimahi*, *ono*, *‘ōpakapaka*, and other species. Traditional Hawaiian fishing practices, shoreline gathering practices, and ocean access are protected by State law.

Archaeological Investigations and Resources

Previous archaeological studies conducted in the general project area provide a working model for the types and density of features that the archaeologists could expect on the project site. These studies are reviewed in Appendix 2; they identified mounds, feature complexes, platforms, walls, trails, *ahu*, C-shaped rock structures, stone alignments, faced depressions, pits and ravines. These features were interpreted as having been used for habitation, burial, ceremonial, and agricultural purposes.

Fieldwork at the Moore Property was conducted in August 2017, under the direction of Benjamin Barna, Ph.D. The entire property was walked along northeast/southwest transects with fieldworkers spaced at 10-meter intervals. Archaeological features, along with landforms and disturbed areas, were plotted on a map using GPS data and compass-and-tape mapping techniques. Features were then cleared of vegetation, photographed, and described using standardized site record forms. A single hand-excavated test trench was used to determine if archaeological evidence of Site 18418A (a trail recorded on a nearby parcel) was present *mauka* of the shoreline within the property itself.

Fieldwork determined that one previously unrecorded archaeological site (SIHP Site 50-10-45-30712), an agricultural complex, was present within the property. The site comprises 64 features that include 22 mounds, 22 walls and three wall remnants, nine modified depressions, three cleared soil areas, three modified outcrops, one cluster of *pāhoehoe* excavations, and one rock alignment. Based on the relatively informal and opportunistic construction of the features, their association with soil deposits, and their widespread distribution, they have all been interpreted as agricultural clearing, planting, or boundary features. When considered in the context of previous archaeological studies in the coastal Maku‘u-Pōpōkī-Hālona area, the patterning of archaeological features corroborates ethnohistoric accounts of the area as a dispersed coastal settlement surrounded by opportunistic agricultural land use. Subsurface testing in the hand-excavated trench produced negative results, indicating that the trail denoted as Site 18418A does not exist *mauka* of the shoreline within the property.

Site 30712 is assessed to be historically significant under only Criterion d, for the information yielded relative to the type and extent of agricultural features in the Maku‘u-Pōpōki-Hālona area. The archaeologists consider the archaeological study sufficient to fully document Site 30712 and to exhaust its potential to yield further information important for research on prehistory or history. Therefore, no further historic preservation work is recommended for the site. It should be noted that it is the landowner’s intention to avoid disturbing the archaeological features during construction activities, and to incorporate these features functionally into the proposed agroforestry. Additional details of the survey methods and findings are contained in Appendix 2.

Evaluation of Significance and Assessment of Impacts to Archaeological Resources

Site 30712 was evaluated by the archaeologists as significant for the information it has yielded. The site was fully documented during the archaeological survey, and the archaeologists propose that the site documentation has served to mitigate any potential impacts from the future development of a single-

family residence. As the significance of the archaeological resource derives from information already collected from Site 30712, and the likelihood of encountering additional significant subsurface archaeological resources is remote, no further historic preservation work is recommended. The survey was provided to SHPD for their review and comment on November 12, 2017, with no response yet. In the unlikely event that any unanticipated archaeological resources are unearthed within the project site during the proposed development activities, work in the immediate vicinity of those resources should be halted and SHPD should be contacted in compliance with Hawai‘i Administrative Rules 13§13-280.

Cultural Resources and Practices

When assessing potential cultural impacts to resources, practices, and beliefs, input gathered from community members with genealogical ties and/or long-standing residency relationships to the project area is vital. It is precisely these individuals who ascribe meaning and value to traditional resources and practices. Community members may also retain traditional knowledge and beliefs unavailable elsewhere in the historical or cultural record of a place.

As stated in the OEQC Guidelines for Assessing Cultural Impacts, the goal of the oral interview process is to identify and help determine the significance of potential cultural resources, practices, and beliefs associated with the affected project area, along with potential cultural impacts and appropriate mitigation as necessary. A notice describing the action and location and inviting consultation was published in the Office of Hawaiian Affairs (OHA) newspaper *Ka Wai Ola* (October 2017).

To date, there have been no response to the *Ka Wai Ola* notice, but there has been significant prior consultation conducted as part of earlier studies in the Maku‘u and Keonepoko areas (Ewart and Luscomb 1974; Ketner and Rechtman 2011; Rechtman 2003; Rechtman and Kepa‘a 2014; Terry 2000), in which several individuals with ties to the Maku‘u, Pōpōkī, and Hālona area were consulted. The information obtained from these earlier consultation interviews that is applicable to the current assessment study is presented below.

Ewart and Luscomb (1974) cited notes from a July 4, 1956 interview conducted by Mrs. Violet Hansen with Mary Ann Kamahele (who was 70 years old at the time). Mary Ann Kamahele was described as a member of the only Hawaiian family resident at Maku‘u at that time; she was living near the Moore property on Grant No. 1013. Mrs. Kamahele provided the following information about two place names in the vicinity: Opunaha was a canoe landing, and Kula was a *ko‘a* (a fishing ground) for *āholehole*.

During the EA process conducted for the development of a single-family residence on TMK: (3) 1-5-010:025, located six parcels to the northwest of the Moore property and similarly situated between the old Government Road and the coastal cliffs, two native Hawaiian individuals with direct ties to the area were interviewed, Ms. Puanani Mukai and Mr. Frank Kamahele (nephew of Ulrich “Sonny” Kamahele). Ms. Mukai was described as the guardian of an adjacent parcel; and Frank Kamahele spent much of his childhood in the area, beginning in 1938. Frank Kamahele described that the use of the area during the early and middle twentieth century centered on farming, ranching, and fishing. Access to the ocean was much easier at that time because the Maku‘u cinder cone sloped gently to the rocky beach and was

covered with grass. Wave action has since created a steep cliff above the beach, and most fishing is now done from the cliffs. He indicated that landowners in the area have always allowed fishermen access to the cliffs but did not recall any particular trails or access routes. With respect to other residents in the area, Mr. Kamahele recalled that the coastal area was sparsely populated, partly because the nearest train station was more than a two-mile walk away. The development of the Hawaiian Paradise Park subdivision in the early 1960s connected the Old Government Road (Government Beach Road) to the current Kea'au-Pāhoa Highway and made access to the area much easier. Terry (2000) reported that neither Mr. Kamahele nor Ms. Mukai identified any specific sites with traditional cultural significance in the area; and with respect to the then-proposed and now constructed single-family home on TMK: (3) 1-5-010:025, neither could think of any possible adverse cultural impacts to the area.

As part of the assessment of cultural impacts for the proposed development of TMK: (3) 1-5-010:032 located nine parcels to the northwest of the Moore property, between the Government Beach Road and the coast, additional extended members of the Kamahele Family were consulted, Richard Ha and Melani Dominguez. Mr. Ha's grandmother's brother was Ulrich Kamahele; and as Mr. Ha relates in his online blog, "Everyone knew him (Ulrich) as Uncle Sonny, as if there was only one 'Uncle Sonny' in all of Hawai'i." In this same online blog, Mr. Ha prepared a four-part story about his life experiences at Maku'u. Excerpts from these stories are presented to highlight life in the general project area during the middle twentieth century.

> My extended Kamahele family came from Maku'u. When we were small kids, Pop would take us in his '51 Chevy to visit.
>
> He would turn left just past the heart of Pahoa town, where the barbershop is today. We drove down that road until he hit the railroad tracks, and then turned left on the old railroad grade back toward Hilo. A few miles down the railroad grading was the old Maku'u station. It was an old wooden shack with bench seats, as I recall. That is where the train stopped in the old days. A road wound around the pahoehoe lava flow all the way down the beach to Maku'u. That was before there were the Paradise Park or Hawaiian Beaches subdivisions.
>
> We did not know there was a district called Maku'u; we thought the family compound was named Maku'u. Of the 20-acre property, maybe 10 acres consisted of a kipuka where the soil was ten feet deep. The 10 acres on the Hilo side were typical pahoehoe lava. The property had a long oceanfront with a coconut grove running the length of the oceanfront. It was maybe 30 trees deep and 50 feet tall.
>
> The old-style, two-story house sat on the edge of a slope just behind the coconut grove. If I recall correctly, it had a red roof and green walls. Instead of concrete blocks as supports for the posts, they used big rocks from down the beach.
>
> There was no telephone, no electricity and no running water. So, when we arrived it was a special occasion. We kids never, ever got as welcome a reception as we got whenever we went to Maku'u.

> And the person happiest to see us small kids was tutu lady Meleana. She was my grandma Leihulu's mom. She was a tiny, gentle woman, maybe 100 pounds, but very much the matriarch of the family. She spoke very little English but it was never an issue. We communicated just fine. We could not wait to go down the beach. Once she took us kids to catch ʻohua—baby manini. She used a net with coconut leaves as handles that she used to herd the fish into the net. I don't recall how she dried it, but I remember how we used to stick our hands in a jar to eat one at a time. They were good.
>
> She would get a few ʻopihi and a few haukeuke and we spent a lot of time poking around looking at this sea creature and that.
>
> Between the ocean in the front and the taro patch, ulu trees, bananas and pig pen in the back, there was no problem about food. I know how Hawaiians could be self-sufficient because I saw it in action.
>
> The house was full of rolls of stripped lauhala leaves. There were several lauhala trees and one was a variegated type. I don't recall if it was used for lauhala mats but it dominated the road to the house.
>
> There were lauhala mats all over the place, four and five thick. There was a redwood water tank, and the kitchen water pipe had a Bull Durham bag on the spout as a water filter.

When asked about the proposed development of TMK: (3) 1-5-010:032, Mr. Ha indicated that if the landowner adhered to the Conservation District rules and the treatment plans for the archaeological sites that development of a proposed single-family residence would be fine.

As reported by Ketner and Rechtman (2011), Melani Dominguez has strong genealogical ties to the area, having descended from Hawaiians residing in Makuʻu dating from *Māhele* times, and likely Pre-Western contact times. Melaniʻs personal recollections of the Makuʻu area extend back to the late 1970s, when she was a small girl. Melani recalled picking *limu* and fishing with her grandmother Theresa Kamahele down at their property on TMKs: (3) 1-5-010:009 and 010; Grant 1014. She also remembered hearing about a *menehune* trail that meandered through their property *mauka*/*makai*. When asked about the proposed construction of the single-family dwelling on TMK: (3) 1-5-010:032, Melani indicated that she would feel alright about it as long as no cultural sites were impacted.

Consultation was also conducted during the CIA for the proposed development of TMK: (3) 1-5-010:028, which is situated three parcels to the northwest of the Moore property. Rechtman and Kepaʻa (2014) contacted members of the Makuʻu Farmers Association, a Department of Hawaiian Home Lands (DHHL) beneficiaries' entity living and farming tracts of land in the portions of Makuʻu, Hālona, and Pōpōkī that lie inland from the current study area. The president of the association, Paula Keakahuna, was asked about the projected construction of a single-family dwelling on the 3.5-acre, shoreline parcel. She did not feel that the proposed construction of a single-family dwelling on the parcel would impact any of the

association's activities, considering the distance between the DHHL farm lots and the Rechtman and Kepa'a study area, which is closer to the farm lots than is the current study area.

In summary, the investigations of the property and its history did not reveal any cultural resources or practices aside from shoreline resources. No consulted individuals with ties to and history with the area had any specific information concerning the property. The archaeological features found on the property have all been interpreted as agricultural clearing, planting, or boundary features (see discussion above and Appendix 2). When considered in the context of previous archaeological studies in the coastal Maku'u-Pōpōkī-Hālona area, the patterning of archaeological features corroborates ethnohistoric accounts of Maku'u Village as a dispersed coastal settlement surrounded by opportunistic agricultural land use. Archaeologists concluded that Site 30712 was significant for information, and the thorough documentation of the site during the study exhausted its potential to yield further information important for research on prehistory or history; thus, no further historic preservation work was recommended. It is the landowner's intention to avoid disturbing the archaeological features as much as is possible during any future construction activities and to incorporate these features functionally into agroforestry practices. Traditional gathering and fishing are known to still be practiced on the shoreline *makai* of the property. While some users are newcomers simply engaging in recreation and/or collecting food, others have deeper ties and are undertaking cultural practices as well. The Moore property does not contain any springs, *pu'u*, or caves that might be important cultural sites. No gathering of plant material is noted from the property, and aside from a shoreline strip that includes a native portion that will not be disturbed in any way, most vegetation is either non-native weeds. Although *hala* is present in clumps throughout the property, it can largely be avoided and will be encouraged to grow as part of the implementation of agroforestry practices, in which hala plays a valuable role.

Impacts and Mitigation Measures for Cultural Resources

Shoreline access and the cultural activities this affords will not be affected. It is reasonable to conclude, based upon the limited range of resources and the proposed mitigation to all affected resources, that the exercise of native Hawaiian rights related to gathering, access or other customary activities will not be affected, and there will be no adverse effect upon cultural practices or beliefs. The Draft EA was distributed to agencies and groups who might have knowledge in order to confirm this finding. No party reviewing the Draft EA supplied any cultural information.

3.3 Public Roads, Services and Utilities

3.3.1 Roads and Access

Existing Environment, Impacts and Mitigation Measures

The sole road access to the project site is via an existing rough driveway from the Government Beach Road, (see Figure 1 and 2b). The existing driveway that currently extends to proposed house site would be widened to 15 feet and improved with gravel but left unpaved. The driveway would also be expanded to include an improved but unpaved parking and turn-around area near the residence.

3.3.2 Public Utilities and Services

Environmental Setting, Impacts and Mitigation Measures

Electrical power to the home would be provided by rooftop-mounted photovoltaic solar. There would thus be no extension of electrical power lines from the Government Beach Road.

Domestic water would be supplied from an onsite water well (see Figure 3 for location). It would have a 1.5-HP pump capable of delivering up to 50 gallons per minute at maximum use. A 10,000-gallon storage tank will be located *mauka* of the farm shed. The proposed storage is expected to be more than adequate to meet the expected demand, based on the owner‘s expected use of less than 300 gallons per day.

Wastewater would be treated with a septic system in conformance with requirements of the State Department of Health (see Figure 3 for location). No parks, schools or other public facilities are present nearby.

Police, fire and emergency medical service are available about seven road miles away at new facilities on Highway 130 in Pahoa. For fire protection, the applicant proposes use of the water tank.

There will be no adverse impact to any public or private utilities. The addition of one single-family home will have no measurable adverse impact to or additional demand on public facilities such as schools, police or fire services, or recreational areas. Mr. Moore acknowledges and understand that this lot, along with almost all other residences in the Puna District, is not located within a mile of emergency services.

3.4 Secondary and Cumulative Impacts

Due to its small scale, the proposed project would not produce any major secondary impacts, such as population changes or effects on public facilities.

Cumulative impacts result when implementation of several projects that individually have limited impacts combine to produce more severe impacts or conflicts in mitigation measures. The County of Hawai‘i occasionally performs road maintenance on the Government Beach Road. No substantial government or private projects such as roadways, schools, businesses, or subdivisions, are known to be occurring or in planning for this portion of Puna. Reopening of various roadways covered by the 2018 lava flows, including Highway 132, will be occurring approximately 10 miles away but would not produce impacts in the Maku‘u area. There are several dozen private lots on the three-mile stretch of the narrow and unpaved Government Beach Road between the Hawaiian Paradise Park and Hawaiian Shores subdivisions. At any given time, a home may be under construction, and occasionally there are two or more homes under construction simultaneously. The adverse effects of building a single-family residence and implementing agroforestry practices in this context are very minor and involve temporary disturbances to air quality, noise, traffic and visual quality during construction. It should again be noted that the proposed home and farm are in a somewhat isolated, sparsely populated area, and no accumulation of adverse construction effects would be expected. Other than the precautions for preventing adverse impacts during construction

listed above in Sections 3.1.3 and 3.1.6, no special mitigation measures should be required to counteract the small adverse cumulative effect.

3.5 Required Permits and Approvals

County of Hawai'i:

Special Management Area Permit or Exemption
Plan Approval and Grubbing, Grading, and Building Permits

State of Hawai'i:

Conservation District Use Permit
Wastewater System Approval
Water Well Permit

3.6 Consistency with Government Plans and Policies

3.6.1 Hawai'i County General Plan

The *General Plan* for the County of Hawai'i is the document expressing the broad goals and policies for the long-range development of the Island of Hawai'i. The plan was adopted by ordinance in 1989 and revised in 2005. The General Plan's Land Use Allocation Guide Map designates the property as Open. The *General Plan* is organized into thirteen elements, with policies, objectives, standards, and principles for each. There are also discussions of the specific applicability of each element to the nine judicial districts comprising the County of Hawai'i. Below are pertinent sections followed by a discussion of conformance.

ECONOMIC GOALS

(a) Provide residents with opportunities to improve their quality of life through economic development that enhances the County's natural and social environments.
(b) Economic development and improvement shall be in balance with the physical, social, and cultural environments of the island of Hawaii.
(d) Provide an economic environment that allows new, expanded, or improved economic opportunities that are compatible with the County's cultural, natural, and social environment.

Discussion: The proposed construction and occupation of a single-family home and the implementation of agroforestry practices would be in balance with the natural, cultural and social environment of the County, would create temporary construction jobs for local residents, and would indirectly boost the economy through construction industry purchases from local suppliers. A multiplier effect takes place

when these employees spend their income for food, housing, and other living expenses in the retail sector of the economy. Such activities are in keeping with the overall economic development of the island.

ENVIRONMENTAL QUALITY GOALS

(a) Define the most desirable use of land within the County that achieves an ecological balance providing residents and visitors the quality of life and an environment in which the natural resources of the island are viable and sustainable.
(b) Maintain and, if feasible, improve the existing environmental quality of the island.
(c) Control pollution.

ENVIRONMENTAL QUALITY POLICIES

(a) Take positive action to further maintain the quality of the environment.

ENVIRONMENTAL QUALITY STANDARDS

(a) Pollution shall be prevented, abated, and controlled at levels that will protect and preserve the public health and well being, through the enforcement of appropriate Federal, State and County standards.
(b) Incorporate environmental quality controls either as standards in appropriate ordinances or as conditions of approval.
(c) Federal and State environmental regulations shall be adhered to.

Discussion: The proposed construction and occupation of a single-family home and the implementation of agroforestry practices would not have a substantial adverse effect on the environment and would not diminish the valuable natural resources of the region. The home and associated improvements would be compatible with the existing rural single-family homes and recreational uses in the area. Pertinent environmental regulations would be followed, including those for mitigation of water quality impacts.

HISTORIC SITES GOALS

(a) Protect, restore, and enhance the sites, buildings, and objects of significant historical and cultural importance to Hawaii.
(b) Appropriate access to significant historic sites, buildings, and objects of public interest should be made available.

HISTORIC SITES POLICIES

(a) Agencies and organizations, either public or private, pursuing knowledge about historic sites should keep the public apprised of projects.
(b) Amend appropriate ordinances to incorporate the stewardship and protection of historic sites, buildings and objects.
(c) Require both public and private developers of land to provide historical and archaeological surveys

and cultural assessments, where appropriate, prior to the clearing or development of land when there are indications that the land under consideration has historical significance.
(d) Public access to significant historic sites and objects shall be acquired, where appropriate.

Discussion: An archaeological inventory survey properly documented the one historic site present on the property, which consists of features indicative of former agricultural use. The archaeologists proposed that the site is no longer significant and does not require preservation or further data recovery, but the owner wishes to informally preserve as many features as possible and reutilize some of them for Polynesian agroforestry practices. There are no known cultural resources or known or practices on the lot; traditional fishing and shellfish gathering occur *makai* of the lot, which will not be affected.

FLOOD CONTROL AND DRAINAGE GOALS

(a) Protect human life.
(b) Prevent damage to man-made improvements.
(c) Control pollution.
(d) Prevent damage from inundation.
(e) Reduce surface water and sediment runoff.
(f) Maximize soil and water conservation.

FLOOD CONTROL AND DRAINAGE POLICIES

(a) Enact restrictive land use and building structure regulations in areas vulnerable to severe damage due to the impact of wave action. Only uses that cannot be located elsewhere due to public necessity and character, such as maritime activities and the necessary public facilities and utilities, shall be allowed in these areas.
(g) Development-generated runoff shall be disposed of in a manner acceptable to the Department of Public Works and in compliance with all State and Federal laws.

FLOOD CONTROL AND DRAINAGE STANDARDS

(a) "Storm Drainage Standards," County of Hawaii, October, 1970, and as revised.
(b) Applicable standards and regulations of Chapter 27, "Flood Control," of the Hawaii County Code.
(c) Applicable standards and regulations of the Federal Emergency Management Agency (FEMA).
(d) Applicable standards and regulations of Chapter 10, "Erosion and Sedimentation Control," of the Hawaii County Code.
(e) Applicable standards and regulations of the Natural Resources Conservation Service and the Soil and Water Conservation Districts.

Discussion: The proposed home site and all areas planned for structures are within Zone X, or areas outside of the 500-year floodplain as determined by detailed methods in the Flood Insurance Rate Maps (FIRM). The project will conform to applicable drainage regulations and policies of the County of Hawai‘i.

NATURAL BEAUTY GOALS

(a) Protect, preserve and enhance the quality of areas endowed with natural beauty, including the quality of coastal scenic resources.
(b) Protect scenic vistas and view planes from becoming obstructed.
(c) Maximize opportunities for present and future generations to appreciate and enjoy natural and scenic beauty.

NATURAL BEAUTY POLICIES

(a) Increase public pedestrian access opportunities to scenic places and vistas.
(b) Develop and establish view plane regulations to preserve and enhance views of scenic or prominent landscapes from specific locations, and coastal aesthetic values.

Discussion: The improvements are minor and consistent with traditional uses of the land and will not cause scenic impacts or impede access.

NATURAL RESOURCES AND SHORELINES GOALS

(a) Protect and conserve the natural resources from undue exploitation, encroachment and damage.
(b) Provide opportunities for recreational, economic, and educational needs without despoiling or endangering natural resources.
(c) Protect and promote the prudent use of Hawaii's unique, fragile, and significant environmental and natural resources.
(d) Protect rare or endangered species and habitats native to Hawaii.
(e) Protect and effectively manage Hawaii's open space, watersheds, shoreline, and natural areas.
(f) Ensure that alterations to existing land forms, vegetation, and construction of structures cause minimum adverse effect to water resources, and scenic and recreational amenities and minimum danger of floods, landslides, erosion, siltation, or failure in the event of an earthquake.

NATURAL RESOURCES AND SHORELINES POLICIES

(a) Require users of natural resources to conduct their activities in a manner that avoids or minimizes adverse effects on the environment.
(c) Maintain the shoreline for recreational, cultural, educational, and/or scientific uses in a manner that is protective of resources and is of the maximum benefit to the general public.
(d) Protect the shoreline from the encroachment of man-made improvements and structures.
(h) Encourage public and private agencies to manage the natural resources in a manner that avoids or minimizes adverse effects on the environment and depletion of energy and natural resources to the fullest extent.
(p) Encourage the use of native plants for screening and landscaping.
(r) Ensure public access is provided to the shoreline, public trails and hunting areas, including free public parking where appropriate.

(u) Ensure that activities authorized or funded by the County do not damage important natural resources.

Discussion: The home would be set back a minimum of about 300 feet from the sea cliff and 160 feet from the certified shoreline at an elevation of about 20 feet above sea level, and it would not affect shoreline resources or be damaged by waves or tides.

PUNA COMMUNITY DEVELOPMENT PLAN

The Puna Community Development Plan (CDP) encompasses the judicial district of Puna and was developed under the framework of the February 2005 County of Hawai‘i General Plan. Community Development Plans are intended to translate broad General Plan Goals, Policies, and Standards into implementation actions as they apply to specific geographical regions around the County. CDPs are also intended to serve as a forum for community input into land-use, delivery of government services and any other matters relating to the planning area.

The Puna CDP does not specify land use in the project area but contains the following Goals for Managing Growth that are relevant to the action.

3.1.1 Goals (for Managing Growth)
a. Puna retains a rural character while it protects its native natural and cultural resources.
b. The quality of life improves and economic opportunity expands for Puna’s residents.
d. Exposure to high risk from natural hazards situations is reduced.
f. Native vegetation, coastal and historic resources are provided new forms of protection.

Discussion: The proposed single-family home and the implementation of agroforestry practices help the area retain a rural character. Through provision of housing and production of fruit, it improves the quality of life, natural resources and the economy. The lot shares the same volcanic and seismic hazard as all of Puna. By virtue of the home’s proposed location on the lot, coastal hazards are largely avoided. No native vegetation, rare species, coastal resources or historic sites will be adversely affected. The construction of a of a single-family home and the implementation of agroforestry practices are not inconsistent with the Puna CDP.

3.6.2 Hawai‘i County Zoning and Special Management Area

The State Land Use District for property is Conservation. The entire property is zoned by the County of Hawai‘i as within the Agricultural District, minimum lot size of one acre (A-1a), although County zoning per se does not apply in the Conservation District. No aspect of the project appears to be inconsistent with County zoning.

The entire property is within the Special Management Area. Single-family residences may be determined to be an exempt action under the County’s Special Management Area (SMA) guidelines. The County of Hawai‘i Planning Department requires preparation of an SMA Assessment Application, in which SMA issues are expressly dealt with. A summary of consistency is provided below.

The proposed land use complies with provisions and guidelines contained in Chapter 205A, Hawai‘i Revised Statutes (HRS), entitled *Coastal Zone Management*. Single-family residences and the agroforestry uses may be determined to be an exempt action under the County's Special Management Area (SMA) guidelines. The proposed use would be consistent with Chapter 205A because it would not affect public access to recreational areas, historic resources, scenic and open space resources, coastal ecosystems, economic uses, or coastal hazards.

The proposed improvements are not likely to result in any substantial adverse impact on the surrounding environment. The house site is set back from the shoreline and will not restrict any shoreline uses such as hiking, fishing or water sports. Lateral pedestrian use of the shoreline area will not be impacted and there will be no effect on the public's access to or enjoyment of this shoreline area. Furthermore, viewplanes towards the project site will not be adversely impacted in any substantial way, as views from the Government Beach Road are totally blocked by trees. It is expected that the project will not result in any impact on the biology or economy of the coast. The project site is not situated over any natural drainage system or water feature that would flow into the nearby coastal ecosystem. The property contains mostly non-native and a few common native plants. No floodplains are present in the area. In terms of beach protection, construction is set back from the shoreline and would not affect any beaches nor adversely affect public use and recreation of the shoreline in this area. With implementation of Best Management Practices associated with grading permits and the Farm Management Plan, there should be no impacts on marine resources. No historic sites will be adversely affected. Aside from shoreline area uses, which will not be affected, there are no known cultural resources or practices.

The Planning Director will be asked to make the determination that the proposed development of a single-family home and the implementation of agroforestry practices are not considered "development" under Special Management Area Rules and Regulations of the County of Hawai‘i, Section 9-4 (10) (B) and is otherwise not subject to an SMA Major Permit.

3.6.3 Conservation District

The State Land Use District for the Moore property is Conservation. Its subzone is Resource, for which, according to Hawai‘i Administrative Rules (HAR) §13-5-15, both a single-family residence and farming (given an approved Farm Management Plan) are identified uses. Any proposed use must undergo an examination for its consistency with the goals and rules of this district and subzone. The applicant has concurrently prepared a Conservation District Use Application (CDUA), to which this EA is an appendix. The CDUA includes a detailed evaluation of the consistency of the project with the criteria of the Conservation District permit process. Briefly, the following individual consistency criteria should be noted:

1. The proposed land use is consistent with the purpose of the Conservation District;

The development of the single-family residence and the implementation of agroforestry practices are in conformance with the purpose of the Conservation District. Both are identified uses within the

Conservation District, requiring a Board Permit for such use. A commitment by the applicant to management of the site as reflected in the Farm Management Plan will conserve, protect and preserve the natural features on the subject property. The proposed use will not impact lateral coastal access or the public's ability to utilize the coastal resources that front this property. Additionally, due to the careful and limited nature of the proposed development, there would be no significant impacts to the natural or cultural resources of the area.

2. The proposed land use is consistent with the objectives of the subzone of the land on which the use will occur;

The objective of the Resource subzone "…*is to develop, with proper management, areas to ensure sustained use of the natural resources of those areas."* These identified uses, which conform to the design standards in 13-5-41, will ensure the sustained use of the natural resources in the project area by mitigating potential impacts as outlined in this document. Single-family residences are an identified use in the Resource subzone under HAR 13-5-24, R-8, and agriculture in an area greater than one acre is an identified use under HAR 13-5-23, L-1, requiring a management plan.

3. The proposed land use complies with provisions and guidelines contained in Chapter 205A, Hawaii Revised Statutes (HRS), entitled "Coastal Zone Management," where applicable;

The proposed land uses comply with provisions and guidelines contained in Chapter 205A, Hawai‘i Revised Statutes (HRS), entitled *Coastal Zone Management*, as discussed above in Section 3.6.2.

4. The proposed land use will not cause substantial adverse impact to existing natural resources within the surrounding area, community or region;

Because of the relatively minor nature of the project and the lack of native terrestrial ecosystems and threatened or endangered plant species, the proposed single-family residence and the implementation of agroforestry practices are not likely to cause adverse biological impacts. Impacts to the island wide-ranging endangered Hawaiian hoary bat and Hawaiian Hawk will be avoided through timing of vegetation removal and/or hawk nest survey. No effect on any coastal ecosystem will occur, because of the wide shoreline vegetated zone that will be left almost completely untouched except for removal and thinning of some invasive trees, along with planned precautions for preventing soil runoff during construction and later during agroforestry practices. The proposed action will also have no impact on the public's current access to or use of the shoreline area.

5. The proposed land use, including buildings, structures and facilities, shall be compatible with the locality and surrounding areas, appropriate to the physical conditions and capabilities of the specific parcel or parcels;

The proposed use is consistent with other single-family residential and farming uses in the area. The proposed one-story home will be 20'1" high, 3,546 square feet in size (including lanais, water tank, and pump house) and will be set back a minimum of 160 feet from the certified shoreline, approximately 20

feet above sea level, outside the flood zone. It will be in area not visible to the public on the Government Beach Road and only moderately visible from the shoreline or offshore boats. This identified use, which conforms to the design standards in HAR 13-5-41, will ensure the sustained use of the natural resources in the project area by mitigating impacts. The use will not adversely affect the surrounding properties or how these properties are utilized. The proposed implementation of agroforestry practices will be conducted in an area that currently supports a non-native weed forest. This land use will be attractive and compatible with the area, as across Government Beach Road there is an existing ranch.

6. The existing physical and environmental aspects of the land, such as natural beauty and open space characteristics, will be preserved or improved upon, whichever is applicable;

The proposed use of the subject property for a single-family residence and agroforestry practices will help conserve, protect and preserve the natural features of the area.

7. Subdivision of land will not be utilized to increase the intensity of land uses in the Conservation District;

The proposed action does not involve or depend upon subdivision and will not lead to any increase in intensity of use beyond the requested single-family residence.

8. The proposed land use will not be materially detrimental to the public health, safety and welfare.

The proposed single-family residence and the implementation of agroforestry practices will not be detrimental to the public health, safety, and welfare.

PART 4: DETERMINATION, FINDINGS AND REASONS

4.1 Determination

Based on the findings below, and upon consideration of comments to the Draft EA, the applicant expects that the State of Hawai‘i, Department of Land and Natural Resources, will determine that the proposed action will not significantly alter the environment, as impacts will be minimal, and that this agency will accordingly issue a Finding of No Significant Impact (FONSI).

4.2 Findings and Supporting Reasons

1. *The proposed project will not involve an irrevocable commitment or loss or destruction of any natural or cultural resources.* No valuable natural or cultural resource would be committed or lost. Common native plants are present but native ecosystems would not be adversely affected. The project site is dominated by alien vegetation, with the only sensitive ecosystem on the property being the shoreline vegetation, where common native plants mixed with weeds are present. Development avoids this area, but some ironwoods will be removed and others will be trimmed. No adverse impact upon vegetation or endangered species should occur. Because of the location and nature of the project relative to sensitive

vegetation and species, construction and use of the single-family residence as well as implementation of agroforestry practices are not likely to cause adverse biological impacts. An archaeological inventory survey properly documented historic sites present on the property, which will not be adversely affected. No valuable cultural resources and practices such as coastal access, fishing, gathering, hunting, or access to ceremonial sites would be affected in any way.

2. *The proposed project will not curtail the range of beneficial uses of the environment.* No restriction of beneficial uses would occur by residential and agroforestry use on this lot.

3. *The proposed project will not conflict with the State's long-term environmental* policies. The State's long-term environmental policies are set forth in Chapter 344, HRS. The broad goals of this policy are to conserve natural resources and enhance the quality of life. The project is minor and basically environmentally benign, and it is thus consistent with all elements of the State's long-term environmental policies.

4. *The proposed project will not substantially affect the economic or social welfare of the community or State.* The project would not have any substantial effect on the economic or social welfare of the Big Island community or the State of Hawai‘i.

5. *The proposed project does not substantially affect public health in any detrimental way.* The project would not affect public health and safety in any way. Wastewater will be disposed of in conformance with State Department of Health regulations.

6. *The proposed project will not involve substantial secondary impacts, such as population changes or effects on public facilities*. The small scale of the proposed project would not produce any major secondary impacts, such as population changes or effects on public facilities.

7. *The proposed project will not involve a substantial degradation of environmental quality*. The project is minor and environmentally benign, and thus it would not contribute to environmental degradation.

8. *The proposed project will not substantially affect any rare, threatened or endangered species of flora or fauna or habitat.* Thorough survey has determined that no endangered plant species are present. Other than Hawaiian hoary bats and Hawaiian hawks, island wide-ranging species that will experience no adverse impacts due to mitigation in the form of timing of vegetation removal and/or hawk nest survey, no rare, threatened or endangered species of fauna are known to exist on or near the project site, and none would be affected by any project activities.

9. *The proposed project is not one which is individually limited but cumulatively may have considerable effect upon the environment or involves a commitment for larger actions.* The adverse effects of building a single-family residence and implementation of agroforestry practices are limited very minor and temporary disturbance to traffic, air quality, noise, and visual quality during construction. This area is fairly isolated from sensitive receptors other than similar single-family residences. The County of

Hawai‘i occasionally performs road maintenance on the Government Beach Road. There are no substantial government or private projects in construction or planning, and no accumulation of adverse construction effects would be expected. Other than the precautions for preventing adverse effects during construction listed above, no special mitigation measures should be required to counteract the small adverse cumulative effect.

10. *The proposed project will not detrimentally affect air or water quality or ambient noise levels.* No substantial effects to air, water, or ambient noise would occur. Brief, temporary effects would occur during construction and would be mitigated. Some noise would also occur during agroforestry practices, as trees are removed through chain sawing. The context of the property's location, with no residences, parks, or other sensitive uses nearby, will help avoid noise impacts. Water quality impacts from the proposed farming methods would be minimal, with sedimentation impacts essentially zero.

11. *The project does not affect nor would it likely to be damaged as a result of being located in environmentally sensitive area such as a flood plain, tsunami zone, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal area.* The proposed home site is not located in a flood zone. The home would be 160 feet *mauka* of the certified shoreline at an elevation of about 20 feet above sea level, outside the area historically affected by tsunami or high waves. In general, geologic conditions do not impose undue constraints on the proposed action, as much of the Puna District faces similar volcanic and seismic hazard and yet continues to be the fastest growing region of the State. The applicant understands that there are hazards associated with homes in this geologic setting and has made the decision that a residence is not imprudent to construct or inhabit.

12. *The project will not substantially affect scenic vistas and viewplanes identified in county or state plans or studies.* No scenic views are located nearby or would be affected in any way. Coastal views from the Government Beach Road are totally obstructed by over 1,000 feet of dense vegetation. The attractive design of the home, given the existing context in which the home would not be visible from public vantage points, would not materially degrade the scenery of the project area. The agroforestry practices would involve trees and other crops that could be visible from the road, but would result in a landscape in harmony with the rural landscape of Puna.

13. *The project will not require substantial energy consumption*. Negligible amounts of energy input would be required for construction and operation of the residence and agroforestry practices. Electrical power will be provided via a solar photovoltaic (PV) system.

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Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

APPENDIX 1a
Comments in Response to Early Consultation

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DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

October 20, 2017

Geometrician Associates, LLC
Attention: Mr. Ron Terry
P.O. Box 396
Hilo, Hawaii 96721

via email: rterry@hawaii.rr.com

Dear Mr. Terry:

SUBJECT: Early Consultation for Environmental Assessment for **Mike Moore**'s Proposed Single-Family Residence in the Conservation District located at Puna, Island of Hawaii; TMK: (3) 1-5-010:031

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR) Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comments.

At this time, enclosed are comments from the (a) Division of Aquatic Resources, (b) Engineering Division, (c) Division of Forestry & Wildlife, (d) Office of Conservation & Coastal Lands, and (e) Land Division – Hawaii District on the subject matter. Should you have any questions, please feel free to call Darlene Nakamura at (808) 587-0417. Thank you.

Sincerely,

Russell Y. Tsuji
Land Administrator

Enclosures
cc: Central Files

5668

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RECEIVED
SEP 26 2017
Division of Aquatic Resources
DAR 5618

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 26, 2017

MEMORANDUM

TO: **DLNR Agencies:**
X Div. of Aquatic Resources
__ Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
__ Div. of State Parks
X Commission on Water Resource Management
X Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Early Consultation for Environmental Assessment for Proposed Single-Family Residence in the Conservation District
LOCATION: Puna District, Island of Hawaii; TMK: (3) 1-5-010:031
APPLICANT: Geometrician Associates, LLC on behalf of **Mike Moore**

Transmitted for your review and comment is information on the above-referenced subject matter. We would appreciate your comments by **October 18, 2017.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(✓) Comments are attached.

Signed: Bruce S. Anderson

Print Name: Bruce S. Anderson, Ph.D., DAR Administrator

Date: 9/29/17

cc: Central Files

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

Date: 9/28/17
DAR # 5618

MEMORANDUM

TO: Bruce S. Anderson, PhD
DAR Administrator

FROM: Troy Sakihara, Aquatic Biologist

SUBJECT: Environmental Assessment for Proposed Single Family Residence in the Conservation District, Puna District, Hawaii Island, TMK (3) 1-5-010:031

Request Submitted by: Russell Tsuji, Administrator, Land Division, DLNR, State of Hawaii

Location of Project: Puna District, Hawaii Island

Brief Description of Project:

Property owner, Mike Moore, plans to build a home on his 8.75 acre oceanfront property, TMK (3) 1-5-010:031, located in a Conservation District between Hawaiian Paradise Park and Hawaiian Shores subdivisions on Hawaii Island. The proposed home is to be 2,955 square feet and is to meet all regulatory requirements. Mr. Moore also plans to farm on a portion of his property, in addition to removing some non-native vegetation to provide a sight line to the ocean. Mr. Moore also plans to eventually remove invasive trees on his property with a chain saw and replace the denuded landscape with Hawaiian agroforestry plants (i.e., ulu, banana, taro, coconut) in addition to avocado and citrus trees.

Comments:

☐ No Comments ☒ Comments Attached

Thank you for providing DAR the opportunity to review and comment on the proposed project. Should there be any changes to the project plan, DAR requests the opportunity to review and comment on those changes.

Comments Approved: Bruce S. Anderson Date: 9/29/17
Bruce S. Anderson, PhD
DAR Administrator

DAR# 5618

Comments

The DAR's primary interests in this instance are the well being of the the coastal and intertidal marine habitat, that these resources are naturally maintained for public use and and enjoyment, and that any detrimental impacts from the proposed activities are prevented on said habitat. The DAR recognizes and appreciates the applicant's awareness of the concerns stated above and his proposed efforts to address them. However, DAR would still like to remind the applicant that all Best Management Practices are upheld during home construction, farming, and the clearing and/or planting of vegetation on the property. In particular, DAR urges that any potential erosion caused by ground disturbance during the proposed activities is mitigated, which can be achieved by strategically planting vegetation in areas that water flows and collects during wet conditions. Also, DAR recommends that tree cuttings and excess leaf litter/plant material from invasive vegetation clearing are removed from the area near the shoreline to prevent these materials from possibly entering the ocean during high surf.

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

17 SEP 26 AM 11:02 ENGINEERING

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

RECEIVED
2017 OCT 11 AM 8:15
DLNR LAND DIVISION

September 26, 2017

MEMORANDUM

TO:

DLNR Agencies:
X Div. of Aquatic Resources
___Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
___Div. of State Parks
X Commission on Water Resource Management
X Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Early Consultation for Environmental Assessment for Proposed Single-Family Residence in the Conservation District
LOCATION: Puna District, Island of Hawaii; TMK: (3) 1-5-010:031
APPLICANT: Geometrician Associates, LLC on behalf of **Mike Moore**

Transmitted for your review and comment is information on the above-referenced subject matter. We would appreciate your comments by **October 18, 2017.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(✔) Comments are attached.

Signed: _____

Print Name: Carty S. Chang, Chief Engineer

Date: 9/28/17

cc: Central Files

DEPARTMENT OF LAND AND NATURAL RESOURCES
ENGINEERING DIVISION

LD/Russell Y. Tsuji
Ref: Early Consultation for Environmental Assessment for Proposed Single-Family Residence in the Conservation District, Puna District, Island of Hawaii; TMK: (3) 1-5-010:031

COMMENTS

The rules and regulations of the National Flood Insurance Program (NFIP), Title 44 of the Code of Federal Regulations (44CFR), are in effect when development falls within a designated Flood Hazard.

The owner of the project property and/or their representative is responsible to research the Flood Hazard Zone designation for the project. Flood Hazard Zone designations can be found using the Flood Insurance Rate Map (FIRM), which can be accessed through the Flood Hazard Assessment Tool (FHAT) (http://gis.hawaiinfip.org/FHAT).

Be advised that 44CFR reflects the minimum standards as set forth by the NFIP. Local community flood ordinances may take precedence over the NFIP standards as local designations prove to be more restrictive. If there are questions regarding the local flood ordinances, please contact the applicable County NFIP Coordinators below:

- Oahu: City and County of Honolulu, Department of Planning and Permitting (808) 768-8098.
- Hawaii Island: County of Hawaii, Department of Public Works (808) 961-8327.
- Maui/Molokai/Lanai County of Maui, Department of Planning (808) 270-7253.
- Kauai: County of Kauai, Department of Public Works (808) 241-4846.

Signed: _____
CARTY S. CHANG, CHIEF ENGINEER

Date: SEP 28 2017

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

JEFFREY T. PEARSON, P.E.
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET, ROOM 325
HONOLULU, HAWAII 96813

October 16, 2017

TO: Russel Y. Tsuji
Land Administrator

ATTN: Darlene Nakamura

FROM: James Cogswell
Wildlife Program Manager

SUBJECT: Division of Forestry and Wildlife Comments on Early Consultation for Environmental Assessment for Proposed Single-Family Residence in the Conservation District

The Department of Land and Natural Resources Division of Forestry and Wildlife has received your inquiry regarding an early consultation for environmental assessment for the proposed single family residence in the conservation district located in the Puna District of Hawaii County, TMK (3) 1-5-010:031. The proposed action involves construction of a single-family residence on 8.75 acres of land and would consist of 2,955 square feet with a two bedroom and two bathrooms single story structure. The resident intends to farm on a portion of the property and will develop a Farm Management Plan, and construct a 765 square foot outbuilding for storage and backside eave to shelter sheep and goats.

The State and Federally listed Hawaiian hoary bat (*Lasiurus cinereus semotus*) has the potential to occur in the vicinity of the project area. Therefore, DOFAW recommends avoiding using barbed wire, as bat mortalities have been documented as a result of becoming ensnared by barbed wire during flight. If any trees are planned for removal during the bat breeding season there is a risk of injury or mortality to juvenile bats. To minimize the potential for impacts to this species, woody plants greater than 15 feet (4.6 meters) tall should not be disturbed, removed, or trimmed during the bat birthing and pup rearing season (June 1 through September 15). Site clearing should be timed to avoid disturbance to breeding Hawaiian hoary bats. The endangered Hawaiian hawk or 'io (*Buteo solitaries*) may occur in the project vicinity. DOFAW recommends surveying the area to ensure no Hawaiian hawk nests are present if trees are to be cut. Finally, we note that artificial lighting can adversely impact seabirds that may pass through the area at night causing disorientation which could result in collision with manmade artifacts or grounding of birds. The oceanfront location of this property increases the risk of lighting impacts to seabirds that are returning at night from the sea. If nighttime lighting is required, DOFAW recommends that any lights used be fully shielded to minimize impacts.

Due to the intent of introducing of ungulates onto Conservation District land, DOFAW strongly encourages to keep all farm animals enclosed on the property and requests further information on

the anticipated numbers and uses of the goats and sheep proposed. DOFAW strongly encourages landowners in the conservation district to prioritize the restoration of native ecosystems whenever possible, along with removal of invasive species.

Should the proposed location of the project change, or should it become evident in the future that listed species are being impacted, DOFAW requests that the project proponent reinitiate consultation. If you have any questions, please contact Kate Cullison, Conservation Initiative Coordinator at 808-587-4148 or Katherine.cullison@hawaii.gov.

A

Re: OA 18-61

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RECEIVED
LAND DIVISION
2017 OCT 11 AM 10:

RECEIVED
OFFICE OF CONSERVATION
AND COASTAL LANDS
2017 SEP 26 A 11:06

RECEIVED
DEPT OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 26, 2017

MEMORANDUM

OCT 10 2017

FROM:
~~TO:~~

DLNR Agencies:
X Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
__Div. of State Parks
X Commission on Water Resource Management
→ X Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

TO:
~~FROM:~~ Russell Y. Tsuji, Land Administrator

SUBJECT: Early Consultation for Environmental Assessment for Proposed Single-Family Residence in the Conservation District
LOCATION: Puna District, Island of Hawaii; TMK: (3) 1-5-010:031
APPLICANT: Geometrician Associates, LLC on behalf of **Mike Moore**

Transmitted for your review and comment is information on the above-referenced subject matter. We would appreciate your comments by **October 18, 2017.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417. Thank you.

Attachments

LETTER SENT TO AGENT FOR LANDOWNER - SEE ATTACHED

( ) We have no objections.
( ) We have no comments.
(X) Comments are ~~attached~~.

Signed:

Print Name: ALEX J. ROY

Date: 10-10-2017

cc: Central Files

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF: OCCL: AJR

COR: HA-18-61

OCT - 6 2017

Ron Terry
c/o Geometrician Associates
PO Box 396
Hilo, HI 96721

SUBJECT: EARLY CONSULTATION FOR ENVIRONMENTAL ASSESSMENT FOR PROPOSED SINGLE FAMILY RESIDENCE IN THE CONSERVATION DISTRICT
Puna District, Island of Hawaii
TMK: (3) 1-5-010:031

Dear Mr. Terry,

The Office of Conservation and Coastal Lands (OCCL) is in receipt of your letter regarding the proposed development of the subject parcel. For reference, the proposed project parcel is located entirely within the State Land Use (SLU) Conservation District, *Resource* Subzone.

According to the information provided the landowner (Mike Moore) is proposing to:

- Construct a 2,955-square foot (sq. ft.) Single Family Residence (SFR);
- Conduct Agriculture using "Polynesian agroforestry";
- Conduct Animal Husbandry (i.e., sheep and goats);
- Construct a 765-sq. ft. "out building" for storage and farm use;
- Conduct invasive species removal, tree removal, and landscaping; and
- Create grazing areas for animals.

Staff would like to reiterate the requirements set forth in Hawaii Administrative Rules (HAR) §13-5, *Exhibit 4*, with regards to the **Maximum Developable Area** (MDA). Please note that the MDA consists of all areas under roof, including, but not limited to: 1st, 2nd, 3rd floors, decks, lanais, carports, pools, decking around the pool, sheds, storage buildings, and other development structures such as outdoor showers. Please note that the applicant should clearly outline the total

MDA, and the MDA calculations. Additionally, the OCCL requests that all measurements, area calculations, dimensions, and descriptions of each proposed structure should be included.

A Single Family Residence (SFR) is an identified land use to which you may apply for in the SLU Conservation District *Resource* Subzone, pursuant to HAR §13-5-24, R-7 **SINGLE FAMILY RESIDENCE** (D-1) *A single Family Residence that conforms to design standards as outlined in this chapter.* In order to apply for this land use, the applicant will be required to submit to this office a completed Conservation District Use Application (CDUA) for review and processing. Please note that the final decision to approve or deny this application will rest with the Board of Land and Natural Resources (BLNR).

Agriculture, including animal husbandry, is an identified land use to which you may apply for in the SLU Conservation District *Resource* Subzone, pursuant to HAR §13-5-23, L-1 **AGRICULTURE** (D-1) *Agriculture, within an area of more than one acre, defined as the planting, cultivating, and harvesting of horticultural crops, floricultural crops, or forest products, or animal husbandry. A management plan approved simultaneously with the permit, is also required.* In order to apply for this land use, the applicant will be required to submit a completed CDUA for review and processing, along with a completed *Management Plan.* Pursuant to HAR §13-5-39 (a) *Where required, management plans shall be submitted with the board permit application and shall include the requirements listed in HAR 13-5, Exhibit 3, entitled "Management Plan Requirements".* Please note that the final decision to approve or deny this proposed land use will rest with the BLNR.

Landscaping, as described in the submitted letter, is considered an identified land use to which you may apply for in the SLU Conservation District *Resource* Subzone, pursuant to HAR §13-5-23, L-2 **LANDSCAPING** (D-1) *Landscaping (including clearing, grubbing, grading and tree removal), including chemical and mechanical control methods, in accordance with state and federal laws and regulations, in an area of or more than 10,000 square feet. Any replanting shall be appropriate to the site location and shall give preference to plant material that are endemic or indigenous to Hawaii. The introduction of invasive plant species is prohibited.* In order to apply for this use the applicant will be required to submit to this office a completed CDUA for review and processing. Please note that the final decision to approve or deny this land use will rest with the BLNR.

OCCL recognizes that each of the proposed land uses will require submittal of a board permit application (i.e., CDUA), however, we will accept one CDUA for the entire project. Please note that each CDUA section should differentiate between the proposed uses, and discussions should be very specific to the uses proposed. Additionally, the CDUA is a stand-alone document; each question should be answered fully and completely with specific information related to the uses described. CDUA questions which refence EA sections or "Exhibits" will not be accepted and may cause your application to be rejected.

As discussed above, a *Management Plan* will also be required to be submitted with the CDUA for the proposed agriculture and animal husbandry land uses. The management plan should be very specific regarding both the proposed agriculture and animal husbandry. Since the proposed land

uses have different impacts associated with each use, the CDUA should be very specific which use is being discussed and the various impacts or influences of each use.

OCCL staff would like to remind the applicant that a discussion on access and water requirements for the *County of Hawaii Fire Department* should be included in the EA.

If you have any questions regarding this letter, or the process of submitting and processing a CDUA, please contact Alex J. Roy, M.Sc., of our Conservation and Coastal Land staff at 808-587-0316 or via email at alex.j.roy@hawaii.gov

Sincerely,

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

CC: *Chairperson*
County of Hawaii – Planning Department

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 26, 2017

MEMORANDUM

RECEIVED
LAND DIVISION
2017 OCT -2 A11:0

TO: **DLNR Agencies:**
X Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
X Engineering Division
X Div. of Forestry & Wildlife
__Div. of State Parks
X Commission on Water Resource Management
X Office of Conservation & Coastal Lands
X Land Division – Hawaii District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Early Consultation for Environmental Assessment for Proposed Single-Family Residence in the Conservation District
LOCATION: Puna District, Island of Hawaii; TMK: (3) 1-5-010:031
APPLICANT: Geometrician Associates, LLC on behalf of **Mike Moore**

Transmitted for your review and comment is information on the above-referenced subject matter. We would appreciate your comments by **October 18, 2017.**

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417. Thank you.

Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed: _____

Print Name: GORDON C. HEIT

Date: 9/29/17

cc: Central Files

Harry Kim
Mayor

Paul K. Ferreira
Police Chief

Kenneth Bugado Jr.
Deputy Police Chief

County of Hawai`i

POLICE DEPARTMENT
349 Kapiolani Street • Hilo, Hawai`i 96720-3998
(808) 935-3311 • Fax (808) 961-8865

September 29, 2017

Mr. Ron Terry, Principal
Geometrician Associates
P. O. Box 396
Hilo, HI 96721

Dear Mr. Terry:

SUBJECT: EARLY CONSULTATION FOR ENVIRONMENTAL ASSESSMENT FOR PROPOSED SINGLE-FAMILY RESIDENCE IN THE CONSERVATION DISTRICT, PUNA DISTRICT, ISLAND OF HAWAII, TMK: (3^{RD}) 1-5-010:031

Staff, upon reviewing the provided documents, does not anticipate any significant impact to traffic and/or other public safety concerns.

Thank you for allowing us the opportunity to comment.

If you have any questions, please contact Captain Samuel Jelsma, Puna District Commander, at 965-2716.

Sincerely,

HENRY J. TAVARES, JR.
ASSISTANT POLICE CHIEF
AREA I OPERATIONS BUREAU

SJ:lli
170904

Harry Kim
Mayor

Wil Okabe
Managing Director

Allan G. Simeon, P.E.
Acting Director

Merrick H. Nishimoto
Acting Deputy Director

County of Hawai'i
DEPARTMENT OF PUBLIC WORKS
Aupuni Center
101 Pauahi Street, Suite 7 · Hilo, Hawai'i 96720-4224
(808) 961-8321 · Fax (808) 961-8630
public_works@hawaiicounty.gov

DECEMBER 15, 2017

ATTN: RON TERRY
GEOMETRICIAN ASSOCIATES, LLC.
P.O. BOX 396
HILO, HAWAII 96721
(via email to rterry@hawaii.rr.com and jmleonard@mac.com)

SUBJECT: EARLY CONSULTATION FOR ENVIRONMENTAL ASSESSMENT FOR PROPOSED SIGNLE-FAMILY RESIDENCE IN THE CONSERVATION DISTRICT, PUNA DISTRICT, ISLAND OF HAWAII
TMK: (3) 1-5-010:031

Please accept our apologies for the delay. We received the subject dated September 20 2017 and have the following comments:

The subject parcel is in an area designated as Flood Zone X and VE on the Flood Insurance Rate Map (FIRM) by the Federal Emergency Management Agency (FEMA). Flood Zone VE is the Special Flood Hazard Area inundated by the 100-year coastal flood (1% chance of occurring in any given year) with velocity hazard (wave action). All construction within Flood Zone VE shall comply with the requirements of Hawaii County Code, Chapter 27, Floodplain Management.

All development-generated runoff shall be disposed of on site and not directed toward any adjacent properties.

Access to the property shall comply with the requirements of Hawaii County Code, Chapter 22, County Streets.

All activities shall comply with the requirements of Hawaii County Code, Chapter 10, Erosion and Sedimentary Control. Agricultural operations, including ranching, crop or livestock production may qualify for a conservation program with the applicable soil and water conservation district. An approved conservation program would be an exclusion to Chapter 10.

Should there be any questions concerning this matter, please contact Ms. Robyn Matsumoto in our Engineering Division at (808) 961-8924.

BEN ISHII, Division Chief
Engineering Division

RM

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Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

APPENDIX 1b
Comments to Draft EA and Responses

[This page intentionally left blank]

DAVID Y. IGE
GOVERNOR OF
HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

CDUA: HA-3847
Acceptance Date: July 5, 2019
180-Day Exp. Date: January 1, 2020

AUG 27 2019

James M. Leonard
JM Leonard Planning, LLC
56 Laukona St.
Hilo, HI 96720

SUBJECT: Conservation District Use Application (CDUA) HA-3847 Single Family Residence; Subsistence Agriculture; Landscaping and Associated Improvements Located at Pōpōkī, Puna, County of Hawai'i, Tax Map Key: (3) 1-5-010:031

Dear Mr. Leonard:

This letter is regarding the processing of CDUA HA-3847 and the associated EA. The public and agency comment period on the EA has closed (August 22,2019). Attached to this letter are copies of the comments received by the Office of Conservation and Coastal Lands (OCCL) regarding your client's CDUA/EA.

Please send copies of your responses to the questions raised in these letters directly to the authoring agency. The final copy of this project's Environmental Assessment (EA) needs to include your responses to the queries raised in these letters. These responses can be attached to the end of the Final EA document.

The OCCL notes the subject area is within the Special Management Area (SMA). The applicant's responsibility includes complying with the provisions of Hawai'i's Coastal Zone Management law (Chapter 205A, HRS) that pertain to the Special Management Area (SMA) requirements administered by the various counties. Negative action on this application can be expected should you fail to obtain and provide us, one of the following:

- An official determination that the proposal is exempt from the provisions of the county rules relating to the SMA;
- An official determination that the proposed development is outside the SMA; or
- An SMA Use Permit for the proposed development.

Further, the OCCL offers the following comments on the Draft EA and CDUA:

- The OCCL notes the maximum developable area or total floor area in square feet that includes the first story and loft area appears to be approximately 4,050-ft² under roof;

- The Shed plans do not reflect 15-ft wide eaves for animal shelter;

- More information is required in the Management Plan that should discuss the animal's sustenance, care and welfare (How will the animals be managed?) while residing on the property;

- What is the maximum number of grazing animals proposed; and

- Fences, enclosures other than temporary grazing fences need to be sited on the overall site plan. Discuss how the ungulates shall be enclosed and controlled on the property.

Please send 2 hard copies of the Final EA and 2 CDs or flash drives **in searchable pdf. format** to the OCCL by **September 12, 2019**. You may wish to include an electronic copy of the Office of Environmental Quality Control (OEQC) Publication Form on the data storage unit or you may send an electronic copy of the Publication Form to Tiger Mills at kimberly.mills@hawaii.gov. If the project summary has changed, include a new summary. Please include a hard copy of the submitted publication form with the Final EAs.

Should the Department determine a Finding of No Significant Impact (FONSI) for the final version of the Environmental Assessment then this project's CDUA shall be placed on the agenda of the Board of Land and Natural Resources for their consideration. Early submittal of your response to comments will expedite the review process. Should you have any questions, please contact Tiger Mills of our Office of Conservation and Coastal Lands at (808) 587-0382.

Sincerely,

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

2029

DAVID Y. IGE
GOVERNOR OF
HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

2019 AUG

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

CDUA: HA-3847
Acceptance Date: July 5, 2019
180-Day Exp. Date: January 1, 2020
SUSPENSE DATE: 21 Days from stamped date

JUL 19 2019

MEMORANDUM

~~TO:~~ From

State Agencies

____ DLNR-Resource Enforcement
____ DLNR-Aquatic Resources
____ DLNR-Hawaii District Land Office
✓ DLNR-Forestry and Wildlife
____ DLNR-Na Ala Hele
** DLNR-Historic Preservation
-via e-mail w/6E Form

____ Office of Hawaiian Affairs

County Agencies:

____ Planning Department
____ Fire Department

~~FROM:~~ To:

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

SUBJECT: REQUEST FOR COMMENTS
Conservation District Use Application (CDUA) HA-3847
Single Family Residence; Subsistence Agriculture; Landscaping and Associated Improvements

APPLICANT: Mike Moore
TMK: (3) 1-5-010:031
LOCATION: Pōpōkī, Puna, County of Hawai'i
PUBLIC HEARING: No

Attached please find a CD of CDUA HA-3847 and the draft Environmental Assessment along with our Department's notice to the applicant. These documents may also be found on our website at dlnr.hawaii.gov/occl under current applications. We would appreciate your agency's review and comment on this application. If no response is received by the suspense date, we will assume there are no comments. The suspense date starts from the date stamp.

Contact Tiger Mills at (808) 587-0382 should you have any questions on this matter.

( ) Comments Attached

(✓) No Comments

DAVID G. SMITH, Administrator

Signature/ Print your Name and Title

RECEIVED
JUL 19 2019
Division of Aquatic Resources
2019 AUG 15 PM 3:59

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

CDUA: HA-3847
Acceptance Date: July 5, 2019
180-Day Exp. Date: January 1, 2020
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JUL 19 2019

MEMORANDUM

TO:

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-via e-mail w/6E Form

____ Office of Hawaiian Affairs

County Agencies:

____ Planning Department
____ Fire Department

FROM: Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

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Conservation District Use Application (CDUA) HA-3847
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(✗) Comments Attached

( ) No Comments

Signature/ Print your Name and Title

DAVID Y. IGE
GOVERNOR OF
HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
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FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

Date: 8/9/19
DAR # 5978

MEMORANDUM

TO: Brian J. Neilson
DAR Administrator

FROM: Troy Sakihara, Aquatic Biologist

SUBJECT: Request for comments, Conservation District Use Application (CDUA), HA-3847

Request Submitted by: Samuel J. Lemmo, Administrator, OCCL

Location of Project: Pōpōkī, Puna District, County of Hawai'i

Brief Description of Project:

This is a request for comments on a Conservation District Use Application (CDUA) HA-3847, for a single family residence, subsistence agriculture, landscaping and associated land use in Pōpōkī, Puna District, County of Hawai'i, TMK: (3) 1-5-010:031. The property is approximately 8.75 acres and is located within the resource subzone of the Conservation District.

Comments:

☐ No Comments ☒ Comments Attached

Thank you for providing DAR the opportunity to review and comment on the proposed project. Should there be any changes to the project plan, DAR requests the opportunity to review and comment on those changes.

Comments Approved: _____ Date: 8/13/19

Brian J. Neilson
DAR Administrator

DAR# 5978

Comments

The DAR requests that all proposed construction, agriculture and agroforestry activities adhere to Best Management Practices, such that appropriate measures are taken to prevent any impact or disturbance to aquatic or coastal marine habitat. In particular, steps should be taken to prevent erosion, or sedimentation, organic debris, pollutants and any form of contaminants from entering and measurably impacting or altering aquatic habitat and resources within the area. This includes the coastal marine habitat and anchialine habitats (land-locked tidally influenced brackish pools) that may be in the area. More specifically, proposed use of ungulates for grazing and fencing should take these factors into consideration. An outline of how these concerns will be addressed should be provided.

Mills, Kimberly T

From: Cab General
Sent: Monday, August 12, 2019 10:43 AM
To: Mills, Kimberly T
Cc: rterry@hawaii.rr.com
Subject: Comments on Draft EA Moore Single Family Residence at Popoki Project

Hi Tiger

Thank you for the opportunity to provide comments on the subject project.
Please see our standard comments at:
https://health.hawaii.gov/cab/files/2019/04/Standard-Comments-Clean-Air-Branch-2019.pdf .

Please let me know if you have any questions.

Barry Ching
Clean Air Branch
Hawaii Department of Health
(808) 586-4200

Standard Comments for Land Use Reviews
Clean Air Branch
Hawaii State Department of Health

If your proposed project:

Requires an Air Pollution Control Permit

You must obtain an air pollution control permit from the Clean Air Branch and comply with all applicable conditions and requirements. If you do not know if you need an air pollution control permit, please contact the Permitting Section of the Clean Air Branch.

s

Includes construction or demolition activities that involve asbestos

You must contact the Asbestos Abatement Office in the Indoor and Radiological Health Branch.

Has the potential to generate fugitive dust

You must control the generation of all airborne, visible fugitive dust. Note that construction activities that occur near to existing residences, business, public areas and major thoroughfares exacerbate potential dust concerns. It is recommended that a dust control management plan be developed which identifies and mitigates all activities that may generate airborne, visible fugitive dust. The plan, which does *not* require Department of Health approval, should help you recognize and minimize potential airborne, visible fugitive dust problems.

Construction activities must comply with the provisions of Hawaii Administrative Rules, §11-60.1-33 on Fugitive Dust. In addition, for cases involving mixed land use, we strongly recommend that buffer zones be established, wherever possible, in order to alleviate potential nuisance complaints.

You should provide reasonable measures to control airborne, visible fugitive dust from the road areas and during the various phases of construction. These measures include, but are not limited to, the following:

a) Planning the different phases of construction, focusing on minimizing the amount of airborne, visible fugitive dust-generating materials and activities, centralizing on-site vehicular traffic routes, and locating potential dust-generating equipment in areas of the least impact;
b) Providing an adequate water source at the site prior to start-up of construction activities;
c) Landscaping and providing rapid covering of bare areas, including slopes, starting from the initial grading phase;
d) Minimizing airborne, visible fugitive dust from shoulders and access roads;
e) Providing reasonable dust control measures during weekends, after hours, and prior to daily start-up of construction activities; and
f) Controlling airborne, visible fugitive dust from debris being hauled away from the project site.

If you have questions about fugitive dust, please contact the Enforcement Section of the Clean Air Branch

Clean Air Branch (808) 586-4200 cab@doh.hawaii.gov	Indoor Radiological Health Branch (808) 586-4700

Barry Ching

April 1, 2019

geometrician
ASSOCIATES, LLC
integrating geographic science and planning

phone: (808) 969-7090 PO Box 396 Hilo Hawaii 96721 rterry@hawaii.rr.com

September 17, 2019

Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Lemmo:

Subject: Comments on Draft Environmental Assessment (DEA)/Conservation District Use Application (CDUA) for Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī, Puna District, Island of Hawai'i, TMK 3-1-5-010:031

I am in receipt of your August 27, 2019 letter for the subject project to project planner James Leonard, which provided comment letters on the Draft EA and also discussed the CDUA content and processing.

In the interest of a complete record on comment letters to the EA/CDUA, I would first like to acknowledge receipt of comments from DLNR and other agencies contained within form memos circulated by your office. We acknowledge here the *no-comment* remarks of the Division of Forestry and Wildlife.

Regarding the August 13, 2019 memo from Brian J. Neilson, DAR Administrator, we understand the request that construction, agriculture and agroforestry activities adhere to BMPS that would prevent impact to aquatic or coastal marine habitat, especially from erosion/sedimentation, organic debris, and pollutants. The value of the coastal marine habitat and anchialine habitats is also noted, along with the concerns about the use of ungulates for grazing and fencing. In response, we would note that the configuration of project site and all proposed activities have been specifically designed to avoid direct or indirect impacts to the aquatic environment.

As stated in the EA, no natural water features such as streams, springs, or anchialine ponds are found on or near the property. The house would be set back a minimum of about 300 feet from the sea cliff and 160 feet from the certified shoreline, and no grading activities would occur makai of this area. A set of water quality BMPS and the permit process related to house and driveway construction are detailed in Section 3.1.3 of the EA. All the improvements have been sited in such a way as to minimize grading, which will cover only the very small necessary footprint for these features. The agroforestry area is set back behind the house, an additional 150 feet from the sea

cliff, as shown in Figure 3 of the EA. Section 1.1 of the EA describes the agroforestry practices, including the associated BMPs**. It is important to emphasize the point made in the EA that the agroforestry involves no grading**. Section 1.1 of the EA describes in detail the planned phased transition of the forest canopy through the systematic hand-clearing of invasive trees and plants, in approximately 1 to 1.5-acre segments. Those trees being removed will be cut, chipped and used as mulch onsite, especially in the garden areas and around new tree plantings, to contribute to the soil development, and also for water retention and weed control. Tree stumps of the more persistent invasives, such as strawberry guava, gunpowder trees, and melochia, may require spot treatment with a chemical herbicide to effectively control these from re-sprouting or spreading. A spot treatment of the trees at the stump is recommended over a broadcast spray in order to enhance its effectiveness and to limit the potential for environmental drift that could impact other desired trees and plants. This would be followed by a fencing of the selected area with a temporary electrical fencing used to contain grazing animals (principally goats) that will help maintain the cleared area from the reestablishment of the invasive or weedy plants. In response to the interest expressed in your comment, we are providing the following additional information on goat management, which is also included in the Final EA.

The specific fencing to be used is Timeless © electric fencing, which will be established around the perimeter of the property mauka of the house area. The Timeless Step In Post will be used to move the goats from area to area. It is generally recommended to use 3 to 4 full sized goats per acre to clear brush. The plan is to have 6 to 8 for the entire 9 acres, which will allow an initial period of steady, gradual clearing followed by long-term sustainable weed control and goat support. The entire process will be supervised by the owner and his family onsite. It is important to understand that the property, and all adjacent coastal property, is currently unfenced, and thus is subject to pig rooting and wallowing, along with most undeveloped parts of the rainforest in Puna. Fencing the goats in will also exclude pigs, which are much worse for water quality.

Concerning the August 12, 2019 memo from the Department of Health, Clean Air Branch, referring us to the standard DOH comments on their website, we had consulted these in preparing the EA. The project would does not require any air quality permits and because of its location and minimal disturbance would not involve any appreciable dust. The agroforestry methods are specifically designed to involve minimal to no ground disturbance other than the tree planting hole.

We offer the following in response to the comments from your agency with regard to both the Draft EA and the CDUA:

1) *The OCCL notes the maximum developable area or total floor area in square feet that includes the first story and loft area appears to be approximately 4,050-ft^2 under roof.*
   The developed area has now been recalculated by adding in the sidewalk area under the eaves; the total area is now calculated at 4,301 sf.
2) *The Shed plans do not reflect 15-ft wide eaves for animal shelter*.
   The Site Plan has been updated to show the shed eaves.
3) *More information is required in the Management Plan that should discuss the animal's sustenance, care and welfare (How will the animals be managed?) while residing on the property; what is the maximum number of grazing animals proposed*.
   As discussed in the response to the DAR comment above, 6-8 goats will be rotated around the entire property to remove alien vegetation. Fewer goats may be required as the vegetation achieves stability and the agroforestry plantings begin to grow in. Goats are

relatively low-maintenance farm animals, and the owner is familiar and capable of their care. The goats will be cared for in accordance with normal husbandry practices and will be given supplemental feed if required and provided veterinary care as appropriate. This information has been added to the Final EA.

4) *Fences, enclosures other than temporary grazing fences need to be sited on the overall site plan. Discuss how the ungulates shall be enclosed and controlled on the property.*
No permanent fencing is proposed. Ungulate control is described in the response above to the DAR comment.

Thank you for circulating the EA and CDUA for review by DLNR agencies. If you have any questions about the EA, please contact me at (808) 969-7090; for questions about the project or CDUA, please contact James Leonard, Project Planner, at (808) 896-3459.

Sincerely,

Ron Terry, Principal
Geometrician Associates

Cc: James Leonard, Michael Moore
DLNR agencies: DAR
Barry Ching, DOH-CAB

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Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

APPENDIX 2
Archaeological Inventory Survey

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An Archaeological Inventory Survey of TMK: (3) 1-5-010:031

Pōpōkī Ahupuaʻa
Puna District
Island of Hawaiʻi

DRAFT VERSION

Prepared By:

Ashton K. Dircks Ah Sam
and
Benjamin Barna, Ph.D.,

Prepared For:

Michael Moore
6215 Kanan-Dume Rd. M1079
Malibu, CA 90265

October 2017

ASM affiliates
Archaeology • History • Anthropology • Architectural History
Hilo Office: (808) 969-6066 Fax: (808) 443-0065
507-A E. Lanikaula Street, Hilo, HI 96720
Honolulu Office: (808) 439-8089 Fax: (808) 439-8087
820 Mililani Street, Suite 700, Honolulu, HI 96813

ASM Project Number 28820.00

An Archaeological Inventory Survey of TMK: (3) 1-5-010:031

Pōpōkī Ahupuaʻa
Puna District
Island of Hawaiʻi

ASM affiliates

EXECUTIVE SUMMARY

At the request of Michael Moore (landowner), ASM Affiliates (ASM) has prepared this Archaeological Inventory Survey (AIS) of a roughly 8.75-acre Conservation Zoned property (TMK: (3) 1-5-010:031) located in Pōpōkī Ahupuaʻa, Puna District, Island of Hawaiʻi. This undeveloped parcel is a portion of a former land grant (Grant 1537) sold to Kapohana in 1855, and is currently situated within the State Conservation District. The landowner plans to develop a single-family residence on the property, which given the Conservation District zoning requires the preparation of an Environmental Assessment (EA) and Conservation District Use Application (CDUA) pursuant to Hawaiʻi Revised Statutes (HRS) Chapter 343. The current study has been prepared in support of the EA and CDUA, and was undertaken in accordance with Hawaiʻi Administrative Rules (HAR) 13§13-284. In order to satisfy the Historic Preservation review process requirements of the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) as well as the County of Hawaiʻi Planning Department rules and guidelines, the structure and contents of the current report adhere to the *Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports* as contained in HAR 13§13-276.

Fieldwork for the current project was conducted August 9–15, 2017, under the direction of Benjamin Barna, Ph.D. The entire parcel was subject to northeast/southwest pedestrian transects with fieldworkers spaced at 10-meter intervals. Archaeological features (and landforms, disturbances, etc.) were plotted on a map of the current study parcel using GPS data and compass-and-tape mapping techniques. Features were then cleared of vegetation, photographed, and described using standardized site record forms. A single hand-excavated test trench (TT-1) was used to determine if archaeological evidence of Site 18418A (a trail recorded on a nearby parcel) was present *mauka* of the shoreline in the current study area.

As a result of the fieldwork for the current study one previously unrecorded archaeological site (SIHP Site 50-10-45-30712), an agricultural complex was identified within the current study parcel. The site comprises sixty-four features that include twenty-two mounds, twenty-two walls and three wall remnants, nine modified depressions, three cleared soil areas, three modified outcrops, one cluster of *pāhoehoe* excavations, and one rock alignment. Based on the relatively informal and opportunistic construction of the features, their association with soil deposits, and their widespread distribution within the study area, they have all been interpreted as agricultural clearing, planting, or boundary features. When considered in the context of previous archaeological studies in the coastal Makuʻu-Pōpōkī-Hālona area, the patterning of archaeological features corroborates ethnohistoric accounts of Makuʻu Village as a dispersed coastal settlement surrounded by opportunistic agricultural land use. Subsurface testing in TT-1 produced negative results, indicating that Site 18418A does not exist *mauka* of the shoreline in the current study area.

Based on the results of the current study, Site 30712 is assessed to be historically significant under Criterion d only for the information yielded relative to the type and extent of agricultural features in the Makuʻu-Pōpōki-Hālona area. It is argued that the current study has been sufficient to fully document Site 30712 and to exhaust its potential to yield further information important for research on prehistory or history. Therefore, no further historic preservation work is recommended for the site. Additionally, it is the landowner's intention to avoid disturbing the archaeological features during construction activities, and to incorporate these features without modification into any proposed landscaping.

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1. INTRODUCTION

At the request of Michael Moore (landowner), ASM Affiliates (ASM) has prepared this Archaeological Inventory Survey (AIS) of a roughly 8.75-acre Conservation Zoned property (TMK: (3) 1-5-010:031) located in Pōpōkī Ahupuaʻa, Puna District, Island of Hawaiʻi (Figures 1 and 2). This undeveloped parcel (Figure 3) is a portion of a former land grant (Grant 1537) sold to Kapohana in 1855, and is currently situated within the State Conservation District. The landowner plans to develop a single-family residence on the property (Figure 4), which given the Conservation District zoning, requires the preparation of an Environmental Assessment (EA) and Conservation District Use Application (CDUA) pursuant to Hawaiʻi Revised Statutes (HRS) Chapter 343. The current study has been prepared in support of the EA and CDUA, and was undertaken in accordance with Hawaiʻi Administrative Rules (HAR) 13§13-284. In order to satisfy the Historic Preservation review process requirements of the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) as well as the County of Hawaiʻi Planning Department rules and guidelines, the structure and contents of the current report adhere to the *Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports* as contained in HAR 13§13-276.

This report contains background information outlining the project area's physical and cultural contexts, a presentation of previous archaeological work in the vicinity of the parcel, and current survey expectations based on that previous work. Also presented is an explanation of the project's methods, a detailed description of the archaeological features encountered, interpretation and evaluation of those resources, and treatment recommendations for the documented site.

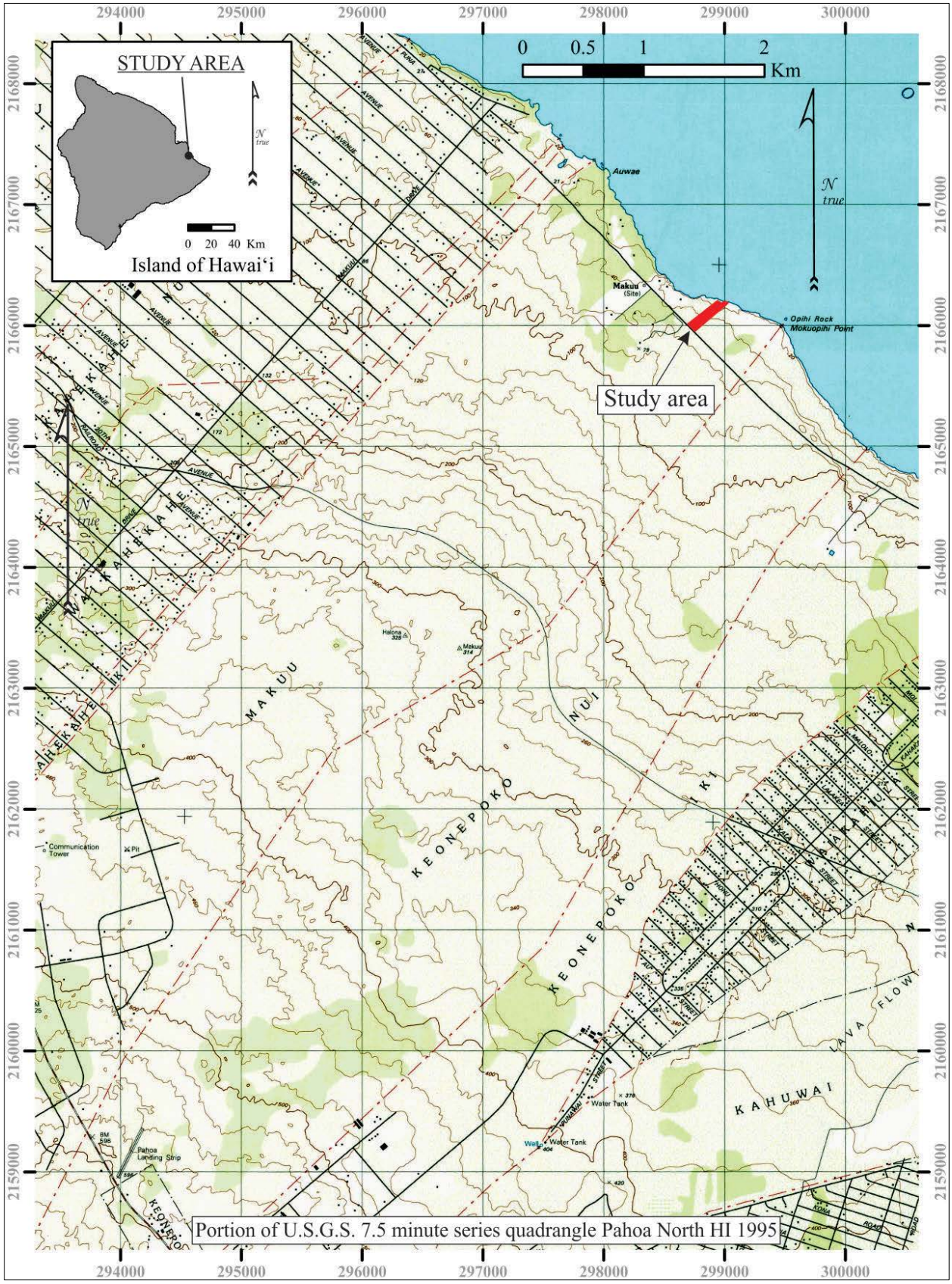


Figure 1. Study area location.

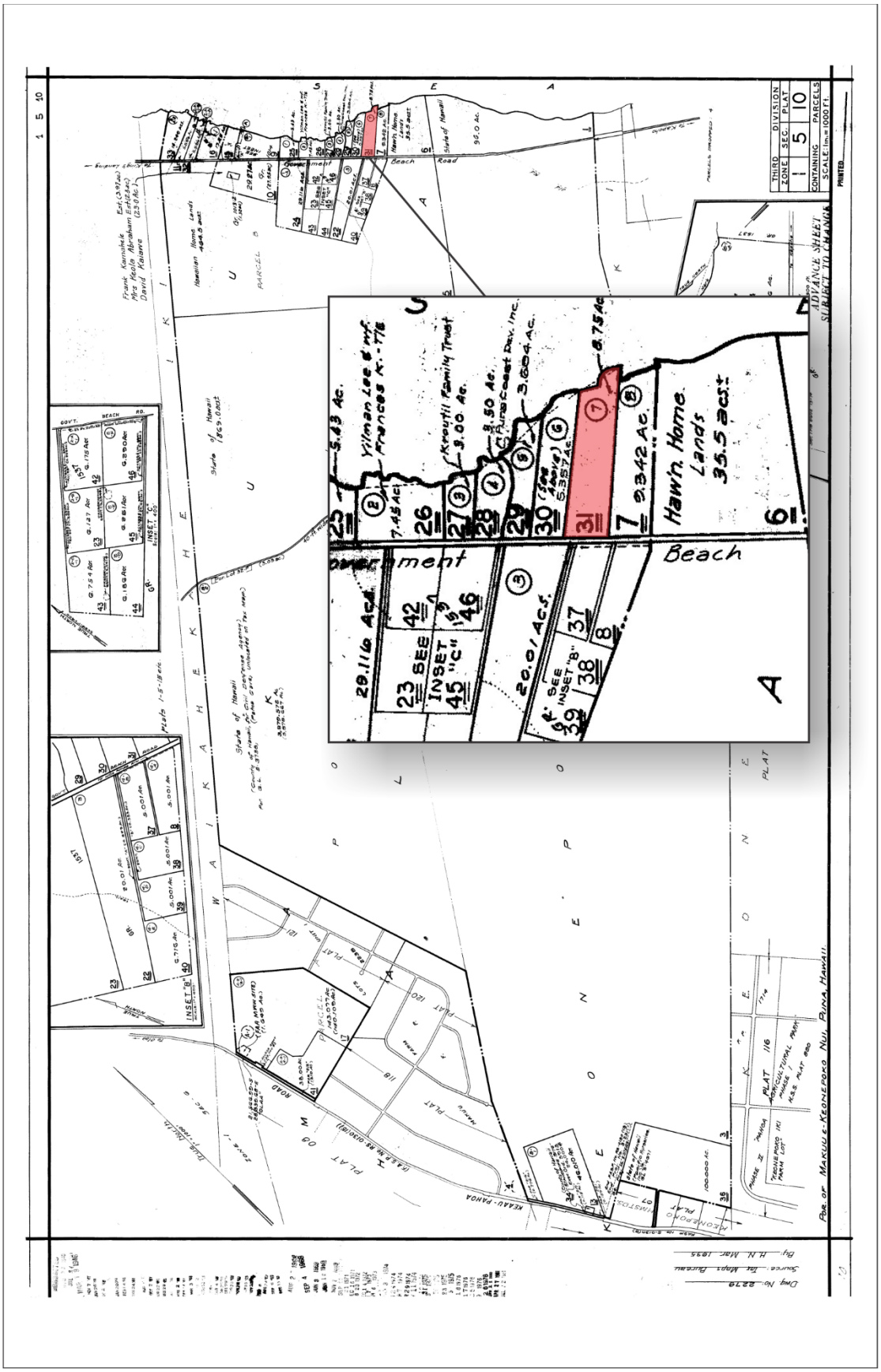


Figure 1. Tax Map Key plat (3) 1-5-010 with study area indicated.

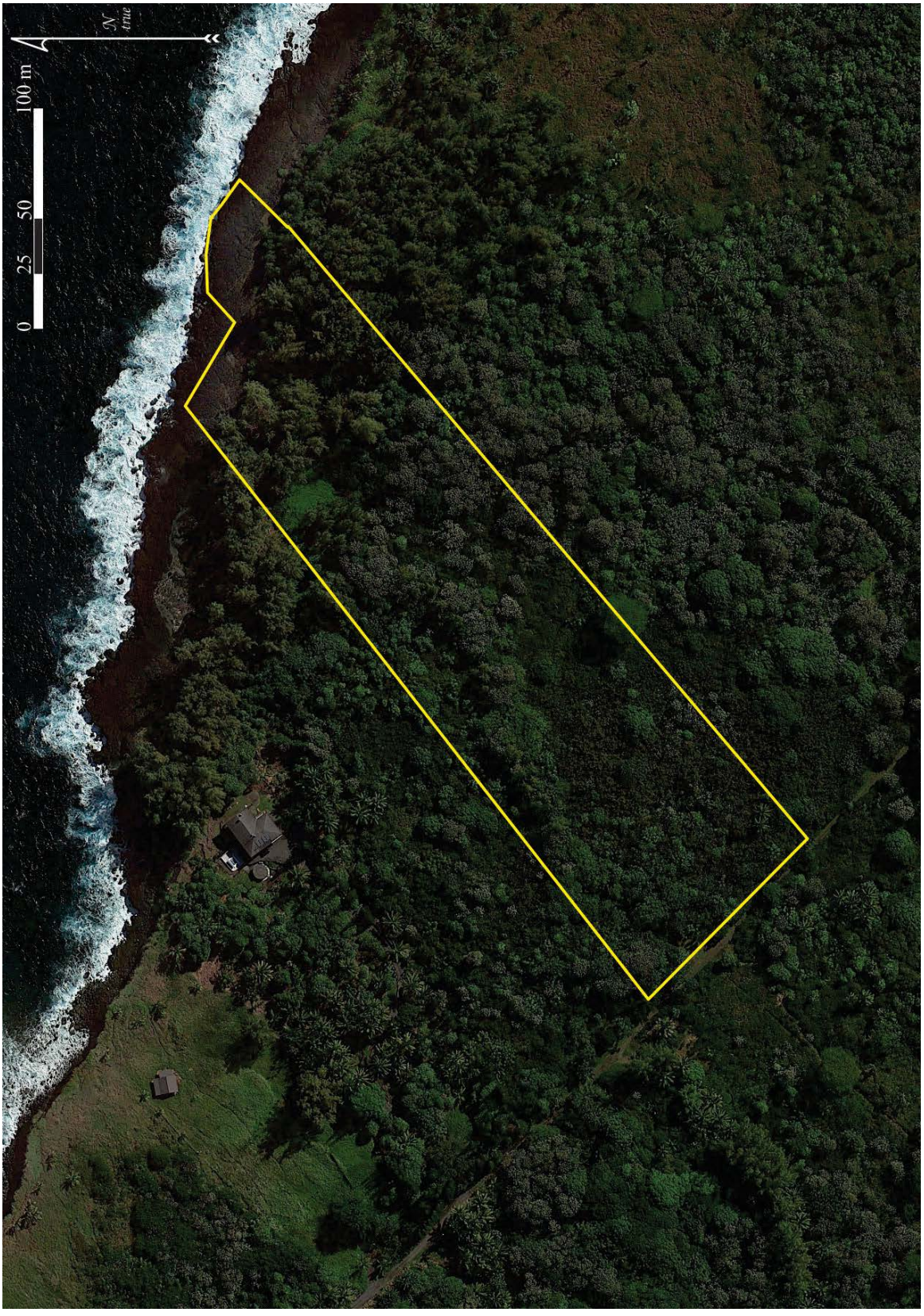


Figure 2. Google Earth ™ satellite image (2014) of the current study area (outlined in yellow).

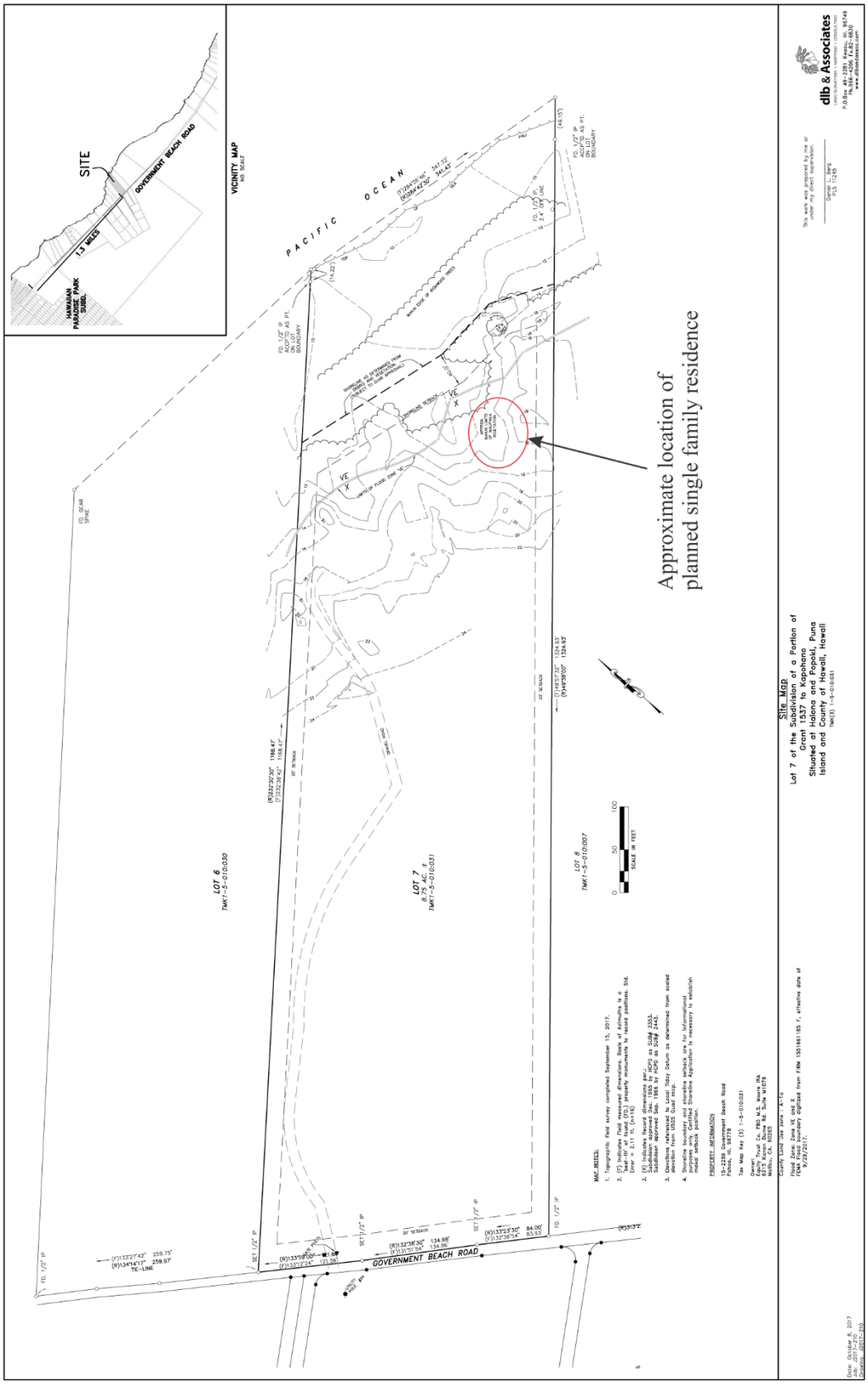


Figure 3. Approximate location of proposed single family residence to be built in the current study area.

STUDY AREA DESCRIPTION

The current study area consists of 8.75 acres located in Pōpōkī Ahupuaʻa, Puna District, Island of Hawaiʻi (see Figures 1 and 2). The parcel is located southeast of the Hawaiian Paradise Park residential subdivision between the old Government Road (the Government Beach Road) and the coast at elevations ranging from 15 to 65 feet above sea level. The parcel is bounded along its *makai* edge (to the northeast) by sea cliffs (Figure 5), to the northwest by a privately-owned, undeveloped parcel (Parcel 30), to the southwest by a privately-owned, undeveloped parcel (Parcel 7), and along its *mauka* edge by the old Government Road (Figure 6). Access to the parcel is through a gated driveway along the *makai* edge of the old Government Road, in the northwest portion of the current study parcel (Figure 7). The driveway extends in a northeast direction through the north portion of the parcel towards the coast (Figure 8).

Terrain within the project area slopes gently to the northeast, and the underlying geology (Figure 9) consists primarily of *pāhoehoe* lava flows (Qp4o in Figure) that originated from Kilauea Volcano 450 to 750 years ago (Wolfe and Morris 1996). A small finger of younger (dated to A.D. 1410) *pāhoehoe* has been mapped at the *makai* end of the property, but during the fieldwork for the current study this flow was observed to cover a slightly different portion of the study area. Soils in this area (Figure 10) overlying the older flow are classified as Opihikao extremely rocky muck (Sato et al. 1973). This soil typically consists of a thin layer of very dark brown, strongly acidic muck about three inches thick that is generally underlain by *pāhoehoe* lava bedrock. The muck is rapidly permeable, and the lava is very slowly permeable, but water moves rapidly through cracks in the lava bedrock. Runoff is slow, and the erosion hazard is slight. Roots are matted over the *pāhoehoe* lava, but they can penetrate cracks to a depth of two feet (Sato et al. 1973). Sato et al. (1973) classify the soils over the younger *pāhoehoe* flow as Lava flows, pahoehoe, which is a miscellaneous land type typically bare of soil. This area typically receives 60 to 100 inches of rain per year (Giambelluca et al. 2016).

Figure 5. Sea cliffs at the *makai* boundary of the study area, view to the northwest.

Figure 6. Old Government Road on the *mauka* boundary of the study area, view to the northwest.

Figure 7. Gated driveway to the current study parcel extending makai from the old Government Road, view to the northeast.

Figure 8. Access road extending northeast through the north portion of the study parcel, view to the northeast.

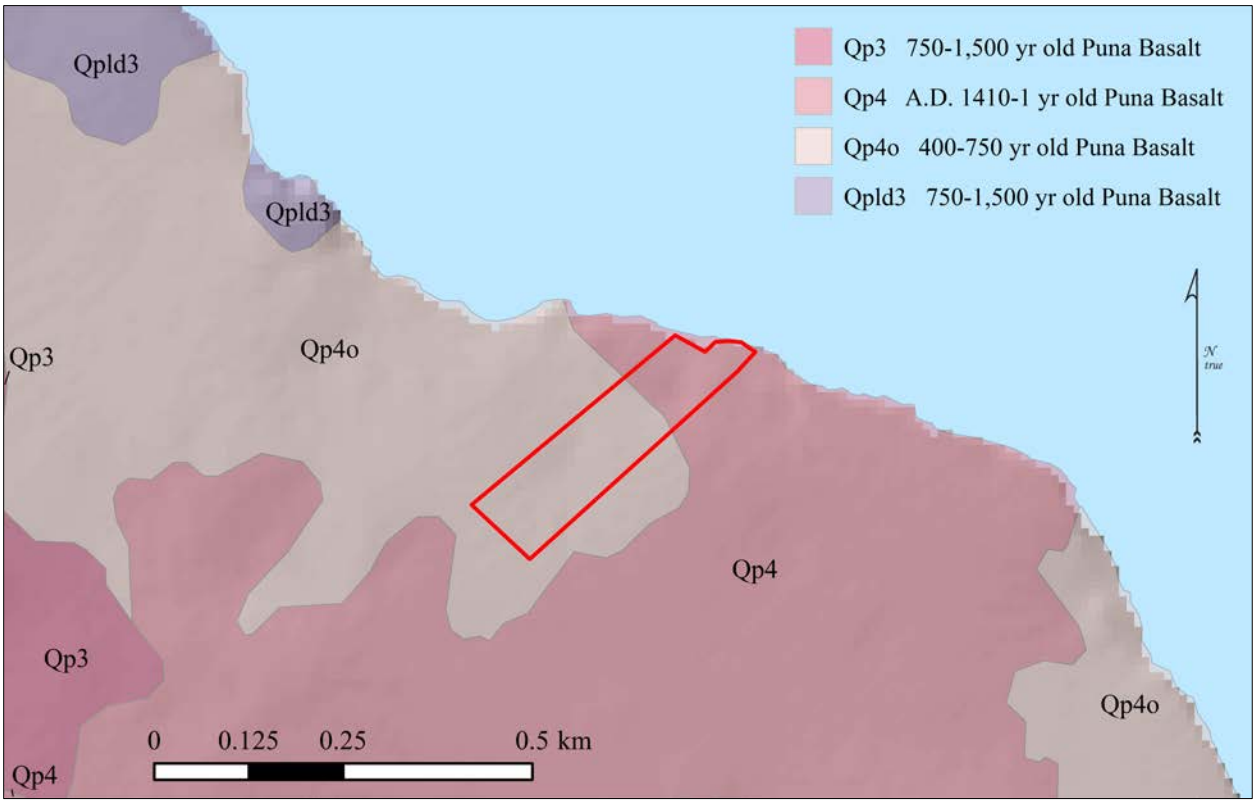


Figure 9. Geology in the current study area (after Wolfe and Morris 1996).

Figure 10. Soils in the current study area (after Sato et al. 1973).

Most of the current study parcel has not been subject to previous mechanical clearing, except for the bulldozed access road and a small area at the northeast end of the access road (Figure 11). The study parcel can be divided into three terrain zones. The *makai* zone (extending approximately 30 meters inland from the sea cliffs) consists of an area of exposed *pāhoehoe* bedrock (Figure 12) corresponding to A.D. 1410 *pāhoehoe* flow. Extending roughly 30 meters *mauka* from the exposed bedrock is a wide sandy area containing scattered cobbles and boulders (Figure 13). A modern fire-pit is located in the northeast portion of the study area, where the *pāhoehoe* transitions to sand (Figure 14). Vegetation in the sandy area consists primarily of ironwood trees (*Casuarina equisetifolia*), tree heliotrope (*Heliotropium foertherianum*), false *kamani* (*Terminalia catappa*), guinea grass (*Megathyrsus maximus*), wedelia (*Sphagneticola trilobata*), and *naupaka* (*Scaevola sericea*) (Figures 15).

Mauka of the sandy area, the ground surface transitions to uneven *pāhoehoe* bedrock corresponding to the older Kīlauea lava flow that covers the remainder of the study area. The ground surface exhibits fracturing, as well as scattered cobbles, and the Opihikao extremely rocky muck soils (Figure 16). There are numerous outcrops of varying height, depressions of varying depth, and pockets of soil that extend upslope to the property boundary along the old Government Road. The A.D.1410 *pāhoehoe* flow has created a slightly elevated, nearly barren area of exposed bedrock that covers nearly one-third of the parcel. The actual area covered by this flow differs slightly from that shown in Figure 9. Vegetation in the central/*mauka* section of the study area consists of strawberry guava (*Psidium cattleianum*) interspersed with *hala* (*Pandanus tectorius*), *ʻōhiʻa lehua* (*Metrosideros polymorpha*), *noni* (*Morinda citrifolia*), mango (*Mangifera indica*), coconut (*Cocos nucifera*), white moho (*Heliocarpus popayanensis*), melochia (*Melochia umbellata*), octopus tree (*Brassaia actinophylla*), Chinese banyan (*Ficus nitida*), gunpowder tree (*Trema orientalis*), bingabing (*Macaranga mappa*), ti (*Cordyline fruticosa*), *lauaʻe* (*Phymatosorus grossus*), bamboo orchid (*Arudina graminifolia*), *hilahila* (*Mimosa pudica*), castor tree (*Ricinus communis*), *ʻawapuhi* (*Zingiber zerumbet*), and *kupukupu* (*Nephrolepis cordifolia*) entangled with *maile pilau* (*Paederia foetida*) and *lilikoi* (*Passiflora edulis*) vines.

Figure 11. Bulldozed area at the *makai* end of the access road, view to the northeast.

Figure 12. Exposed *pāhoehoe* in the *makai* portion of the study parcel, view to the west.

Figure 13. Area of sand and scattered cobbles, view to the east.

Figure 14. Modern fire pit near the coast in the southeast portion of the study parcel, view to the northeast.

Figure 15. Vegetation in the sand area of the study parcel, view to the southwest

Figure 16. Typical vegetation in the central/*mauka* portion of the study parcel, view to the north.

Figure 17. Vegetation in the central/mauka portion of the study parcel from the access road, view to the northeast.

2. BACKGROUND

In order to generate a set of expectations regarding the nature of archaeological resources that might be encountered on the study parcel, and to establish an environment within which to assess the significance of any such resources, previous archaeological studies relative to the project area and a general culture-historical context for the region are presented.

CULTURE-HISTORICAL CONTEXT

The *ahupua'a* of Pōpōkī (lit., ti leaf bundle) is one of fifty traditional land divisions found in the *moku* (district) of Puna on the eastern shores of Hawai'i Island (Figure 18). It should be noted that Pōpōkī Ahupua'a is a small *ahupua'a* sandwiched between the larger *ahupua'a* of Maku'u to the northwest, and the small *ahupua'a* of Hālona to the southeast. The boundaries between these *ahupua'a* are not depicted on any of the cartographic resources reviewed for this study, and in the literature all three are often discussed together as a single unit. In fact, the entire area is often described generally as "Maku'u" (Charvet-Pond and Rosendahl 1993:C-1). The placement of the current study area within Pōpōkī Ahupua'a was determined through a reckoning of the parcel's location within the *ahupua'a*, combined with a review of information contained in the records for former Grant 1537, which includes the current study parcel. Based on this information, it is very likely that the current study parcel is located within Pōpōkī Ahupua'a near its boundary with Hālona Ahupua'a.

In *Native Planters in Old Hawaii*, Handy and Handy (1991) describe Puna as an agriculturally fertile land that has been repeatedly devastated by lava flows. Writing during the 1930s, they relate that:

> The land division named Puna—one of the six chiefdoms of the island of Hawaii said to have been cut (*'oki*) by the son and successor of the island's first unifier, Umi-a-Liloa—lies between Hilo to the north and Ka'u to the south, and it projects sharply to the east as a great promontory into the Pacific. Kapoho is its most easterly point, at Cape Kumukahi. The uplands of Puna extend back toward the great central heights of Mauna Loa, and in the past its lands have been built, and devastated, and built again by that mountain's fires. In the long intervals, vegetation took hold, beginning with miniscule mosses and lichens, then ferns and hardier shrubs, until the uplands became green and forested and good earth and humus covered much of the lava-strewn terrain, making interior Puna a place of great beauty. . .
>
> …One of the most interesting things about Puna is that Hawaiians believe, and their traditions imply that this was once Hawaii's richest agricultural region and that it is only in relatively recent time that volcanic eruption has destroyed much of its best land. Unquestionably lava flows in historic times have covered more good gardening land here than in any other district. But the present desolation was largely brought about by the gradual abandonment of their country by Hawaiians after sugar and ranching came in… (Handy and Handy 1991:539-542)

No specific Hawaiian traditions or legendary accounts concerning Pōpōkī Ahupua'a were located while conducting research for this report, but Barrère (1959:15) summarizes the Precontact geopolitics of the Puna District as follows:

> Puna, as a political unit, played an insignificant part in shaping the course of history of Hawaii Island. Unlike the other districts of Hawaii, no great family arose upon whose support one or another of the chiefs seeking power had to depend for his success. Puna lands were desirable, and were eagerly sought, but their control did not rest upon conquering Puna itself, but rather upon control of the adjacent districts, Kau and Hilo.

Despite its perceived lack of importance with respect to the emerging political history of Hawaiian leadership, Puna was a region famed in legendary history for its associations with the goddess Pele and god Kāne (Maly 1998). As the Hawaiian people had no written language until Postcontact times, traditional *mo'olelo* were passed down orally through the generations. Plentiful are the myths and legends associated with the beautiful *wahi pana* of Puna, which frequently refer to the majestic female fire deity, Pele, or "Pele-honua-mea (Pele of the sacred earth)" (Beckwith 1976). Most closely associated with the powerful, temperamental volcanoes of Hawai'i, she was perhaps both feared and respected equally by the people of the islands. Nimmo (1990:44) relates that, "although the actual worship of Pele was most important in the districts of Hawai'i that experienced active volcanism, the mythology of the goddess was widespread throughout the Hawaiian Islands", but that, "there is no evidence that Pele was worshipped extensively

beyond the volcano area of Hawai‘i, although her mythology was apparently widespread throughout the Hawaiian Islands and members of her family were important in ritual throughout the archipelago.” Because of the relatively young geological history and persistent volcanic activity, the region’s association with Pele has been a strong one. However, the association with Kāne is perhaps more ancient. Kāne, ancestor to both chiefs and commoners, is the god of sunlight, fresh water, verdant growth, and forests (Pukui 1983). It is said that before Pele migrated to Hawai‘i from Kahiki, there was “no place in the islands . . . more beautiful than Puna” (Pukui 1983:11). Contributing to that beauty were the groves of fragrant *hala* and forests of *‘ōhi‘a lehua* for which Puna was famous:

> *Puna pāia ‘ala i ka hala* (Puna, with walls fragrant with pandanus blossoms)
>
> Puna, Hawai‘i, is a place of *hala* and *lehua* forests. In olden days the people would stick the bracts of *hala* into the thatching of their houses to bring some of the fragrance indoors. (Pukui 1983:301)

The chronological summary presented below begins with the peopling of the Hawaiian Islands and includes the presentation of a generalized model of Hawaiian Prehistory containing legendary references to the Puna District and Maku‘u and a discussion of the general settlement patterns. The discussion of Prehistory and legendary references is followed by a summary of Historic events in the Puna District that begins with the arrival of foreigners in the islands and then continues with the history of land use after contact. The summary includes a discussion of the changing life ways and population decline of the early Historic Period, a review of land tenure in Pōpōkī and the larger Maku‘u area during the Māhele ‘Āina of 1848, and documentation of the transition to modern industries and agriculture during the late nineteenth and twentieth centuries.

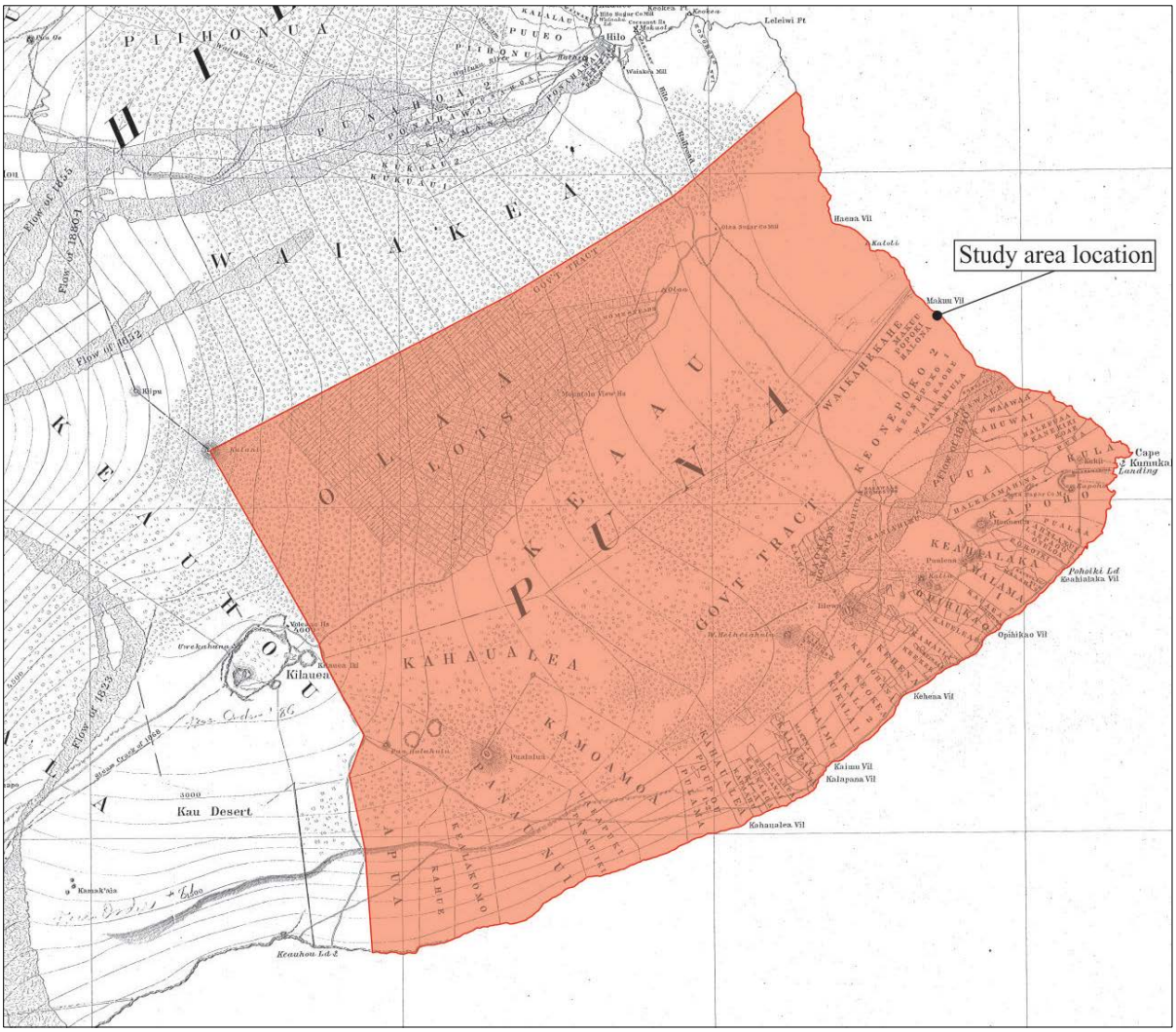


Figure 18. Portion of Hawai‘i Registered Map 2060 with the moku of Puna shaded red.

Generalized Model of Hawaiian Prehistory

The generalized cultural sequence that follows is based on Kirch's (1985) model, but is amended to include recent revisions offered by Kirch (2011). The conventional wisdom has been that first inhabitants of Hawai‘i Island arrived focused habitation and subsistence activity on the windward side of the island (Burtchard 1995; Hommon 1986; Kirch 1985). Recent re-evaluation and syntheses of genealogical, oral historical, mythological, and radiometric data by Kirch (2011) and others (Athens et al. 2014; Duarte 2012; Wilmshurst et al. 2011) have convincingly argued that Polynesians first arrived in the Hawaiian Islands as early as A.D. 1000, and expanded rapidly thereafter. The implications of this on the currently accepted chronology would alter the timing of the Settlement, Developmental, and Expansion Periods, possibly shifting the Settlement Period to A.D. 1000 to 1100, the Developmental Period to A.D. 1100 to 1350, the Expansion Period to A.D. 1350 to 1650, and the Proto-Historic Period to A.D.1650-1795.

The initial settlement in Hawai‘i is believed to have occurred from the southern Marquesas Islands. The Settlement Period was a time of great exploitation and environmental modification, when early Hawaiian farmers developed new subsistence strategies by adapting their familiar patterns and traditional tools to their new environment (Kirch 1985; Pogue 1978). Their ancient and ingrained philosophy of life tied them to their environment and kept order. Order was further assured by the conical clan principle of genealogical seniority (Kirch 1984, 2010). According to Fornander (1969), Hawaiians brought from their homeland certain universal Polynesian customs: the major gods Kāne, Kū, and Lono; the *kapu* system of law and order; cities of refuge; the *‘aumakua* concept; various epiphenomenal beliefs; and the concept of *mana*. Over a period of several centuries areas with the richest natural resources became populated and perhaps even crowded, and the population began expanding to the *kona* (leeward side) and more remote regions of the island (Cordy 2000). In Puna, a few small communities were initially established along sheltered bays with access to fresh water and rich marine resources. The communities shared extended familial relations, and there was an occupational focus on the collection of marine resources.

The Development Period brought about a uniquely Hawaiian culture. The portable artifacts found in archaeological sites of this period reflect not only an evolution of the traditional tools, but some distinctly Hawaiian inventions. The adze (*ko‘i*) evolved from the typical Polynesian variations of plano-convex, trapezoidal, and reverse-triangular cross-section to a very standard Hawaiian rectangular quadrangular tanged adze. Few areas in Hawai‘i contain quality basalt for adze production. Mauna Kea on the island of Hawai‘i was a well-known adze quarry. The two-piece fishhook and the octopus-lure breadloaf sinker are Hawaiian inventions of this period, as are *‘ulu maika* stones and *lei niho palaoa*. The later were status items worn by individuals of high rank, which indicates recognition of status differentiation (Kirch 1985). As the environment reached its maximum carrying capacity, the result was social stress, hostility, and war between neighboring groups (Kirch 1985).

The Expansion Period is characterized by the greatest social stratification, major socioeconomic changes, and intensive land modification. Most of the ecologically favorable zones of the windward and coastal regions of all major islands were settled and the more marginal leeward areas were being developed. The greatest population growth occurred during the Expansion Period. It was during the Expansion Period that a second major migration settled in Hawai‘i, this time from Tahiti in the Society Islands. According to Kamakau (1976), the *kahuna* Pā‘ao settled in the islands during the 13th century. Pā‘ao was the keeper of the god Kū‘kā‘ilimoku, who had fought bitterly with his older brother, the high priest Lonopele. After much tragedy on both sides, Pā‘ao was expelled from his homeland by Lonopele. He prepared for a long voyage, and set out across the ocean in search of a new land. On board Pā‘ao's canoes were thirty-eight men (*kānaka*), two stewards (*kānaka ‘ā‘īpu‘upu‘u*), the chief Pilika‘aiea (Pili) and his wife Hina‘aukekele, Nāmau‘u o Malaia, the sister of Pā‘ao, and the prophet Makuaka‘ūmana (Kamakau 1992). In 1866, Kamakau (1992:100–102) told the following story of their arrival in Hawai‘i:

> Puna on Hawai‘i Island was the first land reached by Pā‘ao, and here in Puna he built his first *heiau* for his god Aha‘ula and named it Aha‘ula [Waha‘ula]. It was a *luakini*. From Puna, Pā‘ao went on to land in Kohala, at Pu‘uepa. He built a *heiau* there called Mo‘okini, a *luakini*.
>
> It is thought that Pā‘ao came to Hawai‘i in the time of the *ali‘i* La‘au because Pili ruled as *mo‘i* after La‘au. You will see Pili there in the line of succession, the *mo‘o kū‘auhau*, of Hanala‘anui. It was said that Hawai‘i Island was without a chief, and so a chief was brought from Kahiki; this is according to chiefly genealogies. Hawai‘i Island had been without a chief for a long time, and the chiefs of Hawai‘i were *ali‘i maka‘āinana* or just commoners, *maka‘āinana*, during this time.

> … There were seventeen generations during which Hawai‘i Island was without chiefs—some eight hundred years. … The lack of a high chief was the reason for seeking a chief in Kahiki, and that is perhaps how Pili became the chief of Hawai‘i. He was a chief from Kahiki and became the ancestor of chiefs and people of Hawai‘i Island.

The concept of the *ahupua‘a* was established sometime during the A.D. 1400s, adding another component to a then well-stratified society (Kirch 1985). This land unit became the equivalent of a local community, with its own social, economic, and political significance. *Ahupua‘a* were ruled by *ali‘i ‘ai ahupua‘a* or lesser chiefs; who, for the most part, had complete autonomy over this generally economically self-supporting piece of land, which was managed by a *konohiki*. *Ahupua‘a* were usually wedge or pie-shaped, incorporating all of the eco-zones from the mountains to the sea and for several hundred yards beyond the shore, assuring a diverse subsistence resource base (Hommon 1986). This form of district subdividing was integral to Hawaiian life and was the product of strictly adhered to resource management planning. In this system, the land provided fruits and vegetables and some meat for the diet, and the ocean provided a wealth of protein resources (Rechtman and Maly 2003). Pōpōkī is one of some fifty *ahupua‘a* that make up the District of Puna (see Figure 18).

Entire *ahupua‘a*, or portions of the land were generally under the jurisdiction of appointed *konohiki*, or lesser chief-landlords, who answered to an *ali‘i-‘ai-ahupua‘a* (chief who controlled the *ahupua‘a* resources). The *ali‘i-‘ai-ahupua‘a* in turn answered to an *ali‘i ‘ai moku* (chief who claimed the abundance of the entire district). Thus, *ahupua‘a* resources supported not only the *maka‘āinana* and *‘ohana* who lived on the land, but also contributed to the support of the royal community of regional and/or island kingdoms. This form of district subdividing was integral to Hawaiian life and was the product of strictly adhered to resources management planning. In this system, the land provided fruits and vegetables and some meat for the diet, and the ocean provided a wealth of protein resources. Also, in communities with long-term royal residents, divisions of labor (with specialists in various occupations on land and in procurement of marine resources) came to be strictly adhered to. The *ali‘i* and the *maka‘āinana* (commoners) were not confined to the boundaries of the *ahupua‘a*; when there was a perceived need, they also shared with their neighbor *ahupua‘a ‘ohana* (Hono-ko-hau 1974). The *ahupua‘a* were further divided into smaller sections such as the *‘ili, mo‘o‘aina, pauku‘aina, kihapai, koele, hakuone,* and *kuakua* (Hommon 1986; Pogue 1978). The chiefs of these land units gave their allegiance to a territorial chief or *mō‘ī* (king).

The Precontact population of the Puna District lived in small settlements along the coast where they subsisted on marine resources and agricultural products. The villages of Puna, McEldowney (1979:17) notes, were similar to those of the Hilo District, and they:

> …comprised the same complex of huts, gardens, windbreaking shrubs, and utilized groves, although the form and overall size of each appear to differ. The major differences between this portion of the coast and Hilo occurred in the type of agriculture practiced and structural forms reflecting the uneven nature of the young terrain. Platforms and walls were built to include and abut outcrops, crevices were filled and paved for burials, and the large numbers of loose surface stones were arranged into terraces. To supplement the limited and often spotty deposits of soil, mounds were built of gathered soil, mulch, sorted sizes of stones, and in many circumstances, from burnt brush and surrounding the gardens. Although all major cultigens appear to have been present in these gardens, sweet potatoes, ti (*Cordyline terminalis*), *noni (Morinda citrifolia*), and gourds (*Lagenaria siceraria*) seem to have been more conspicuous. Breadfruit, pandanus, and mountain apple (*Eugenia malaccensis*) were the more significant components of the groves that grew in more disjunct patterns than those in Hilo Bay.

Located along the coast, the current study area falls within the Coastal Settlement Zone (Zone I) described by McEldowney (1979). Because this part of the *ahupua‘a* also extends out to the ocean fisheries fronting its coastline, with these marine resources and the *mauka* agricultural and forest resources, the former residents of Pōpōkī were once able to procure nearly all that they needed to sustain their families and contribute to the larger community from within the land division. The *ahupua‘a* resources in turn helped support the *ali‘i* that ruled the District of Puna (Maly 1998).

Among the resources abundant in coastal Puna were groves of *hala* trees. As Handy (1940:194) relates, Puna is referred to as “Puna paia ala i ka hala” (Puna hedged with fragrant hala). While frequently exalted for its glorious fragrance, the pandanus tree (*pū hala*) (Figure 23) was also exploited for more utilitarian purposes. The dried leaves were frequently used to plait *lauhala* mats which could be used for thatching onto house rafters (a method typically employed in Puna and the neighboring district of Hilo in the absence of *pili* grass) and house walls, pillows, fans, floor

coverings, canoe sails, baskets, and occasionally as clothing (Handy 1940; Handy and Handy 1991; Summers 1999). According to Fornander (1919–1920), two particular styles of *lauhala* mats associated with Puna were a braided, small-stranded mat called *makali'i* and a mat made from the male pandanus blossom called *puahala* or *hīnano*.

By the seventeenth century, large areas of Hawai'i Island (*moku āina* – districts) were controlled by a few powerful *ali'i 'ai moku*. There is island-wide evidence to suggest that growing conflicts between independent chiefdoms were resolved through warfare, culminating in a unified political structure at the district level. It has been suggested that the unification of the island resulted in a partial abandonment of portions of leeward Hawai'i, with people moving to more favorable agricultural areas (Barrera 1971; Schilt and Sinoto 1980). 'Umi a Līloa, a renowned *ali'i* of the Pili line, is often credited with uniting the Island of Hawai'i under one rule (Cordy 1994). Kamakau (1992:17–18) reports that, at this time, "Hua-'a was the chief of Puna, but Puna was seized by 'Umi and his warrior adopted sons… Hua-'a was killed by Pi'i-mai-wa'a on the battle field of Kuolo in Kea'au, and Puna became 'Umi-a-Liloa's." Umi's reign lasted until around ca. A.D. 1620, and was followed by the rule of his son, Keawenui a 'Umi, and then his grandson, Lonoikamakahiki (Cordy 1994).

Kirch (1985) places the beginning of the Proto-Historic Period during the rule of Lonoikamakahiki. This was a time marked by both political intensification and stress and continual conquest by the reigning *ali'i*. Wars occurred regularly between intra-island and inter-island polities during this period. It was during this time of warfare that Kamehameha, who would eventually rise to power and unite all of the Hawaiian Islands under one rule, was born in the District of North Kohala on the Island of Hawai'i (Kamakau 1992). There is some controversy about the year of his birth, which Kamakau (1992) places during A.D. 1736, but others argue for dates as late as 1753 or 1758; current consensus is that Kamehameha was most likely nearer to the later date (see Kamakau 1992:66–68). In A.D. 1754, after many bloody battles, Kalani'ōpu'u, the *ali'i 'ai moku* of Ka'ū, defeated his main rival Keawe'ōpala in South Kona and declared himself ruler over all of the island of Hawai'i (Kamakau 1992:78). Kalani'ōpu'u was a clever and able chief, and a famous athlete in all games of strength, whose one great fault according to Kamakau (1992) was that he loved war and had no regard for others' land rights.

The chiefs of the Puna District did not figure prominently in the periods of Precontact political strife and turmoil on Hawai'i Island. Barrère (1959:15) summarizes the Precontact geopolitics of the Puna District as follows:

> Puna, as a political unit, played an insignificant part in shaping the course of history of Hawaii Island. Unlike the other districts of Hawaii, no great family arose upon whose support one or another of the chiefs seeking power had to depend for his success. Puna lands were desirable, and were eagerly sought, but their control did not rest upon conquering Puna itself, but rather upon control of the adjacent districts, Kau and Hilo.

History After Western Contact

The arrival of Western explorers in Hawai'i signified the end of the Precontact Period, and the beginning of the Historic Period. With the arrival of foreigners, Hawai'i's culture and economy underwent drastic changes (Kent 1983; Kirch 1985). Demographic trends during the late Proto-Historic Period/early Historic Period indicate population reduction in some areas, due to war and disease, yet increase in others, with relatively little change in material culture. At first there was a continued trend toward craft and status specialization, intensification of agriculture, *ali'i* controlled aquaculture, the establishment of upland residential sites, and the enhancement of traditional oral history. The Kū cult, *luakini heiau*, and the *kapu* system were at their peaks, although western influence was already altering the cultural fabric of the Islands. Foreigners very quickly introduced the concept of trade for profit, and by the time Kamehameha I had conquered O'ahu, Maui and Moloka'i, in 1795, Hawai'i saw the beginnings of a market system economy (Kent 1983). Some of the work of the commoners shifted from subsistence agriculture to the production of foods and goods that they could trade with early visitors. Introduced foods often grown for trade with Westerners included yams, coffee, melons, Irish potatoes, Indian corn, beans, figs, oranges, guavas, and grapes (Wilkes 1856). Later, as the Historic Period progressed, Kamehameha I died, the *kapu* system was abolished, Christianity established a firm foothold in the islands, and introduced diseases and global economic forces began to have a devastating impact on traditional life-ways in the Hawaiian Islands. This marked the end of the Proto-Historic Period and the end of an era of uniquely Hawaiian culture.

The Arrival of Captain James Cook and the End of Kalani'ōpu'u's Reign (1778-1782)

British explorer Captain James Cook, in command of the ships *H.M.S. Resolution* and *H.M.S. Discovery*, landed in the Hawaiian Islands on January 18, 1778. The following January 17th [1779], on a return trip to Hawaiian waters,

Cook anchored near Kaʻawaloa at Kealakekua Bay in the South Kona District to resupply his ships. This return trip occurred at the time of the annual *Makahiki* festival, and many of chiefs and commoners were gathered around the bay celebrating. According to John Ledyard, a British marine on board Cook's ship, upward of 15,000 inhabitants were present at the bay, and as many as 3,000 canoes came out to greet the ships (Jarves 1847). It has been suggested that Captain Cook was mistaken for the god Lono himself returned, as men would not normally be allowed to paddle out during the *Makahiki* without breaking the *kapu* and forfeiting all of their possessions (Kamakau 1992). On January 26th Kalaniʻōpuʻu, the reigning chief of Hawaiʻi Island, visited Cook on board the *H.M.S. Resolution*, where they exchanged gifts. Kamehameha, the future ruler of all of Hawaiʻi, was present at this meeting (Jarves 1847).

On February 4th, Cook set sail from Kealakekua Bay, but a storm off the Kohala coast damaged the mast of the *H.M.S. Resolution*, and both ships were forced to return to Kealakekua to make repairs. With Cook's return, many of the inhabitants of Kealakekua began to doubt that he was actually the physical manifestation of Lono (Kamakau 1992). On February 13th, several natives were discovered stealing nails from the British ships. They were fired upon by the crew, and a chief close to Kalaniʻōpuʻu named Palea was knocked down, and his canoe taken. That night one of Cook's boats was stolen, and the following morning Cook set ashore at Kaʻawaloa with six marines to ask Kalaniʻōpuʻu for its return. Kalaniʻōpuʻu, however, denied any knowledge of the theft; Cook decided to hold the chief captive until the boat was returned (Kamakau 1992). When Cook tried to seize Kalaniʻōpuʻu, however, a scuffle ensued and Cook was killed (along with four of his men and several natives) there on the shores of Kaʻawaloa, struck down by a metal dagger. When Captain Cook fell, the British ships fired cannons into the crowd at the shore and several more natives were killed. Kalaniʻōpuʻu and his retinue retreated inland, bringing the body of Cook with them.

In March of 1779, after Cook's death, Captain King sailed along the Puna shoreline and described the district as sparsely populated, but verdant and fertile (Maly 1998). Captain King, mentioned that Kalaniʻōpuʻu had one of his residences there, and he provided the following description of the landscape:

> …the SE sides of the districts of Opoona & Kaoo [Puna and Kaʻū]. The East part of the former is flat, coverd with Coco nut trees, & the land far back is of a Moderate height. As well as we could judge this is a very fine part of the Island, perhaps the best. Terreeoboo [Kalaniʻōpuʻu] has one of his residences here.
>
> On the SW extremity of Opoona the hills rise abruptly from the Sea side, leaving but a narrow border, & although the sides of the hills have a fine Verdure, yet they do not seem Cultivated, & when we saild pretty near & along this end of Opoona, we did not observe that it was equally Populous with the Eastern parts; before we reachd the East point of the Island, & all along this SE side the snowy mountain calls Roa (or extensive) [Mauna Loa] is very conspicuous. It is flattish at the top or makes what we call Table land… (Beaglehole 1967:606)

After the departure of *H.M.S. Resolution* and *Discovery*, Kalaniʻōpuʻu moved to Kona, where he surfed and amused himself with the pleasures of dance (Kamakau 1992). While he was living in Kona, famine struck. Kalaniʻōpuʻu ordered that all the cultivated products of that district be seized, and he then set out on a circuit of the island. Kalaniʻōpuʻu first went to Hinakahua in Kapaʻau, North Kohala where he amused himself with "sports and games such as hula dancing, *kilu* spinning, *maika* rolling, and sliding sticks" (Kamakau 1992:106). During his stay in Kohala, around 1780, Kalaniʻōpuʻu proclaimed that his son Kiwalaʻō would be his successor, and he gave the guardianship of the war god Kūkaʻilimoku to Kamehameha (Fornander 1969; Kamakau 1992).

It was during his time in Kohala that an uprising led by a highly-esteemed chief of Puna named Imakakoloa occurred. Upon hearing of the uprising, Kalaniʻōpuʻu immediately went to Hilo to quell the rebellion. Although customary at the time to furnish the king's court with items such as "pigs, fish, taro, fruits and other forms of wealth" (Elkin 1904:26), Imakakoloa refused to provide such things to Kalaniʻōpuʻu or his court. It is said that Imakakoloa rebelled because he was tired of the incessant and exorbitant demands of Kalaniʻōpuʻu. As a chief who loved the people of Puna, and was beloved by them in return, he felt that "his own people who cultivated the ground should be provided with the necessaries of life, before the numbers of the royal court, who lived in idleness" (Elkin 1904:26). Rather than allow Kalaniʻōpuʻu access to the toils of the people of Puna, Imakakoloa:

> …seized the valuable products of his district, which consisted of hogs, gray tapa cloth (*ʻeleuli*), tapas made of *mamaki* bark, fine mats made of young pandanus blossoms (*ʻahu hinalo*), mats made of young pandanus leaves (*ʻahuao*), and feathers of the *ʻoʻo* and *mamo* birds of Puna. (Kamakau 1992:106)

This action angered Kalani‘ōpu‘u, who was insulted by the insubordination. He vowed revenge against Imakakoloa, and devised a plan to kill him. A battle between the two men ensued, and although Imakakoloa was a worthy opponent, his army was no match for Kalani‘ōpu‘u’s superior force. After the battle, the Puna chief fled and was sheltered in the district by his people for more than a year. Kalani‘ōpu‘u, sworn to vengeance, ruthlessly stalked the fugitive chief for the duration of his emancipation, and in his rage he ordered that Puna be burned to the ground. Fornander (1969:202) indicates that the district was “literally laid in ashes” as a result of Kalani‘ōpu‘u’s vengeance.

While the rebel Puna chief was sought, Kalani‘ōpu‘u “went to Ka-‘u and stayed first at Punalu‘u, then at Waiohinu, then at Kama‘oa in the southern part of Ka-‘u, and erected a heiau called Pakini, or Halauwailua, near Kama‘oa” (Kamakau 1992:108). Imakakoloa was eventually captured and brought to the *heiau*, where Kiwala‘ō was to sacrifice him. “The routine of the sacrifice required that the presiding chief should first offer up the pigs prepared for the occasion, then bananas, fruit, and lastly the captive chief” (Fornander 1996:202). However, before Kiwala‘ō could finish the first offerings, Kamehameha, “grasped the body of Imakakolo‘a and offered it up to the god, and the freeing of the tabu for the heiau was completed” (Kamakau 1992:109). Upon observing this single act of insubordination, many of the chiefs believed that Kamehameha would eventually rule over all of Hawai‘i. After usurping Kiwala‘ō’s authority with a sacrificial ritual in Ka‘ū, Kamehameha retreated to his home district of Kohala.

The Rule of Kamehameha I (1782-1819)

After Kalani’ōpu‘u died in April of 1782, several chiefs were unhappy with Kiwala‘ō’s division of the island’s lands, and civil war broke out. Kiwala‘ō, Kalani’ōpu‘u’s son and appointed heir, was killed at the battle of Moku‘ōhai, South Kona in July of 1782. Supporters of Kiwala‘ō, including his half-brother Keōua and his uncle Keawemauhili, escaped the battle of Moku‘ōhai with their lives and laid claim to the Hilo, Puna, and Ka‘ū Districts. According to I‘i (1963) nearly ten years of almost continuous warfare followed the death of Kiwala‘ō, as Kamehameha endeavored to unite the Island of Hawai‘i under one rule and conquer the islands of Maui and O‘ahu. Keōua became Kamehameha’s main rival on the Island of Hawai‘i, and he proved difficult to defeat (Kamakau 1992). Keawemauhili would eventually give his support to Kamehameha, but Keōua never stopped resisting. Around 1790, in an effort to secure his rule, Kamehameha began building the *heiau* of Pu‘ukoholā in Kawaihae, which was to be dedicated to the war god Kūka‘ilimoku (Fornander 1996).

Westervelt (1916) relates a story of Keōua, Keawemauhili, and Kamehameha that begins after the battle of Moku‘ōhai, but tells of another battle in ca. 1790 when Kamehameha routed Keōua at Waimea and Hāmākua and then sent men to attack Ka‘ū. As Keōua attempted to return to his home district a portion of his army was killed by an eruption from Kīlauea Volcano. Westervelt writes:

> . . . Kiwalao’s half-brother Keoua escaped to his district Ka-u, on the southwestern side of the island. His uncle Keawe-mau-hili escaped to his district Hilo on the southeastern side.
>
> For some years the three factions practically let each other alone, although there was desultory fighting. Then the high chief of Hilo accepted Kamehameha as his king and sent his sons to aid Kamehameha in conquering the island Maui.
>
> Keoua was angry with his uncle Keawe-mau-hili. He attacked Hilo, killed his uncle and ravaged Kamehameha’s lands along the northeastern side of the island.
>
> Kamehameha quickly returned from Maui and made an immediate attack on his enemy, who had taken possession of a fertile highland plain called Waimea. From this method of forcing unexpected battle came the Hawaiian saying, “The spear seeks Waimea like the wind.”
>
> Keoua was defeated and driven through forests along the eastern side of Mauna Kea (The white mountain) to Hilo. Then Kamehameha sent warriors around the western side of the island to attack Keoua’s home district. Meanwhile, after a sea fight in which he defeated the chiefs of the islands Maui and Oahu, he set his people to building a great temple chiefly for his war-god Ka-ili. This was the last noted temple built on all the islands.
>
> Keoua heard of the attack on his home, therefore he gave the fish-ponds and fertile lands of Hilo to some of his chiefs and hastened to cross the island with his army by way of a path near the volcano Kilauea. He divided his warriors into three parties, taking charge of the first in person. They passed the crater at a time of great volcanic activity. A native writer, probably Kamakau, in the native newspaper *Kuokoa*, 1867, describes the destruction of the central part of this army by an awful explosion from Kilauea. (Westervelt 1916:140-141)

The untimely eruption of Kīlauea, as Keōua's army attempted to return to Kaʻū to stop Kamehameha's warriors from ravaging their home district, cost him about 400 fighting men along with an untold number of women and children (Fornander 1996). Kamehameha's prophets said that this eruption was the favor of the gods who rejoiced at his building of Puʻukoholā Heiau. According to Westervelt, "The people said it was proof that Pele had taken Kamehameha under her special protection and would always watch over his interests and make him the chief ruler" (1916:146).

Unable to defeat Keōua in battle, Kamehameha resorted to trickery. When Puʻukoholā Heiau was completed in the summer of 1791, Kamehameha sent his two counselors, Keaweaheulu and Kamanawa, to Keōua to offer peace. Keōua was enticed to the dedication of the Puʻukoholā Heiau by this ruse, and when he arrived at Kawaihae, he and his party were sacrificed to complete the dedication (Kamakau 1992). It is widely thought that Keōua knew the likely outcome of his visit to Puʻukoholā Heiau, but sacrificed himself anyway to spare the people of Kaʻū further bloodshed. The assassination of Keōua gave Kamehameha undisputed control of Hawaiʻi Island by 1792 (Greene 1993).

By 1796, with the aid of foreign weapons and advisors, Kamehemeha conquered all of the island kingdoms except Kauaʻi. In 1810, when Kaumualiʻi of Kauai gave his allegiance to Kamehameha, the Hawaiian Islands were unified under a single leader (Kuykendall and Day 1976). Kamehameha would go on to rule the islands for another nine years. He and his high chiefs participated in foreign trade, but continued to enforce the rigid *kapu* system.

Early Historical Accounts of Puna (1823-1847)

Early written accounts, such as those presented in the following pages, describe Puna as a populated country containing numerous residences, primarily along the coast where marine resources were easily accessible. These narratives also describe a surprisingly fertile agricultural landscape thriving among what would appear to be unsuitable fields of lava and thin soils, rife with crops such as *kalo*, sweet potatoes, sugar cane, breadfruit, bananas, and arrowroot in addition to non-native species such as coffee, grapes, strawberries, and various citrus trees. It is evident through these accounts that although Puna natives were still largely rooted in traditional subsistence practices, procurement, and trade, western influence was slowly infiltrating into native lifeways.

Following the death of Kamehameha I in 1819, the Hawaiian religious and political systems underwent a radical transformation; Kaʻahumanu proclaimed herself "*Kuhina nui*" (Prime Minister), and within six months the ancient *kapu* system was overthrown. Within a year, Protestant missionaries arrived from America (Fornander 1969; Iʻi 1963; Kamakau 1992). In 1823, British missionary William Ellis and members of the American Board of Commissioners for Foreign Missions (ABCFM) toured the island of Hawaiʻi seeking out communities in which to establish church centers for the growing Calvinist mission. Ellis recorded observations made during this tour in a journal (Ellis 2004). Walking southwest to northeast along the southeastern shore of the District of Puna with his missionary companions Asa Thurston and Artemas Bishop, Ellis' writings present descriptions of residences and practices that are applicable to the general study area (underlined emphasis added):

> The population in this part of Puna, though somewhat numerous, did not appear to possess the means of subsistence in any great variety or abundance; and <u>we have often been surprised to find desolate coasts more thickly inhabited than some of the fertile tracts in the interior</u>; a circumstance we can only account for, by supposing that the facilities which the former afford for fishing, induce the natives to prefer them as places of abode; for they find that where the coast is low, the adjacent water is usually shallow.
>
> <u>We saw several fowls and a few hogs here, but a tolerable number of dogs, and quantities of dried salt fish, principally albacores and bonitos. This latter article, with their *poë* [*poi*] and sweet potatoes, constitutes nearly the entire support of the inhabitants, not only in this vicinity, but on the sea coasts of the north and south parts of the island</u>.
>
> <u>Besides what is reserved for their own subsistence, they cure large quantities as an article of commerce, which they exchange for the vegetable productions of Hilo and Mamakua [Hāmākua], or the *mamake* and other tapas of Ora [ʻŌlaʻa] and the more fertile districts of Hawaii</u>.
>
> When we passed through Punau [Pānau], Leapuki [Laeapuki], and Kamomoa [Kamoamoa], the country began to wear a more agreeable aspect. Groves of coca-nuts ornamented the projecting points of land, clumps of kou-trees appeared in various directions, and the <u>habitations of the natives were also thickly scattered over the coast.</u> (Ellis 2004:263–264)

Ellis and the ABCFM missionaries also traversed along the coast of Kauwai, Waʻawaʻa, and Nānāwale *ahupuaʻa* and then turned *mauka* toward a village in Honolulu Ahupuaʻa, south of the current study area (Ellis 2004:294). On August 8, 1823, the Ellis and the ABCFM missionaries left Honolulu and visited a nearby village in Waiakahiula. Ellis' journal provides a brief first-hand description of the village's location relative to the coast:

> We arose early on the 8th, and Mr. Thurston held morning worship with the friendly people of the place [Honolulu]. Although I had been much indisposed through the night, we left Honoruru [sic] soon after six a.m. and, travelling slowly towards the sea-shore, reached Waiakeheula [sic] about eight, where I was obliged to stop, and lie down under the shade of a canoe-house near the shore. Messrs. Thurston and Bishop walked up to the settlement about half a mile inland, where the former preached to the people. (Ellis 2004:295)

After preaching, Bishop continued on alone toward Waiakea, while Thurston returned to fetch Ellis from the canoe shed. Upon reaching the village, Ellis found its residences to be interspersed among the agricultural fields rather than in a single, nucleated settlement (underlined emphasis added):

> After conversing some time, we walked on, in an inland direction, to Honoruru, a small village situated in the midst of a wood, where we arrived just at the setting of the sun. . .<u>The country was populous, but the houses stood singly, or in small clusters, generally on the plantations, which were scattered over the whole country</u>. Grass and herbage were abundant, vegetation in many places luxuriant, and the soil, though shallow, was light and fertile.
>
> Soon after 5 P.M., they reached Kaau, the last village in the division of Puna. It was extensive and populous, abounding well with cultivated plantations of taro, sweet potatoes, and sugar-cane, and probably owes its fertility to a fine rapid stream, which, descending from the mountains, runs through it into the sea. (Ellis1825:172-174)

Sheldon Dibble was a missionary and teacher at the Lahinaluna School and was an influential instructor of esteemed Hawaiian historians Samuel Kamakau and David Malo. He is associated with the creation of one of the first books on Hawaiian History, the *History of the Sandwich Islands,* containing information methodically gathered by ten of his top scholars at Lahainaluna. Dibble was stationed at the Hilo mission beginning in 1831, where he remained until relocating to Lahaina, Maui in 1834. During his residence on Hawaiʻi Island, Dibble toured the Puna District. His narrative expresses perhaps the most systematic and straightforward of experiences:

> In making the tour of Puna, you first provide yourself with two gourd shells of good water, containing about a bucket a piece. You balance these on a short pole or stick, which you place on the shoulder of one of your attendants. You then fill two calabashes with changes of raiment and small provisions, and balance them on the shoulder of another attendant. You tie a pair of sandals of dried bull's hide on the bottom of your shoes, and take care to place several other pairs among your baggage, for you are to travel over fields of sharp-pointed lava, and a common pair of shoes would serve you but a short time. Then with a native testament and hymn-book in your pocket, and an umbrella in your hand to shield you from a tropical sun, you set out on your way. You arrive at the first village, and sit down perhaps under a grove of cocoanut trees. A shell is blown, and the people assemble. You deliver a short address of 30 minutes, perhaps under the trees, and perhaps in a school-house; make various inquiries about schools, books, and church members; and then pass on to the next village or grove of trees and preach again a short discourse. After passing six or seven villages and preaching as many sermons, it is night-fall, and you turn your attention to food and rest.
>
> Food, after the native form of cooking, you may find in abundance, but it will be a large hog baked whole in the earth, a calabash of fermented poi, or something of the kind, and will not probably please your taste. You look about for a chicken perhaps—roast it on some coals, and that, together with the sweet potatoe or the *kalo*, and some biscuit from your calabash, makes a palatable meal. Thus food is easily obtained.
>
> To find rest is rather more difficult. A mat, braided of the lauhala leaf, something like the palmetto, is the bed, a small pillow you usually carry with you, a sheet of bark cloth is the covering. Such a bed, in a warm climate and after the fatigue of a day's journey, you may enjoy as a luxury, and sleep soundly and quietly. A tour through Puna usually occupies a week or ten days, and the travelling is entirely on foot, under an oppressive sun and over many fields of rugged lava. (Dibble 1843:268–269)

One year after Ellis' tour, the ABCFM established a base church in Hilo. From that church (Hāili), the missionaries traveled to the more remote areas of the Hilo and Puna Districts. David Lyman, who came to Hawai'i in 1832, and Titus Coan, who arrived in 1835 were two of the most influential congregational missionaries in Puna and Hilo. As part of their duties they compiled census data for the areas within their missions. In 1835, 4,800 individuals were recorded as residing in the district of Puna (Schmitt 1973); the smallest total district population on the island of Hawai'i. One year after his arrival to the island, Coan traveled to Puna. He recorded his observations of the dramatic scenery:

> The district of Puna lies east and south of Hilo, and its physical features are remarkably different from those of the neighboring district.
>
> Its shore line, including its bends and flexures, is more than seventy miles in extent. For three miles inland from the sea it is almost a dead level, with a surface of pahoehoe or field lava, and *a-a* or scoriaceous lava, interspersed with more or less rich volcanic soil and tropical verdure, and sprinkled with sand-dunes and a few cone and pit-craters. Throughout its length it is marked with ancient lava streams, coming down from Kilauea and entering the sea at different points along the coast. These lava streams vary in width from half a mile to two or three miles. From one to three miles from the shore the land rises rapidly into the great volcanic dome of Mauna Loa (Long Mountain). The highlands are mostly covered with woods and jungle, and scarred with rents, pits, and volcanic cones. Everywhere the marks of terrible volcanic action are visible. The whole district is so cavernous, so rent with fissures, and so broken by fiery agencies, that not a single stream of water keeps above-ground to reach the sea. All the rain-fall is swallowed by the 10,000 crevices, and disappears, except the little that is held in small pools and basins, waiting for evaporation. The rains are abundant, and subterranean fountains and streams are numerous, carrying the waters down to sea level, and filling caverns, and bursting up along the shore in springs and rills, even far out under the sea. Some of these waters are very cold, some tepid, and some stand at blood heat, furnishing excellent warm baths. There are large caves near the sea where we enter by dark and crooked passages, and bathe by torchlight, far underground, in deep and limpid water.
>
> Puna has many beautiful groves of the cocoa-palm, also breadfruit, pandanus, and ohia, and where there is soil it produces under cultivation besides common vegetables, arrowroot, sugar-cane, coffee, cotton, or anges, citrons, limes, grapes, and other froots [sic]. On the highlands, grow wild strawberries, cape gooseberries, and the ohelo, a delicious berry resembling our whortleberry. (Coan 1882:39–40)

In 1841, five years after Coan's tour through Puna, he documented the population at 4,371, having dropped by 429 individuals since his earlier census assessment conducted in 1835 with Lyman. Coan noted that the majority of the inhabitants lived near the coast, although there were hundreds of individuals who lived inland (Holmes 1985). That same year, the United States Exploring Expedition under the direction of Commander Charles Wilkes, toured Hawai'i Island and travelled through the Puna District. Wilkes produced a map of Puna, which illustrates the coastal trail but shows only a large "Pandanus Forest" covering the lands in the vicinity of the study area (Figure 19). Wilkes, travelling towards Kapoho at the eastern tip of the island, provides the following description of Puna:

> Almost all of the hills or craters of any note have some tradition connected with them; but I found that the natives were now generally unwilling to narrate these tales, calling them "foolishness."
>
> After leaving the pahoihoi [sic - *pāhoehoe*] plain, we passed along the line of cone-craters towards Point Kapoho, the Southeast part of the island.
>
> Of these cone-craters we made out altogether, large and small, fifteen, trending about east-northeast. The names of the seven last are Pupukai, Poholuaokahowele [Pu'u-hōlua-o-Kahawali], Punomakalua, Kapoho, Puukea, Puuku, and Keala. On some of these the natives pointed out where there had formerly been slides, an amusement or game somewhat similar to the sport of boys riding down hill on sleds. These they termed kolua [sic – *holua*].
>
> This game does not appear to be practiced now, and I suppose that the chiefs consider themselves above such boyish amusements. The manner in which an old native described the velocity with which they passed down these slides was, by suddenly blowing a puff; according to him, these amusements were periodical, and the slides were usually filled with dried grass.
>
> As we approached the sea-shore, the soil improved very much, and was under good cultivation, in taro, sweet-potatoes, sugar cane, and a great variety of fruit and vegetables. At about four o'clock,

we arrived at the house of our guide, Kekahunanui, who was the "head man." I was amused to find that none of the natives knew him by this name, and were obliged to ask him, before they could give it to Dr. Judd…

…The view from the guide's house was quite pretty, the eye passing over well-cultivated fields to the ocean, whose roar could be distinctly heard… (Wilkes 1856:186)

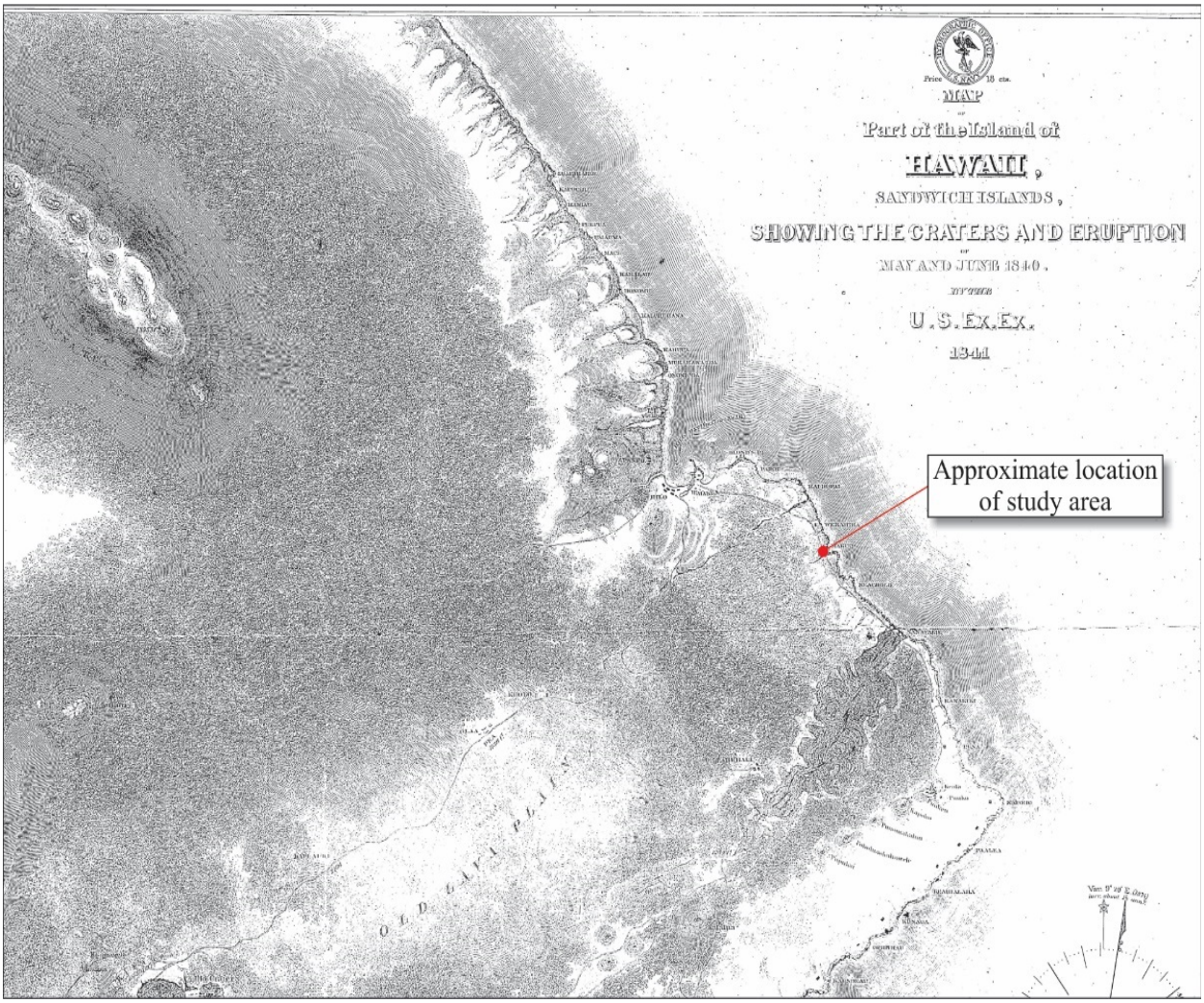


Figure 19. Portion of Hawai'i Registered Map No. 424 prepared by Wilkes in 1841 showing approximate location of current study area.Wilkes continued his journey from Kīlauea to Kea'au, commenting on the bleakness of the landscape and the surprising amount of inhabitants despite the absence of any large village (underlined emphasis added):

We had many kind wishes, and a long line of attendants, as we wended our way among the numerous taro-patches of the low grounds, towards Puna; and thence along the sea-coast towards the place where the lava entered the sea, at Nanavalie [sic - Nānāwale]. The whole population of this section of the country was by the wayside, which gave me an opportunity of judging of their number; this is much larger than might be supposed from the condition of the country, for with the exception of the point at Kapoho, very little ground that can be cultivated is to be seen. The country, however, is considered fruitful by those who are acquainted with it, notwithstanding its barren appearance on the roadsides. The inhabitants seemed to have abundance of bread-fruit, bananas, sugar-cane, taro, and sweet-potatoes. The latter, however, are seen to be growing literally among heaps of stones and pieces of lava, with scarcely soil enough to cover them; yet they are, I am informed, the finest on the island.

> At Puna, there is a large church; but no appearance of a village, the houses being much scattered. The church, it is said, will contain two or three thousand persons. The Rev. Mr. Coan, I understood, officiates here occasionally. (Wilkes 1856:187–188)

After visiting sand hills at Nānāwale, Wilkes and his party continued toward Kea'au, passing through Maku'u and Wehahika without comment.

In 1846, Chester S. Lyman, "a sometime professor" at Yale University visited Hilo, Hawai'i, and stayed with Titus Coan (Maly 1998). Traveling the almost 100-mile-long stretch of the "Diocese" of Mr. Coan, Lyman reported that the district of Puna had somewhere between 3,000-4,000 inhabitants (Maly 1998). Entering Puna from Hilo, and traveling to Kea'au along the coast, Lyman offered the following observations of the Puna District (underlined emphasis added):

> The groves of Pandanus were very beautiful, and are the principal tree of the region. There is some grass and ferns, and many shrubs; but the soil is very scanty. Potatoes are almost the only vegetable that can be raised, and these seem to flourish well amid heaps of stone where scarcely a particle of soil could be discovered. The natives pick out the stones to the depth often of from 2 to 4 feet, and in the bottom plant the potato–how it can expand in such a place is a wonder.
>
> Nearly all Puna is like this. The people are necessarily poor—a bare subsistence is all they can obtain, and scarcely that. Probably there are not $10 in money in all Puna, and it is thought that not over one in five hundred has a single cent. The sight of some of these potatoe patches would make a discontented N.E. farmer satisfied with his lot. Yet, I have nowhere seen the people apparently more contented & happy. (Lyman 1846:3)

Written accounts left by early visitors to the Island of Hawai'i offer insight into what life may have been like for the Hawaiians of Puna. However, by the time Ellis visited Puna, less than fifty years after the arrival of the first Europeans, the population of Hawai'i was already beginning to decline. By 1850, the population of Hawai'i Island had dropped to 25,846 individuals (Schmitt 1973). Maly (1998:36) summarizes the reasons for the rapid decline of native populations thusly:

> Overall, historic records document the significant effect that western settlement practices had on Hawaiians throughout the islands. Drawing people from isolated native communities into selected village parishes and Hawaiian ports-of-call, had a dramatic, and perhaps unforeseen impact on native residency patterns, health, and social and political affairs. In single epidemics hundreds, and even thousands of Hawaiians died in short periods of time.

The *Māhele 'Āina* of 1848 and Subsequent Granting Programs

By the mid-nineteenth century, the ever-growing population of Westerners in Hawai'i forced socioeconomic and demographic changes that promoted the establishment of a Euro-American style of land ownership. In 1848 the *Māhele 'Āina* became the vehicle for determining ownership of native lands. This change in land tenure was promoted primarily by the missionaries and Western businessmen in the island kingdom. Generally, these individuals were hesitant to enter business deals on leasehold land. The *Māhele* (division) defined the land interests of Kamehameha III (the *Mō'ī* or King), the high-ranking chiefs (*ali'i*), and the *konohiki*. During the *Māhele*, all lands in the Kingdom of Hawai'i were placed in one of three categories: (1) Crown Lands (for the occupant of the throne); (2) Government Lands; and (3) *Konohiki* Lands (Chinen 1958, 1961). The chiefs and *konohiki* were required to present their claims to the Board of Commissioner to Quiet Land Titles (also known as the Land Commission) to receive awards for lands provided to them by Kamehameha III. They were also required to provide commutations to the government in order to receive royal patents on their awards. The lands were identified by name only, with the understanding that the ancient boundaries would prevail until the land could be surveyed. This process expedited the work of the Land Commission.

All lands awarded during the *Māhele* were subject to the rights of the native tenants therein; those individuals who lived on the land and worked it for their subsistence and the welfare of the chiefs (Sinoto and Kelly 1975). Native tenants could claim, and acquire title to, *kuleana* parcels that they actively lived on or farmed at the time of the *Māhele*. The Kuleana Act of December 21, 1849 provided the legal framework by which native tenants could apply for and receive fee-simple interest in their *kuleana* lands from the Land Commission. The Board of Commissioners oversaw the program and administered the lands as Land Commission Awards (LCAw.). Not all lands that were claimed were awarded. The volumes of native registry and testimony collected for *kuleana* claims provide a snap-shot of life in Hawai'i during the middle part of the nineteenth century.

In Puna, however, very few claims for *kuleana* were submitted. Maly (1998:37) notes that, with the exception of the islands of Kahoʻolawe and Niʻihau, no other land division of comparable size, had fewer claims for *kuleana* from native tenants than the district of Puna. As a result of the *Māhele*, Pōpōkī, along with the immediately adjacent *ahupuaʻa* of Makuʻu and Hālona, were retained as Government Lands (Buke Mahele 1848:185), and no *kuleana* were awarded. The boundaries of Pōpōkī were never certified by the Commissioners of Boundaries (Boundary Commission), which is why it is so often grouped with the neighboring *ahupuaʻa* of Makuʻu and Hālona on maps and in written descriptions.

In conjunction with the *Māhele ʻĀina* of 1848, the King had authorized the issuance of Royal Patent Grants to applicants for tracts of land, larger than those generally available through the Land Commission. The process for applications was clarified by the "Enabling Act," which was ratified on August 6, 1850. The Act resolved that portions of the Government Lands established during the *Māhele* should be set aside and sold as grants. The stated goal of this program was to enable native tenants, many of whom were not awarded *kuleana* parcels during the *Māhele*, to purchase the lands upon which they lived, or land that they felt they could cultivate (Maly 1999). Despite the stated goal of the grant program many of the Government Lands were eventually sold to foreigners. Between 1852 and 1855, coastal portions of all three *ahupuaʻa* were divided and sold as fee simple Land Grants. The current study area was included in Grant 1537, a 171-acre property sold to Kapohano (sometimes spelled Kapohana) in 1855 (Figure 20). The current study area is situated within the southern coastal portion of the grant (Figures 20, 21, and 22). Kepā Maly (1999:67) translates the boundary description of Grant 1537 as follows:

> This parcel begins at the shore on the Northern corner of this lot, adjoining the land of Kea, and proceeding along this land South 39 1/2 West 24.48 chains to a coconut tree, then proceeding along this land South 37 West 9.30 chains to a breadfruit tree; then proceeding South 41 1/4 East 32.24 chains to a stone cairn; then North 56 1/2 East 35.29 chains to the government road; then North 37 1/2 East 20.00 chains to the shore; then proceeding along the shore to the place of commencement. There are 171 acres within this lot.

Registered Map No. 2258 (see Figure 20) shows a single house within the boundaries of Grant 1537. The house is located near the coast (to the north of the current study area) next to what appears to be a small hill and survey station labeled Opunaha. The small bay located directly *makai* is labeled "Kula". Directly *makai* of the current study area is what appears to be a small bay labeled as Kahuanui. Additionally, the map depicts a coconut grove near the northwestern corner of the current study area as well as a *mauka*/*makai* trail (labeled as "old trail") that parallels the parcel to the south and bisects the 6-foot wide Government Road immediately *mauka* of the current study area.

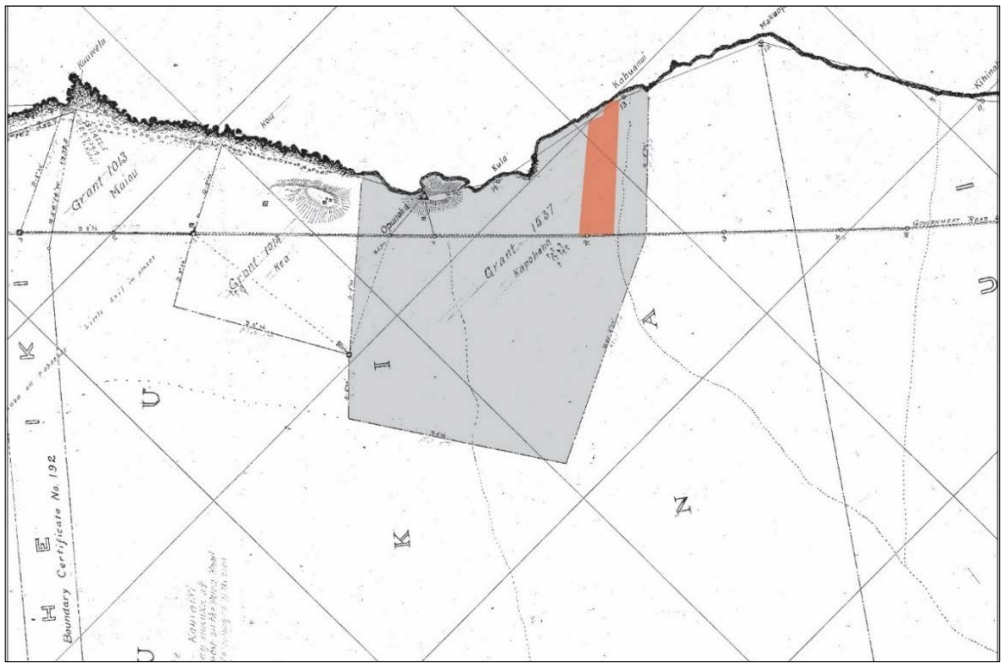
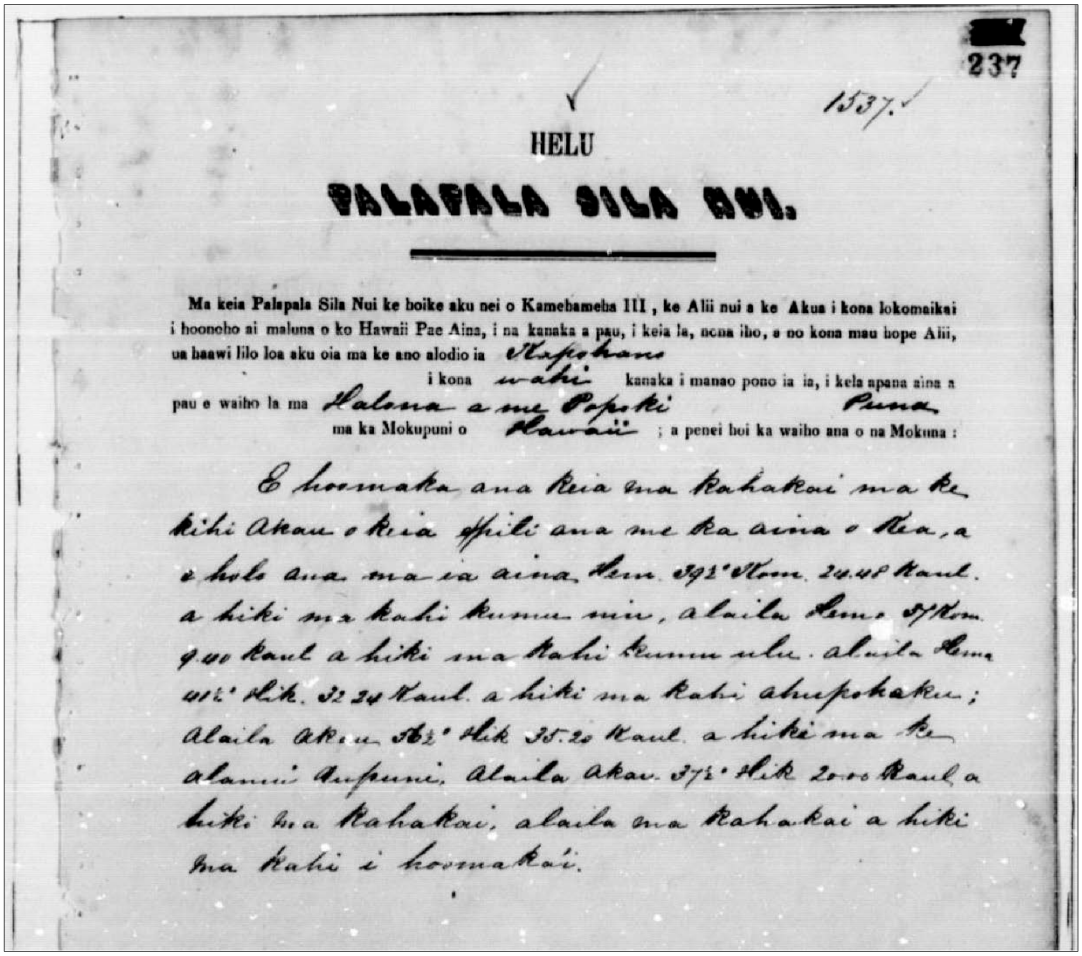


Figure 20. Portion of Registered Map No. 2258 showing approximate location of current study area (shaded red) and Grant 1537 to Kapohano (shaded gray).



237

1537.

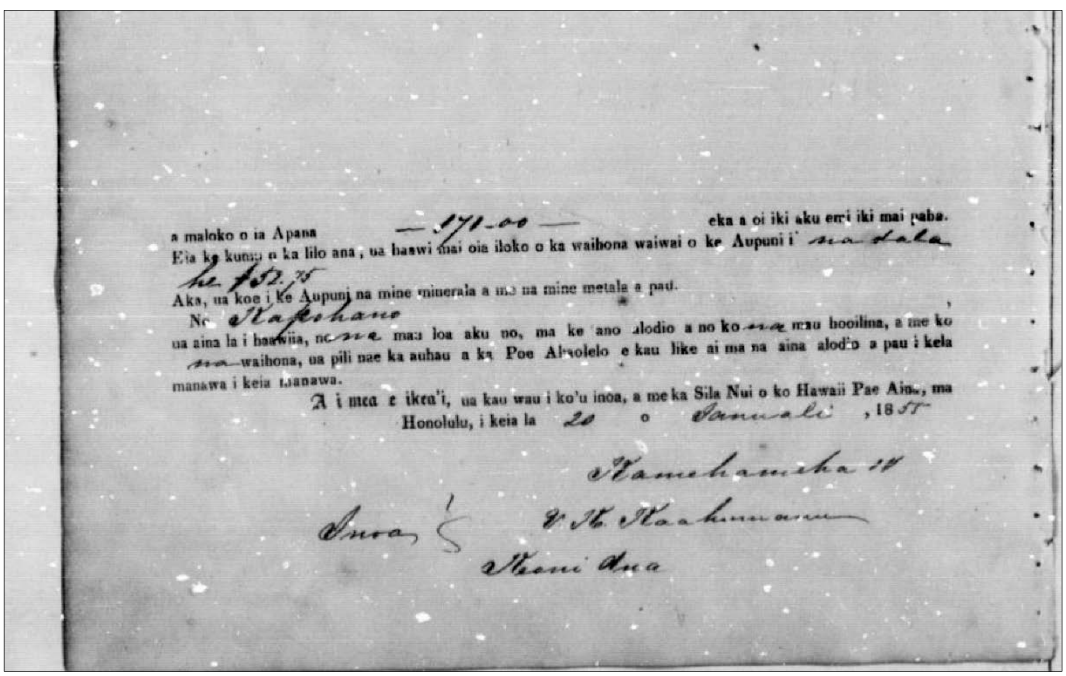
HELU

PALAPALA SILA NUI.

Ma keia Palapala Sila Nui ke hoike aku nei o Kamehameha III, ke Alii nui a ke Akua i kona lokomaikai i hoonoho ai maluna o ko Hawaii Pae Aina, i na kanaka a pau, i keia la, ocna iho, a no kona mau hope Alii, ua haawi lilo loa aku oia ma ke ano alodio ia Kapohano i kona wahi kanaka i manao pono ia ia, i kela apana aina a pau e waiho la ma Halona a me Popoki Puna ma ka Mokupuni o Hawaii ; a penei hoi ka waiho ana o na Mokuna :

E hoomaka ana keia ma kahakai ma ke kihi Akau o keia apili ana me ka aina o Kea, a e holo ana ma ia aina Hem. 39½° Hom. 24.48 Kaul. a hiki ma kahi kumu niu, alaila Hema 57 Hom. 9.40 Kaul a hiki ma kahi kumu ulu. alaila Hema 41½° Hik. 32.24 Kaul. a hiki ma kahi ahupokaku; alaila Akau 56½° Hik 35.20 Kaul. a hiki ma ke alanui Aupuni. Alaila Akau 37½° Hik 20.00 Kaul a hiki ma kahakai. alaila ma kahakai a hiki ma kahi i hoomaka ai.

Figure 21. Grant 1537 to Kapohano, obverse.



a maloko o ia Apana — 171.00 — eka a oi iki aku emi iki mai paha.
Eia ke kumu o ka lilo ana, ua haawi mai oia iloko o ka waihona waiwai o ke Aupuni i na dala he $52.75
Aka, ua koe i ke Aupuni na mine minerala a me na mine metala a pau.
No Kapohano ma kona mau hooilina, a me ko na aina la i haawiia, no na mau loa aku no, ma ke ano alodio a no ko na mau hooilina, a me ko na waihona, ua pili nae ka auhau a ka Poe Ahaolelo e kau like ai ma na aina alodio a pau i kela manawa i keia manawa.

A i mea e ikeaʻi, ua kau wau i koʻu inoa, a me ka Sila Nui o ko Hawaii Pae Aina, ma Honolulu, i keia la 20 o Ianuali, 1855

Kamehameha IV
Inoa { V. K. Kaahumanu
Keoni Ana

Figure 22. Grant 1537 to Kapohano, reverse

Agricultural practices in Maku‘u and Puna.

Historical literature implies that the *‘uala*, or sweet potato, was grown in great quantities throughout Puna, especially in the nineteenth and early twentieth centuries. For example, an account from 1853 relates:

> There is an increasing attention paid to the culture of the sweet potato, to which our soil and climate are admirably adapted. It grows well in almost every part of the Islands, and no where better than among the dry hot stones of Puna, Kau and Kona on Hawaii,—No one who has ever traveled over those districts can fail to have been struck with astonishment at the sight of beautiful sweet potatoes growing in hills of broken lava with not a particle of earth to be seen in their vicinity. The natives sometimes manure these hills of lava by placing a few boughs upon the lava, then piling stones on them, and when they are partially decayed pulling up the stems or woody part which leaves the leaves and bark to moisten and enrich the hill. The sweet potato is the great article of food in the dry burnt districts of Hawaii, and the cost of raising it is next to nothing. The yield, I am told, is from 50 to 75 bbls. per acre. (Royal Hawaiian Agricultural Society 1853:7)

Handy (1940:165) suggests that although *‘uala* was indeed cultivated widely, it does not appear to have been a staple food of the district:

> …The sandy soil southeast of Honolulu must have been utilized for sweet potatoes. As to the interior of northern Puna in ancient times, I have no information. There are a few patches now in Koae and the vicinity of Kapoho; the slopes and higher ground inside Kapoho crater are ideal for sweet potatoes. A variety of wild potato with deeply cut leaf, which had obviously gone wild from cultivation, was found near the rich taro land of Malama homesteads. It is safe to assume that sweet potatoes were cultivated throughout southeast Puna both inland and along the coast wherever there were plantations. They are still grown in small patches at Kaimu, Kalapana, and Kapaahu. It is said that on the barren coast beyond Kapaahu, fishermen scraped together piles of broken lava and rubbish when rains came and successfully grew sweet potatoes in them. Despite the fact that sweet potatoes were planted almost universally and many patches are still maintained, the Puna natives seem to regard this vegetable with little interest, probably because Puna people prided themselves upon and relished their breadfruit, and also because potato was nowhere and at no time the staple for this rainswept district.

While the *‘ulu* appears to have been preferred among residents of Puna, taro (*kalo*) undoubtedly rivaled it as a staple food source. Puna’s lack of flowing streams made growing wetland *kalo* impossible. Puna did, however, receive plentiful rainfall throughout the year, which made the cultivation of dryland *kalo* possible, even “along the coast as far as Hilo (Handy 1940:126) and in the “wet and sometimes marshy pandanus forests from Kapoho through Poho-iki to ‘Opihikao” (Handy and Handy 1991:541). The method of planting dryland taro in the lowland forests of Puna is described as the *pa-hala* (pandanus clearing) method, which required a farmer to:

> …Make holes in the *‘a‘a* (broken lava) by taking out some of the stones. Be sure that the place chosen is in a *pu hala* grove, to save the labor of hauling *hala* branches into the patch later on. Fill the hole with whatever weeds can be found and leave them there for six weeks or more. The weeds will rot and make soil. When the weeds have rotted away, the taro *huli* are wrapped in *lau hala* (*hala* leaves) to keep them moist and are planted. When there or four leaves have appeared on each *huli*, then that is the tame to cut down the *pu hala* to let in the sun. The branches of the *hala* are cut off and the patch covered with them until this is not a trace of the taro to be seen. This is left until sufficiently dry to set on fire. The fire does not hurt the taro much as the *huli* are already well rooted. The *hala* reduced to ashes, give the taro the needed nourishment and they grow so tall that a man can be hidden under their leaves. (Handy and Handy 1991:104–105)

In addition to these staples, other crops such as coconut (*niu*) and *‘awa* were readily produced in Puna. The uses for *niu* recounted by Handy and Handy (1991) were many and varied. The water was palatable and flavorful. It could also be utilized on a spiritual level by priests practicing divination. The raw meat was edible, and could be scraped out of the shell with a large *‘opihi* to be eaten as is or incorporated into the preparation of various sweets including *haupia* (*haukō*), *kūlolo, and pi‘epi‘e ‘ulu*. Besides being utilized for human consumption, coconut meat could also be used to feed animals, and as Handy and Handy (1991:174) note, “in some localities in Puna, pigs were taught to open their own coconuts.” The meat of the coconut could also be crafted into fresh coconut oil. Coconuts also provided husk fibers to plait sennit cordage to be used for lashing house timbers, adzes, and canoe parts, making food containers

(*ʻumeke*) and the main body of the *pahu hula* drum. The shell could be cut in half to be used for drinking, medicinal, or ceremonial cups. Leaf stems and midribs could be used to clean pig intestines, make brooms, shrimp snares, and for stringing *kukui* nuts to be burned as candles. Leaflets were plaited to make fans and playing balls for children, and the end of the leaf could be used as *kapu* markers along the coastline or to frighten fish out from under ocean ledges.

ʻAwa, a plant described as the "cherished narcotic" of the Hawaiian people by Handy and Handy (1991:192) was utilized by all socioeconomic classes in Hawaiian Prehistory, its roots carefully chewed (pounded in later years) into balls (*mana* or *mana ʻawa*), strained with the stem fibers of the *ahuʻawa*, and presented as offerings or drunken out of polished *niu* shell *ʻapu ʻawa* cups for pleasure, ceremonial, and relaxation purposes. It was also an important element in the treatment of both physical and spiritual ailments in living subjects by *kahuna* (priests) and a crucial ingredient in ritualistic use in which its procurement and preparation were handled with the utmost care. Of all the districts of Hawaiʻi Island, Puna was the most renowned for its *ʻawa*, producing the finest *ʻawa kau laʻau*:

> *Kau laʻau* is the famous *awa* of Puna, Hawaii, which grows in the crotches of trees where, according to the Hawaiians, it becomes planted by birds building pieces of the stem into their nests (M). A line from a mele reads: "Ka manu ahai kanu awa e" (The bird clipping the twig of awa and planting it elsewhere; see 21, p. 30). Kaaikamanu (Ka) identifies it as the same as *Mokihana*, but Mrs. Pukui, who is very well acquainted with Puna (Kaaikamanu came from eastern Maui) tells me that any variety might be found growing in this way. This Puna awa was famous for its strength, which was due, in Mrs. Pukui's opinion, to the fact that its roots grew in sunlight. (Handy and Handy 1991:202–203)

During the latter part of the nineteenth century and into the twentieth century, land use within the District of Puna began to change. The native agricultural system was largely abandoned as the population declined (Yent and Ota 1982), and ranching, sugar cane, coffee, and lumber became the dominant industries. The Keaʻau Ranch began grazing cattle on nearby lands as early as the 1850s (Maly 1999), and the Olaa and Puna Sugar Companies operated in Puna from 1900 until the 1980s (Dorrance and Morgan 2000). Beginning in 1900, railroad tracks for hauling the unprocessed cane and passenger travel were laid by the Hawaiʻi Railway Company from the sugarcane fields in lower Puna to the mills in Pahoa and Keaʻau, and then continuing on to Hilo (Clark et al. 2001). The railroad ceased operations in 1946. When operating, the railroad passed through Makuʻu, Holana, and Pōpōkī *ahupuaʻa mauka* of the current study area, where the Makuʻu Station house was located. Aerial photographs from 1954 and 1977 (Figures 26 and 27) show that the current study area was covered with vegetation during the middle to late twentieth century.

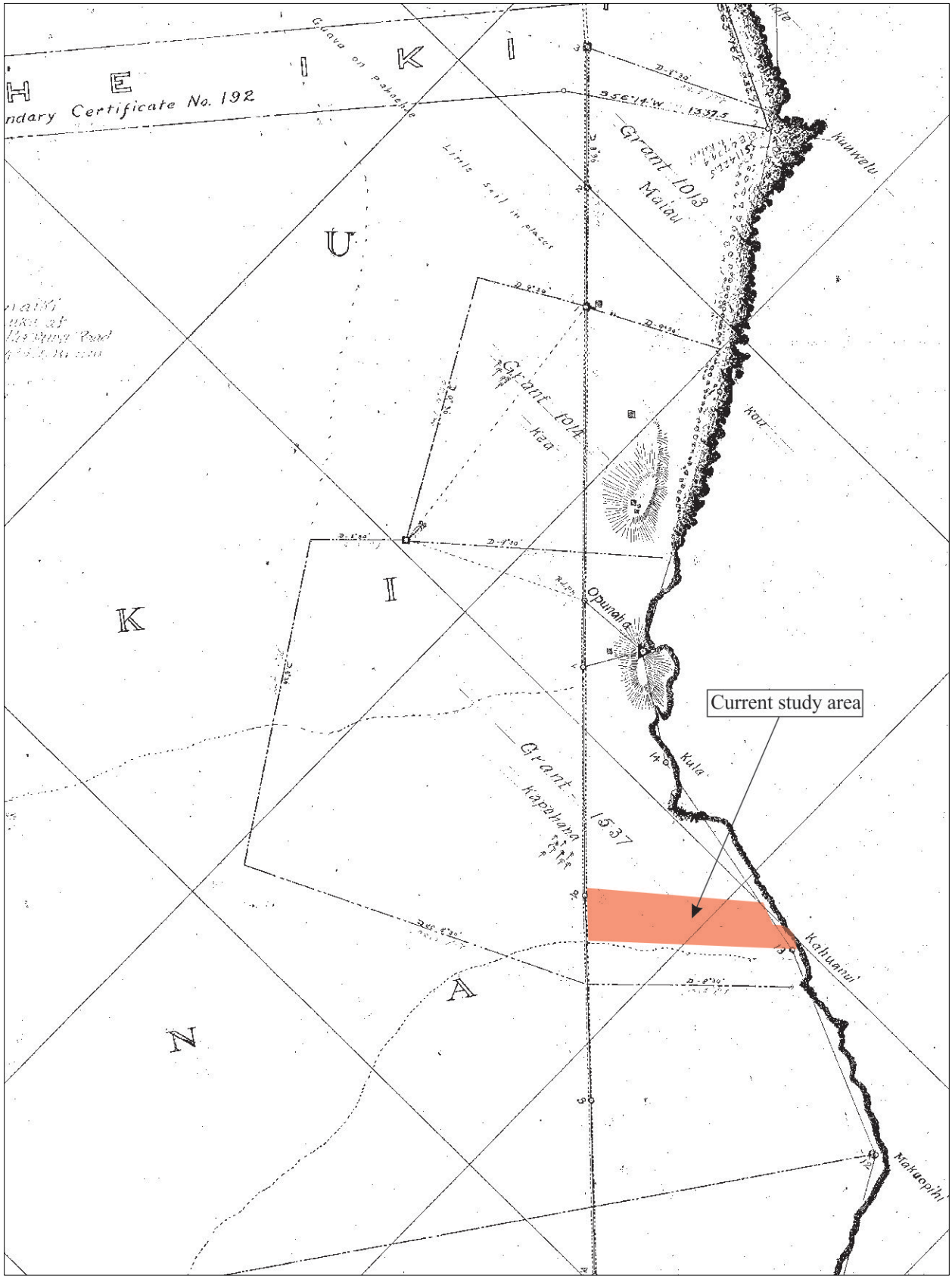


Figure 24. Portion of Registered Map No. 2258 showing land grant parcels and trails ca. 1903.

Figure 25. Portion of the 1924 UGSG Makuu quadrangle (current study area in red).

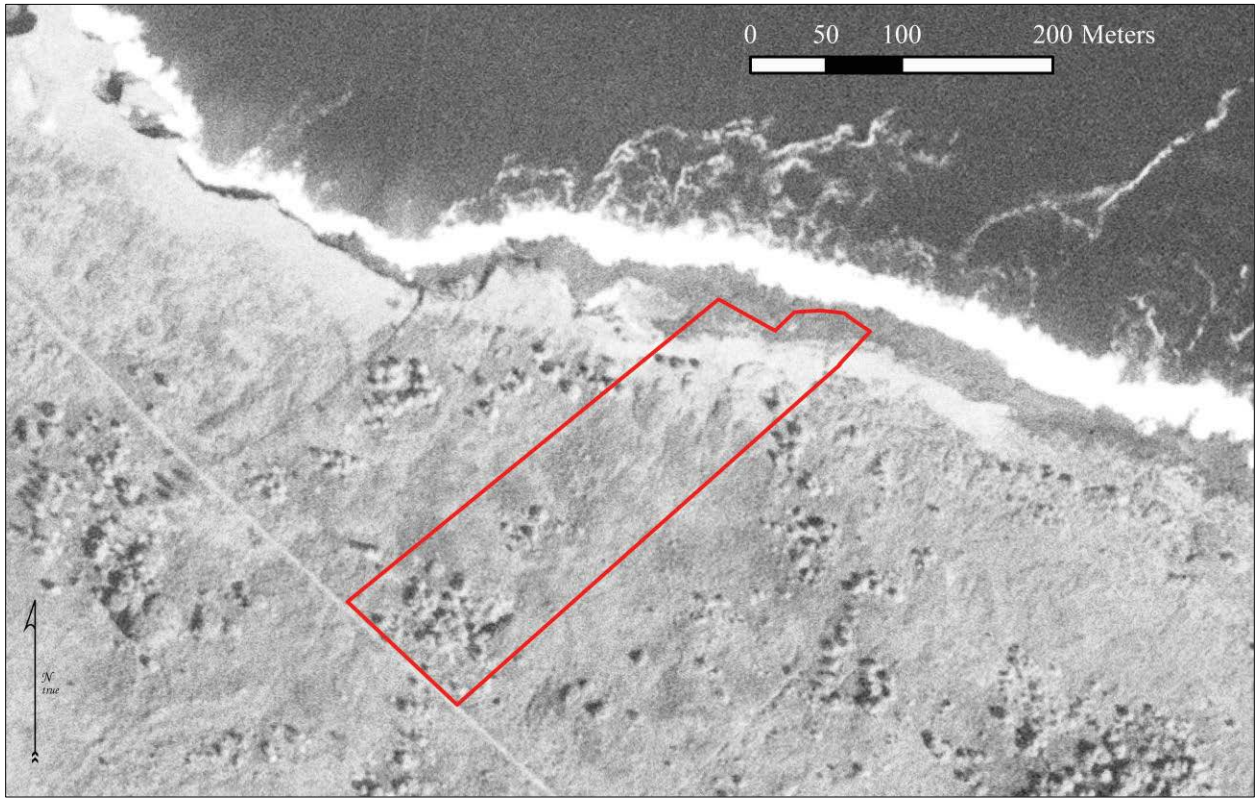


Figure 26. 1954 USGS aerial photograph showing the current study parcel outlined in red.

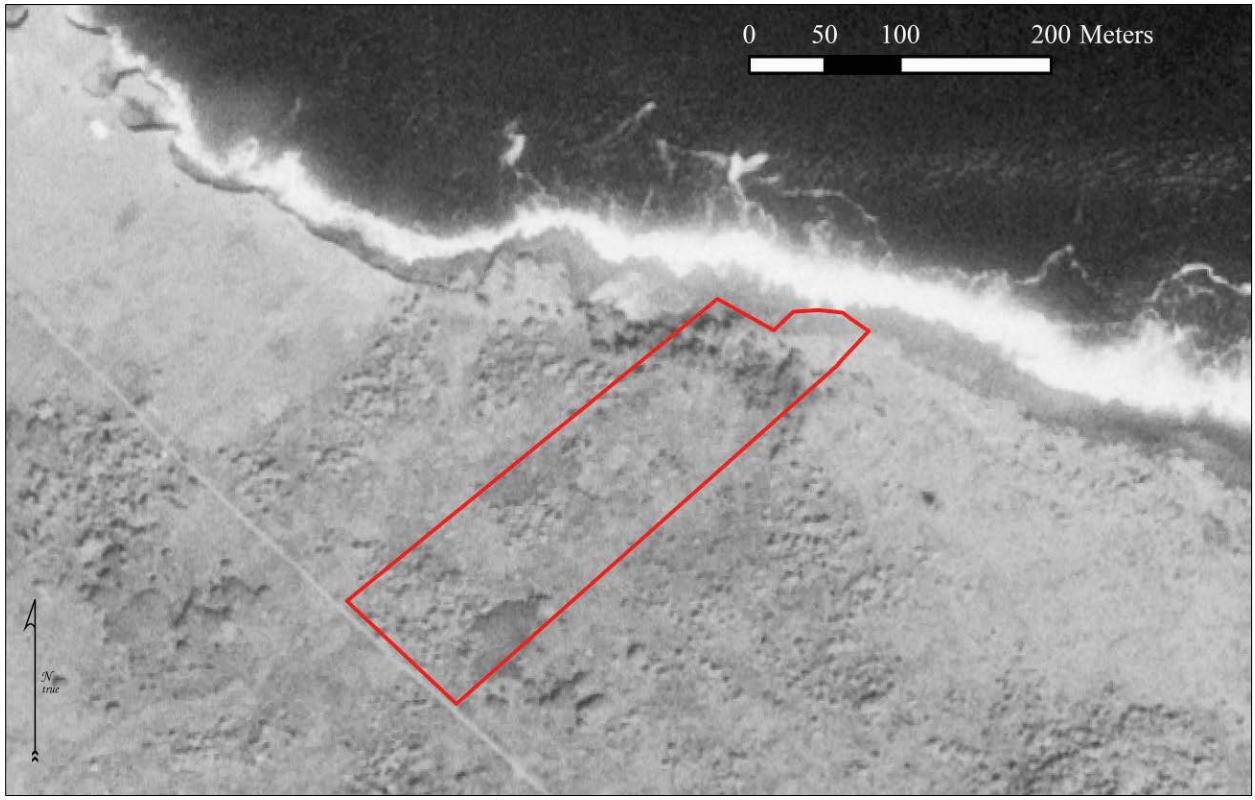


Figure 27. 1977 USGS aerial photograph showing the current study parcel outlined in red.

PREVIOUS ARCHAEOLOGICAL STUDIES

Several previous archaeological studies have been conducted within Maku‘u, Pōpōkī, and Hālona *ahupua‘a* (Table 1 and Figure 28), including eleven studies within the coastal portion of the *ahupua‘a* in the immediate vicinity of the current project area (Barrera and Lerer 1990; Chaffee and Spear 1993; Charvet-Pond and Rosendahl 1993; Clark et al. 2008; Dircks Ah Sam and Rechtman 2013; Ewart and Luscomb 1974; Komori and Petersen 1987; Rosendahl 1989; Spear and Chaffee 1995). These studies have generally confirmed the model described by McEldowney (1979) and Burtchard and Moblo (1994). A brief discussion of the findings of each of these previous studies, arranged in chronological order, follows below. In addition to the coastal studies, seven other studies have been conducted at inland locations within the *ahupua‘a* (Bordner 1977; Clark et al. 2007; Conte et al. 1994; Desilets and Rechtman 2004; McEldowney and Stone 1991; Rechtman 2003) (see Table 1). These studies are not discussed in detail below, but are briefly discussed and referenced because of what they tell us about land use and subsistence within the *ahupua‘a* as a whole. McEldowney and Stone (1991) and Yent (1983) documented extensive lava tube systems containing cultural material related to Precontact habitation and burial in the extreme upland portions of the ahupua‘a. Only three other features were recorded during the four other upland studies, which included over 2,000 acres of total survey area,. One of these features was a cairn recorded by Bordner (1977), another was a small terrace interpreted as a possible agricultural planting area recorded by Desilets and Rechtman (2004), and the third was a complex of surface features recorded by Desilets and Rechtman (2004) that included a large enclosure, a constructed mound, a wall, and a platform that was interpreted as the location of unspecified Native Hawaiian ceremonial activities. The relative lack of archaeological features in the upland area of the *ahupua‘a* is understandable considering that most of the area consists of relatively young lava flows covered by dense (primarily native) vegetation.

Table 1. Previous archaeological studies in Maku‘u, Pōpōkī, and Hālona *ahupua‘a*

Author/Date	*Type of Study*	*Ahupua‘a*
Dircks Ah Sam and Rechtman 2013	Inventory Survey	Pōpōkī
Barrera and Lerer 1990	Inventory Survey	Maku‘u
Bordner 1977	Reconnaissance Survey	Maku‘u
Chaffee and Spear 1993	Burial Testing	Maku‘u
Charvet-Pond and Rosendahl 1993	Inventory Survey	Maku‘u, Hālona, Pōpōkī
Clark et al. 2007	Inventory Survey	Pōpōkī
Clark et al. 2008	Inventory Survey	Maku‘u
Conte et al. 1994	Inventory Survey	Maku‘u, Hālona, Pōpōkī
Desilets and Rechtman 2004	Inventory Survey	Maku‘u, Hālona, Pōpōkī
Ewart and Luscomb 1974	Reconnaissance Survey	Various
Hudson 1932	Archaeological Survey	Various
Komori and Peterson 1987	Cultural and Biological Resource Survey	Various
McEldowney and Stone 1991	Archaeological/Environmental Survey	Various
Rechtman 2003	Archaeological Assessment	Maku‘u, Hālona
Rosendahl 1989	Field Inspection	Maku‘u, Hālona, Pōpōkī
Spear et al. 1995	Data Recovery	Maku‘u
Yent 1983	Archaeological Survey	Maku‘u

The earliest coastal survey of archaeological resources in the vicinity of the current project area was conducted by Hudson (1932). Hudson attempted to inventory the sites of East Hawai‘i Island from Waipio Valley to the Ka‘ū District for the B. P. Bishop Museum. He recorded a wide range of archaeological features including *heiau*, burials, caves, habitations, trails, and agricultural features during his survey. The route of the survey took him through the coastal portion of Maku‘u, Pōpōkī, and Hālona *ahupua‘a*. Hudson noted that it was difficult to obtain information about sites in Puna because “most of them are located along the coast between Keaau and Kopoho where no one now lives, and it is difficult to locate descendants of the former Hawaiian population of the area who might be able to shed light on the nature and function of certain sites”, and that, “back from the sea the land is under cultivation in cane, used for pasture, or covered with dense vegetation which can be penetrated only with difficulty” (Hudson 1932:304).

Forty-two years later, Ewart and Luscomb (1974) of the B. P. Bishop Museum conducted a six-mile long archaeological reconnaissance survey of a proposed Kapoho-Keaukaha Highway route through the District of Puna from Waiakahiula Ahupuaʻa to Keaʻau Ahupuaʻa. The survey area consisted of a 2,000-foot wide corridor that generally followed the route of the old Government Road that passes *mauka* of the current project area (see Figure 28). Ewart and Luscomb (1974:25) noted "virtually continuous settlement in the low-lying fraction" of their study corridor through the Makuʻu area. They recorded numerous archaeological features and feature complexes in the vicinity of the current study area including walls, mounds, petroglyphs, trails, platforms, enclosures, and modified depressions. These features were variously interpreted as being associated with habitation, burial, agriculture, and ranching. Immediately *mauka* of the current study area (Figure 29), Ewart and Luscomb (1974) reported the presence of a lage complex (Site 50-Ha-A3-18) of numerous walls, enclosures, mounds, depressions, and platforms interpreted to be a dense, dispersed settlement. Site 50-Ha-A3-26, a mound suspected to contain a burial, was recorded *mauka* of the current study area as well. To the northwest of the current study area, Ewart and Luscomb also reported cup-shaped depressions in the lava bedrock (Site 50-Ha-03-15) and a complex (Site 50-Ha-A3-3) of free-standing wand retaining walls, a mound, a possible *kuleana* wall, and an enclosure. To the southeast, an isolated wall (Site 50-Ha-A3-2) and a complex (Site 50-Ha-A3-1) of free-standing walls, retaining walls, and small mounds were identified as well. The mounds in Site A3-1 were observed to be located in and around flat, soil-filled terraces. Features within Sites 50-Ha-A3-3and 50-Ha-A3-18 were later re-investigated during archaeological inventory surveys (see below).

Komori and Peterson (1987) conducted a pedestrian survey of a proposed Pohoiki-Keaau transmission line corridor that passed roughly 1.5 miles inland (southwest) of the current project area (see Figure 28). Komori and Peterson recorded five agricultural site complexes, habitation and burial platforms, burial and refuge caves, and petroglyphs. According to Komori and Peterson, the agricultural complexes were all located on or adjacent to *ʻaʻā* lava flows or ash deposits that were more than 1,500 years old. Feature types observed at these agricultural complexes included walls, terraces, clearings, ditches, and modified outcrops. The other sites recorded by Komori and Peterson (1987) were all located on *pāhoehoe* lava flows that originated from Kīlauea Volcano between 300 and 500 years ago. Komori and Peterson suggest that the construction and use of these sites likely dates to between A.D. 1450 and the present, and that the development of the inland agricultural complexes likely followed the establishment of permanent settlements at the coast sometime after A.D. 1450.

Rosendahl (1989) conducted a field inspection of TMK: (3) 1-5-10:028, located on the coast to the northwest of the current study area (see Figure 28). With the exception of a stone wall along the south and east boundaries of the parcel, no surface structural or portable remains of any kind were identified on the property. Rosendahl (1989) relates that the lack of findings was due to widespread bulldozing that had occurred on the parcel at some point prior to the field inspection. Rosendahl (1989:2) concludes:

> As a result of the negative findings of the field inspection, no further archaeological field work is necessary within the present project area. The evaluation and recommendation presented within this report are made solely on the basis of the field inspection survey work. There is always the possibility, however remote, that potentially significant, unidentified subsurface cultural remains and/or surface structural features will be encountered in the course of future archaeological investigations or subsequent development activities. In such situations, archaeological consultation should be sought immediately.

Beginning in 1990, three phases of archaeological study were conducted at TMK:3-1-5-10:33, a 14-acre parcel located along the coast to the northwest of the current project area (see Figure 28). Barrera and Lerer (1990) first conducted an Archaeological Inventory Survey of the parcel. As a result of that study, six archaeological site complexes (Figure 30), each with multiple features, were recorded on the parcel (SIHP Sites 14675, 14981, 14982, 14983, 14984, and 14985). These sites included a wide range of feature types such as modified outcrops, depressions, and lava blisters, walls, mounds, platforms, enclosures, and terraces, which were interpreted as being used for habitation, agriculture, and possible burial during Precontact and Historic times. Only two of the sites, Sites 14675 and 14985, were recommended for further study.

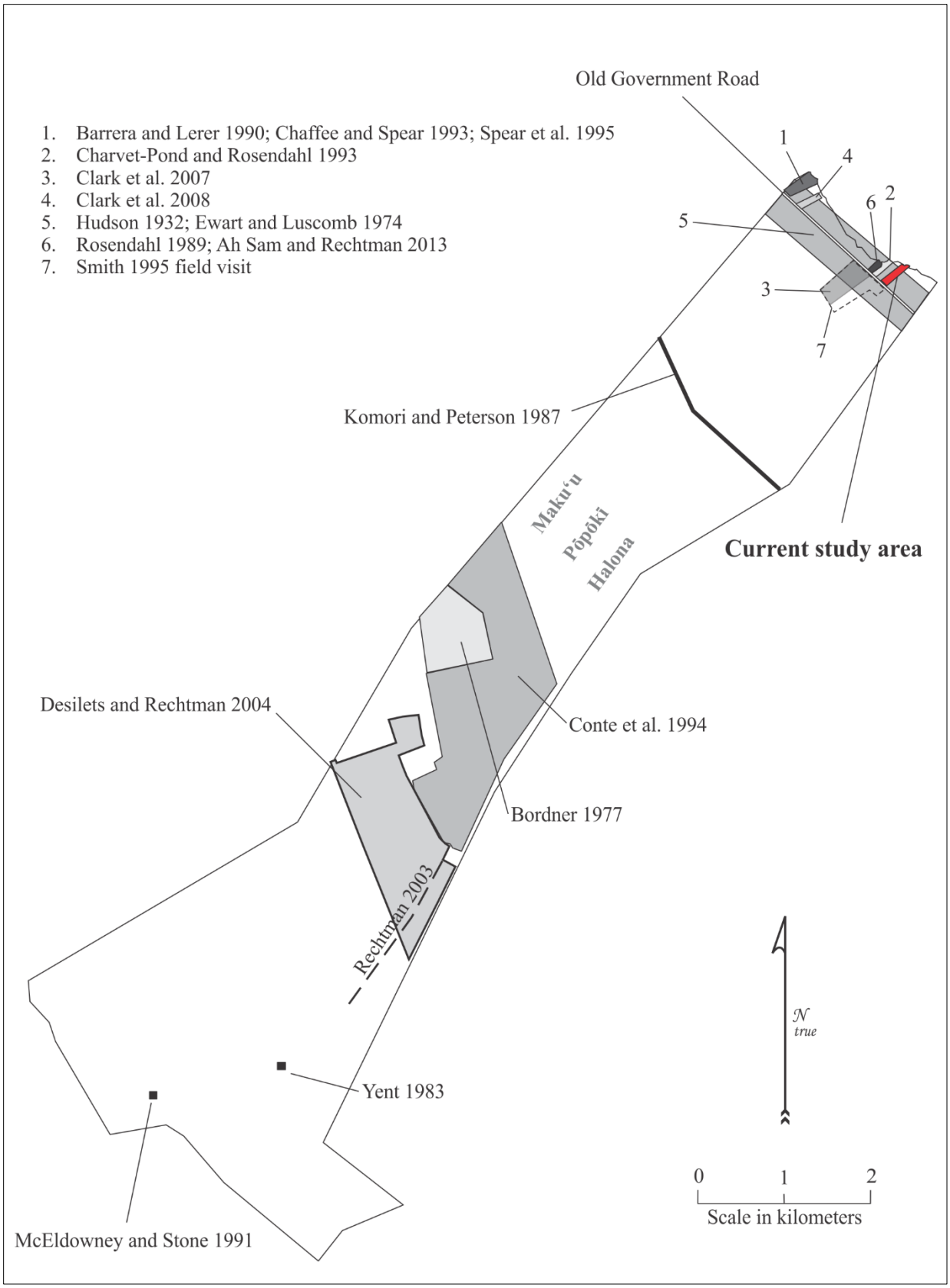


Figure 28. Location of previous archaeological studies conducted in the vicinity of the current study parcel.

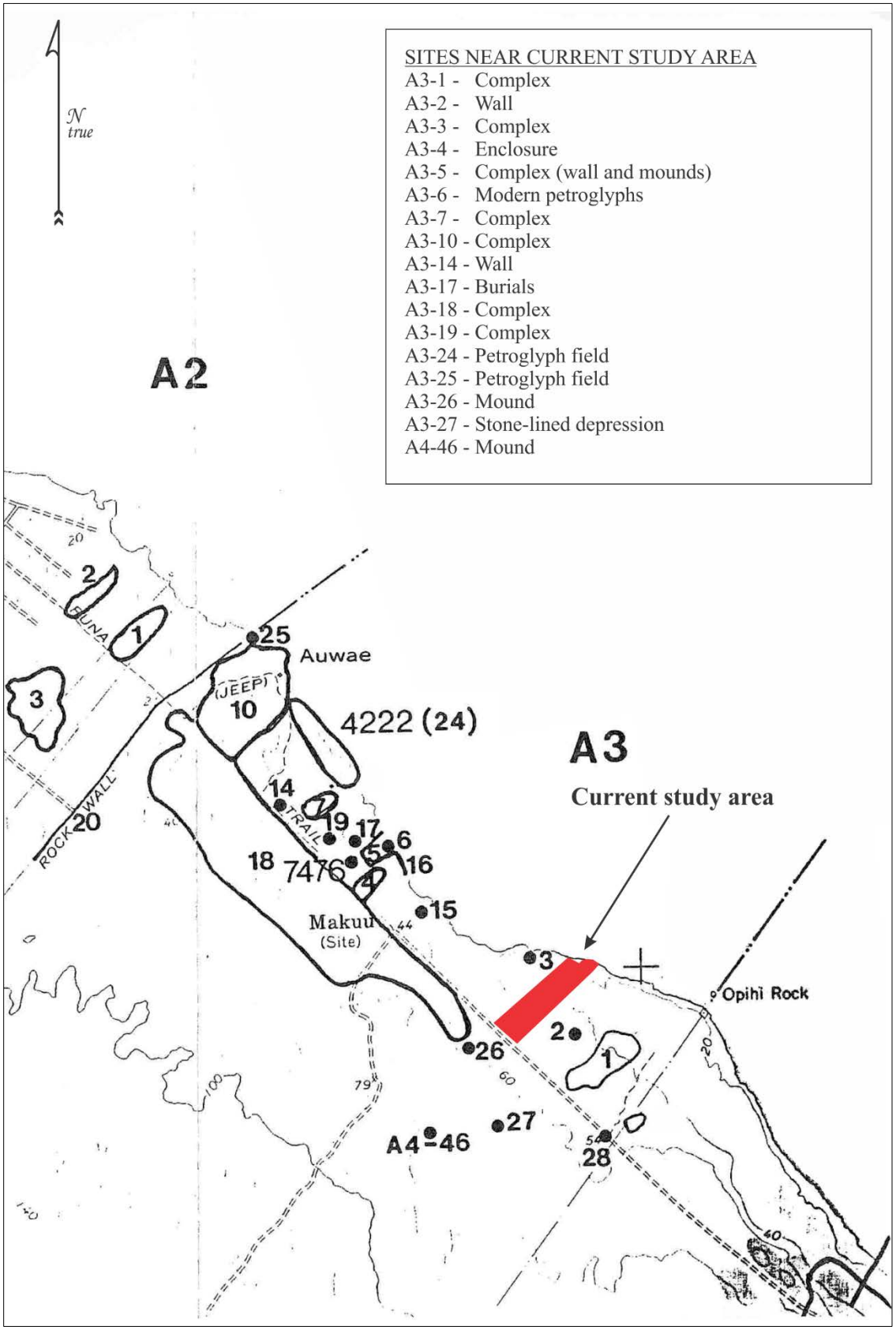


Figure 29. Location of sites identified by Ewart and Luscomb (1974) near the current study area.

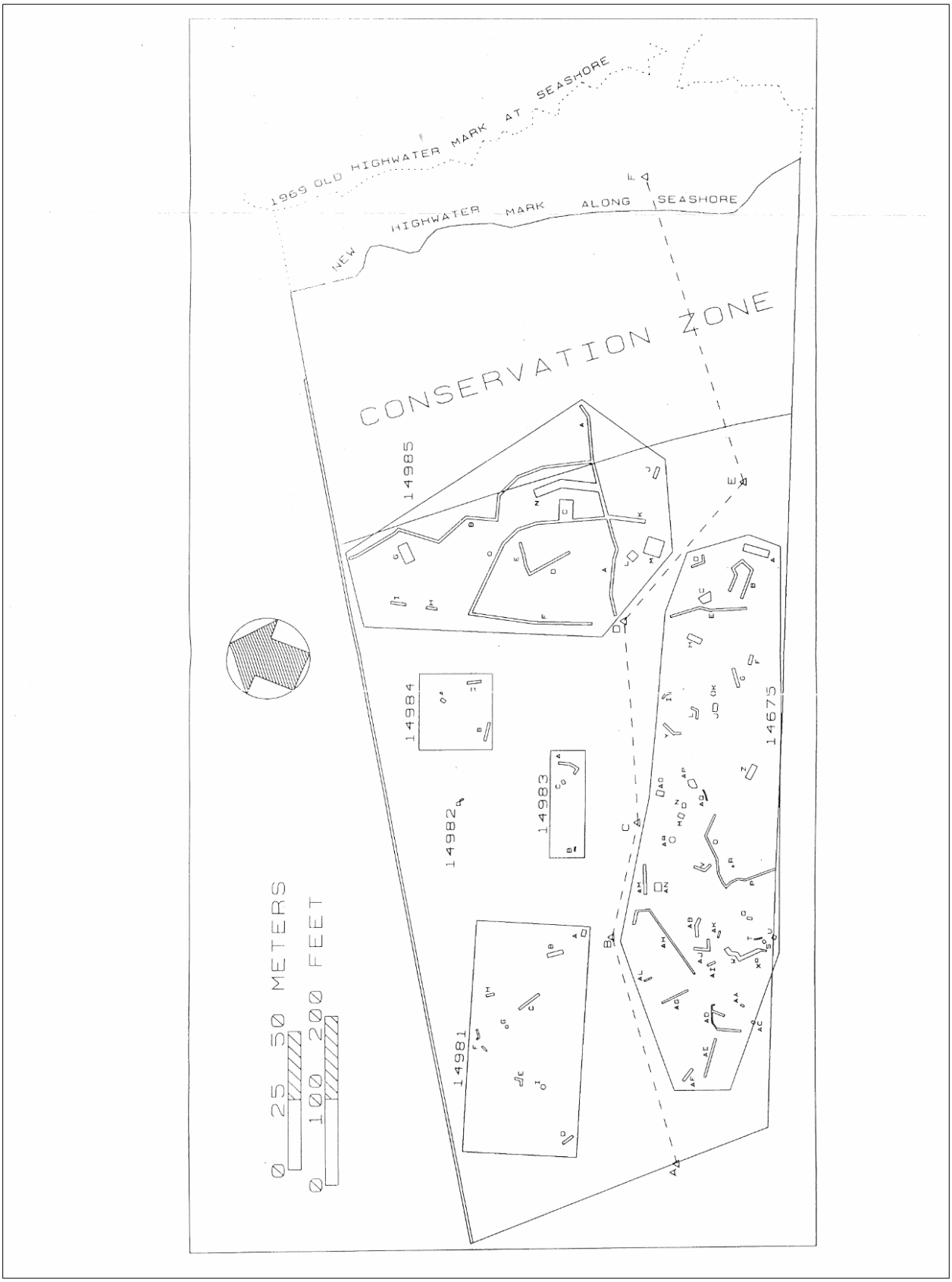


Figure 30. Site location map from Barrera and Lerer (1990).

Chaffee and Spear (1993) followed up on Barrera and Lerer's (1990) work by conducting burial testing at Feature J of Site 14675 (a mound) and Features C, L, and M of Site 14985 (two platforms and a mound). Three of these features (Features J, L, and M) were found to contain subsurface vaults interpreted as burial chambers. Two of the vaults (at Features L and M of Site 14985, a mound and a platform) contained human skeletal remains, while Feature J of Site 14675 lacked human skeletal remains, but was interpreted as a burial feature anyway based on its formal attributes. The lack of human skeletal remains at Feature J was explained by the presence of a wetter micro-environment at that feature, as compared to the other two, which had accelerated the rate of decomposition of the skeletal material (Chaffee and Spear 1993:20). Two of the features (Features J and M) contained associated grave goods that dated to the Historic Period, suggesting a post-contact time frame for the interment of those individuals. With a surface pavement of *ʻiliʻili* and lacking a subsurface vault, Feature C was dissimilar in construction technique to the other three features; and based on the results of the Chaffee and Spear (1993) burial testing, Feature C of Site 14985 was determined to be a habitation platform.

Spear et al. (1995) conducted additional data recovery excavations at some of the remaining features of Sites 14675 and 14985 located northwest of the current project area (see Figure 28). Five features—Feature B (an enclosure), Feature C (a terrace), Feature R (a sealed lava blister), Feature Y (a faced mound), and Feature AP (an enclosure)—were tested at Site 14675, and Feature J (a terrace) of Site 14985 was also tested. Artifacts recovered during the excavations were limited to two types of material; (1) basalt (flakes, manuports, an abrader, and a hammerstone/anvil), and (2) volcanic glass (flakes, debitage, and cores). Most of this material was recovered from Feature J of Site 14985. That feature also yielded a radiocarbon date with a 2 sigma calibrated result of A.D. 1660 to 1950. Based on the data recovery findings Spear et al. (1995) conclude that the large size of most of the tested features suggested that they were used for permanent habitation purposes during the late Precontact Period until perhaps the late nineteenth century. One feature (Feature Y of Site 14675), based on its construction and lack of cultural debris, was interpreted as being used for agricultural purposes.

Charvet-Pond and Rosendahl (1993) conducted an Archaeological Inventory Survey of TMK:3-1-5-10:29, a 3.6-acre coastal parcel located adjacent to the southeast edge of the current study parcel (see Figure 28). As a result of the survey five archaeological sites consisting of twelve features were recorded on the subject parcel (Figure 31.) The sites included a Precontact coastal trail (Site 18418 Feature A), two Historic cattle walls (Site 18419), a coastal terrace complex interpreted as a possible agricultural shrine or *heiau* (Site 18420), two "bait cups" located within the coastal basalt bench (Site 18421), and an agricultural complex containing twenty-six individual features (Site 18422). One of the Site 18419 cattle walls extends along the southeastern boundary of the current study parcel, and Feature A of Site 18418, a coastal trail, extends in the general direction of the current project area, but stops at the Site 18419 cattle wall. Charvet-Pond and Rosendahl (1993:15) described Site 18418A as:

> …a linear rock mound, Feature A,which paralled the coastline and extended across the property onto the neighboring parcels on both sides…
>
> Feature A was a mound of variable construction. In some sections it exhibited a paving of flat waterworn basalt boulders placed into a surface side-by-side near the edges, about one meter or a footstep apart. This feature is very similar to inferred prehistoric coastal-trail segments in the vicinity described by Hudson (1932) and Ewart and Luscomb (1974).

The features of Site 18422 included modified outcrops, modified depressions, terraces, walls, and mounds. Nine of these agricultural features were subject to subsurface testing, which yielded fifty-nine volcanic glass cores and flakes. Subsurface testing was also conducted at Sites 18418, 18420, and 18421, which revealed a complete lack of cultural material at those sites. Based on the predominance of agricultural features and relative lack of cultural debris within their project area, Charvet-Pond and Rosendahl (1993) suggest that many of the activities formerly conducted there were likely related to Precontact agricultural pursuits. It is for this reason that they interpreted Site 18420, a five-feature complex, as a possible agricultural shrine or *heiau*. Three of the terraces of the complex were located on an adjacent parcel to the southeast (TMK:3-1-5-10:30), and were therefore not tested, but Charvet-Pond and Rosendahl (1993) suspect that based on their formal attributes, it is possible that one or all of them may also contain burials. The main feature of Site 18420 is a 1.0 meter high, two-tiered terrace with a water-worn cobble surface. Although several possible functional interpretations are discussed for this feature (e.g. fishing shrine, burial, Precontact or Historic habitation), all are discarded in favor of the agricultural *heiau* interpretation. This interpretation was arrived at based on the feature's formal attributes, the lack of cultural debris, and its proximity to the agricultural features of Site 18422.

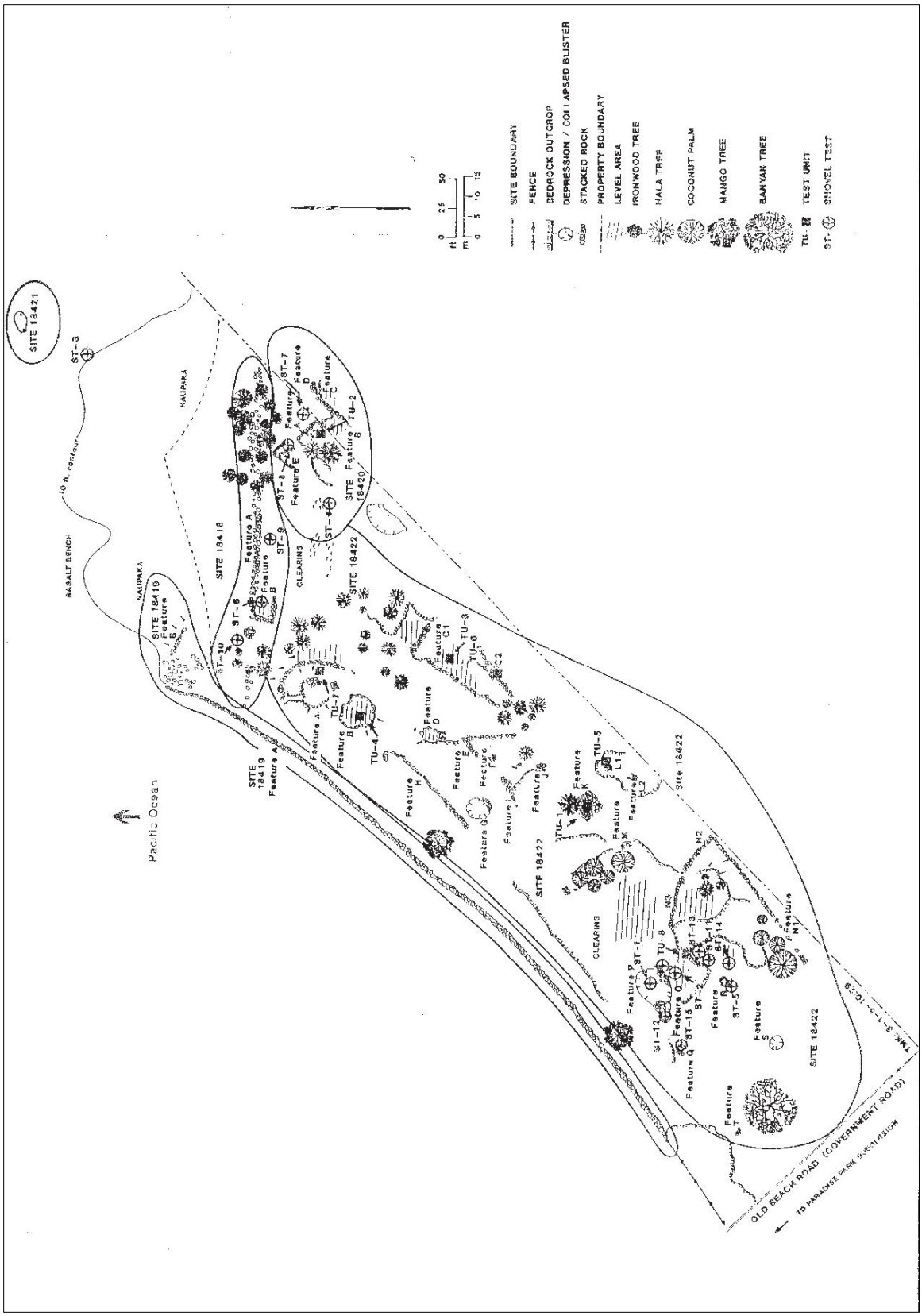


Figure 4. Sites recorded by Charvet-Pond and Rosendahl (1993).

In 1995, former State Historic Preservation Division (SHPD) staff archaeologist Marc Smith conducted a site inspection of TMKs:3-1-5-10:8, 22, and 23, located to the southwest of the current project area, *mauka* of the old Government Road (see Figure 28) at the request of a Mr. Tom Brennen (Don Hibbard letter dated August 14, 1995; on file at DLNR-SHPD). SHPD's letter described stone structures in Parcel 23 that consisted of "a single platform, stacked stone walls, mounds, and modified outcrops. It appears that these structures may be associated with early agricultural practices and may be significant as they reflect past land use patterns, and for their information content."

Clark et al. (2007) conducted an Archaeological Inventory Survey of a 38-acre parcel (TMK:3-1-5-10:23; one of the parcels inspected by Marc Smith in 1995) located *mauka* and west of the current study area (see Figure 28). As a result of that study, five archaeological sites were recorded, including a Precontact agricultural shrine or small *heiau* (Site 26165), a Historic trail/roadway (Site 26166), a habitation complex (Site 26167), and two agricultural complexes (Sites 26168 and 26169). These sites were interpreted as being variously related to Precontact and continued early Historic Hawaiian use of the area for habitation, ceremonial, and agricultural purposes. The two agricultural complexes (Sites 26168 and 26169) were located in geological and soil conditions very similar to those found in the current study area. Site 26168 included four features: two modified depressions, a wall, and an enclosure with an attached wall segment. Site 26169 was much more extensive, and included twenty-nine modified depressions, eleven walls, six mounds, five modified outcrops, and three enclosures. Based on the crude, opportunistic construction of the features in Site 2619, their association with soil deposits, and their widespread distribution, they have all been interpreted as agricultural clearing, planting, or boundary features.

Northwest of the current study area, Clark et al. (2008) conducted an Archaeological Inventory Survey of a 5.586-acre parcel (TMK:3-1-5-10:32) located between the old Government Road and the coast (see Figure 28). As a result of that study, nine archaeological sites (Figure 32) containing a total of 67 features were recorded within their project area. The sites included a core-filled wall along the old Government Road (Site 26658), an enclosure/pavement used for Historic habitation purposes (Site 26659), a Historic habitation complex (Site 26660), a modified bedrock hole used for water collection and storage (Site 26661), three concealed bedrock overhangs interpreted as Historic burial features (Sites 26662, 26663, and 26664), a platform interpreted as a Precontact burial feature (Site 26665), and a large agricultural complex (Site 26666) containing 55 features that spanned the entire project area. Site 26666 has fifty-five distinct features including twelve terrace walls, eight dry-stacked walls, eight core-filled walls, two core-filled/terrace walls, three alignments, one wall/linear mound, one mound, nine modified depressions, and eleven modified outcrops. In addition to the recorded archaeological sites, the presence of a petroglyph field was noted on the coastal shelf *makai* of their study area.

In 2013, ASM Affiliates conducted an Archaeological Inventory Survey (Dircks Ah Sam and Rechtman 2013) of TMK (3) 1-5-010:028, a 3.5-acre parcel located to the northwest of the current study area. While Rosendahl (1989) had previously reported no historic properties, Dircks Ah Sam and Rechtman (2013) identified features of two archaeological sites (SIHP Sites 18419 and 18418) that had escaped the effects of prior bulldozing on the parcel. These sites were originally recorded on the neighboring parcel to the southeast by Charvet-Pond and Rosendahl (1993) and include a core-filled wall (Site 18419 Feature A) and a trail section (a portion of Site 18418 Feature A). Dircks Ah Sam and Rechtman (2013:22) described the trail:

> Within the current study parcel, a slightly elevated earthen alignment with placed water-worn boulders and cobbles was observed approximately 20 meters *mauka* of the sea cliffs; at roughly the same distance inland that Site 18418 Feature A was recorded on the adjacent parcel. This alignment is interpreted to be a segment of this same trail. Within the current project area the trail alignment is traceable for only a 10 meter distance in the southeast portion of the parcel, the remainder either having previously bulldozed away or covered and obscured by soil and vegetation. The trail remnant within the study parcel was first visually identified as a humped area covered with a dense growth of grasses and vines. The vegetation was then removed exposing a 10 meter long section of the elevated trail. This feature consists of an approximately 1.8 meters wide level surface with 60 centimeter sloped margins. On its upslope edge, the trail rises 12 centimeters above the surrounding ground surface and on its downslope edge it is 32 centimeters above the surrounding ground surface. Several water-worn basalt boulders and cobbles have been placed along the edge of the level surface while others have been embedded within the surface; the former rocks seem to define the trail alignment and the latter appear to have been used as steppingstone. A large *pāhoehoe* slab sits on the slope adjacent to the trail's *mauka* edge, likely indicating the extent of former bulldozing in this area.

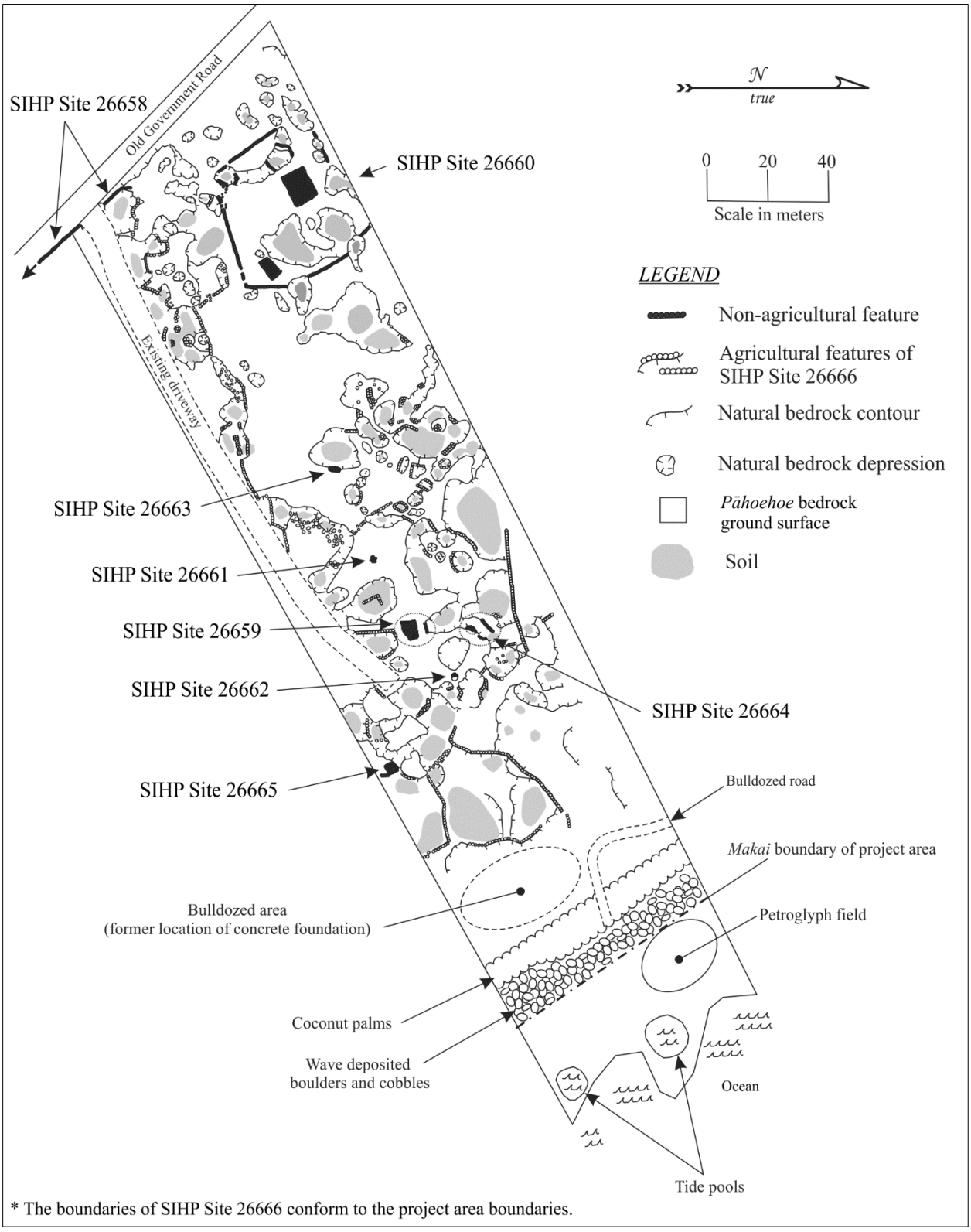


Figure 32. Site location map from Clark et al. (2008).

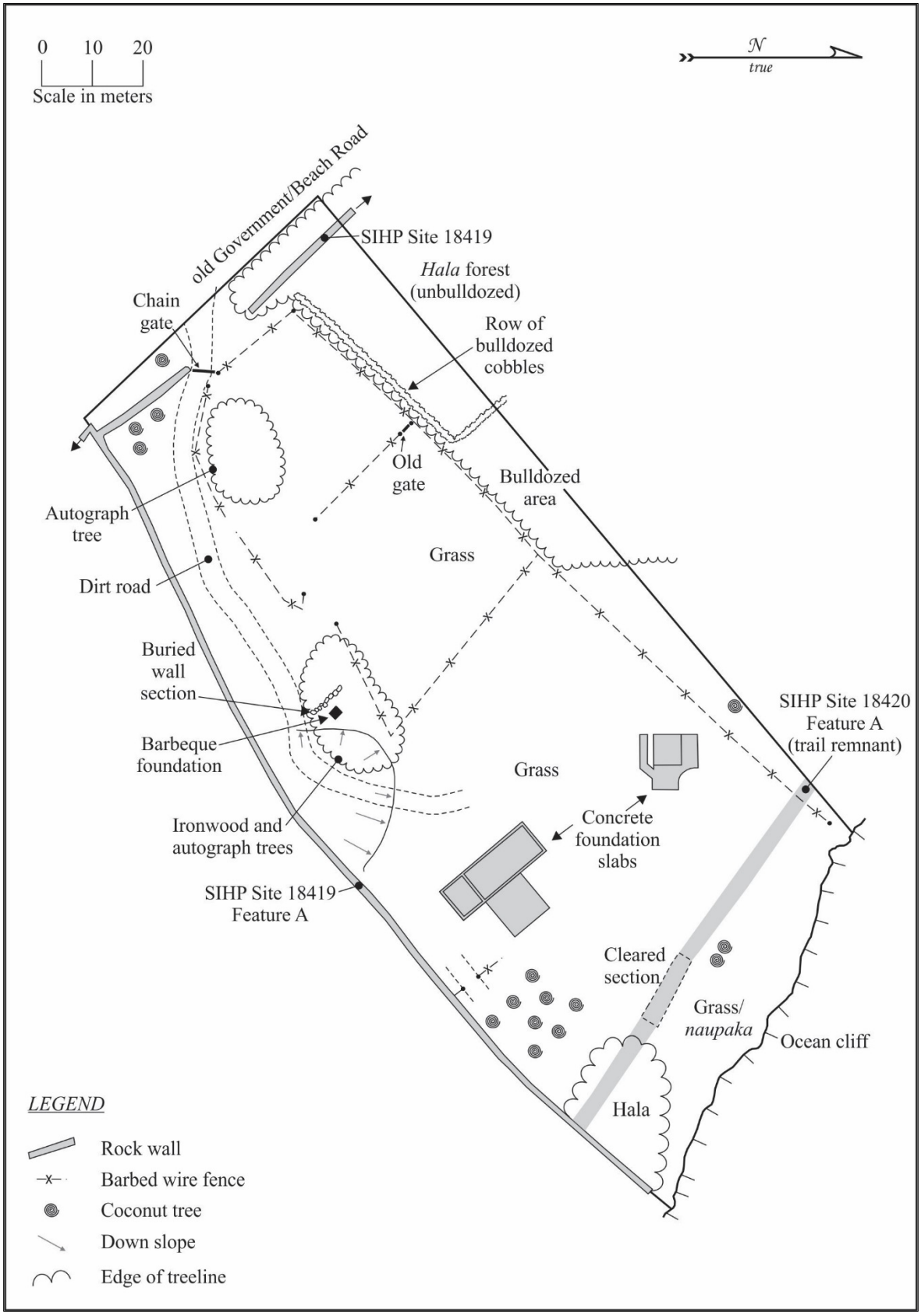


Figure 33. Site location map from Dircks Ah Sam and Rechtman (2013).

3. STUDY AREA EXPECTATIONS

The *ahupua‘a* of Pōpōkī falls within the Coastal Settlement Zone (Zone I) described by McEldowney (1979:15–18). While this model is largely based on early historical accounts, it also considers environmental variables and human resource needs, and offers insights into the prehistoric past (Burtchard and Moblo 1994). In their refinement of the model as it applies to Puna, Burtchard and Moblo elaborate on McEldowney's concept of the Coastal Settlement Zone:

> As with her model, [the Coastal Settlement Zone] includes coastal terrain to about one half mile inland. This is the zone expected to have the greatest density and variety of prehistoric surface features in the general study area. Primary settlements are expected in places where agriculturally productive sediments (principally well-weathered ‘a‘ā flows) co-occur with sheltered embayments and productive fisheries. Settlements within this zone are expected to be logistically linked to inland agricultural and forest exploitation zones accessed through a network of upslope-downslope (*Mauka-makai*) trails. Larger settlements and resource acquisition areas may have been connected by cross-terrain trail networks. (Burtchard and Moblo 1994:26)

Previous archaeological studies have documented a Precontact settlement pattern along this portion of the Puna coast that features dispersed habitation sites and agricultural complexes along with ceremonial and burial areas, all associated with a fairly dense (but not necessarily nucleated) population. Areas inland of the study area were exploited for agricultural purposes and the collection of forest resources, but not generally for habitation. Maku‘u was likely a regional population center during Precontact times. By early Historic times, as drastic population reduction occurred throughout Hawai‘i and traditional sites were abandoned, Maku‘u became a small scattered village (Maly 1998). The later Historic Period saw a minor expansion of settlement in this area of both transplanted Hawaiians and non-Hawaiians alike. This was primarily due to Government grant programs. Grantees often modified their lands obscuring if not obliterating prior residential and agricultural sites. The influx of people during this period waned by the early twentieth century as a result of commercial economic failures, and the population once again dipped.

Present-day vegetation in the study area suggests that little of the parcel has been disturbed by grubbing, grading, or other similar activities. The Precontact/early Historic archaeological landscape is expected to be largely intact. Archaeological features expected to be encountered include agricultural features typical of this part of Puna (e.g., modified depressions, modified outcrops, alignments, and/or mounds associated), possibly intermixed with scattered habitation features (platforms, terraces, pavements, walls, and/or enclosures). Burials are also possible in the study area. Additionally, physical evidence of a former coastal trail (SIHP Site 18418 Feature A) is known to exist on nearby parcels may still may be present in the *makai* portion of the current study area.

4. FIELDWORK

Fieldwork for the current project was conducted August 9–15, 2017. Fieldworkers who participated in the project included Ashton Dircks Ah Sam, B.A., Genevieve Glennon, B.A., Joshua Gastilo, B.A., Keala Kealiʻihoʻomalu, B.A., and Matthew R. Clark, M.A. All fieldwork was conducted under the direction of Benjamin Barna, Ph.D.

FIELD METHODS

During the intensive inventory survey of the study area, the entire parcel was subject to northeast/southwest pedestrian transects with fieldworkers spaced at 10-meter intervals. When archaeological features (or landforms, disturbances, etc.) were encountered, they were plotted on a map of the current study parcel using a data from a Garmin GPSMAP 64st handheld GPS unit (set to the WGS 84 datum) and using measuring tape and compass. Features were then cleared of vegetation, photographed (both with and without a meter stick for scale), and described using standardized site record forms.

A single test trench (TT-1) was excavated to determine if archaeological evidence of Site 18418A was present *mauka* of the shoreline in the current study area. After vegetation was hand-cleared from the test trench, the trench was excavated using a shovel and trowel following natural stratigraphic layers. The recovered soil matrix was passed through 1/8-inch mesh screen. Excavation forms, filled out for each stratigraphic layer, were used to record soil descriptions, cultural constituents collected, and the general layer characteristics. The test trench was excavated to the underlying bedrock, and upon completion, photographs were taken with a meter stick and north arrow for scale and orientation, and a scaled plan view drawing was prepared. The unit was then back filled as close to its original appearance as possible.

FINDINGS

As a result of the fieldwork for the current study one previously unrecorded archaeological site (SIHP Sites 50-10-45-30712), an agricultural complex comprising sixty-three features, was identified within the current study parcel (Figure 34). Subsurface testing (TT-1) produced negative results, indicating that the coastal trail (Site 18418A) does not exist *mauka* of the shoreline in the current study area. The site and the results of subsurface testing is described in further detail below.

Site 50-10-45-30712

Site 30712 is an agricultural complex that occupies most of the study area (see Figure 34), extending along the length of the parcel from the Old Government Road to approximately 80 meters *mauka* of the sea cliffs. The site comprises sixty-three features that include twenty-two mounds, twenty-two walls and three wall remnants, nine modified depressions, three cleared soil areas, three modified outcrops, one cluster of *pāhoehoe* excavations, and one rock alignment (Table 2). Based on the relatively informal and opportunistic construction of the features, their association with soil deposits, and their widespread distribution within the study area, they have all been interpreted as agricultural clearing, planting, or boundary features. Individual feature designations represent interpretive choices based on apparent function, spatial association, and construction sequence. Although presented below as individual features, they are part of a larger organic whole that once functioned together within a nearly completely modified landscape.

Walls and mounds were the most common feature types recorded at Site 30712. A wall is a linear or curvilinear alignment of rock that stands at least two stones high and is considerably longer than it is wide. Walls generally have sloped sides, although in neatly stacked walls and terrace walls the slope approaches vertical. In some cases the walls include adjoining or shaped segments. All twenty-two of the walls present in the current study area were dry-stacked walls, and vary in their condition from neatly-stacked to partially-collapsed. The three wall remnants are very disturbed portions of walls that have lost almost all of their formal attributes (e.g., stacking and shape). Often at Site 30712, it appears that the cobbles used to construct the walls were cleared from the interior soil areas within depressions or on relatively level ground. Dry-stacked walls could have been constructed at any time, but for the purposes of this study they are considered to have been most likely constructed during the Precontact Period. Within the current study area they appear to define planting area boundaries.

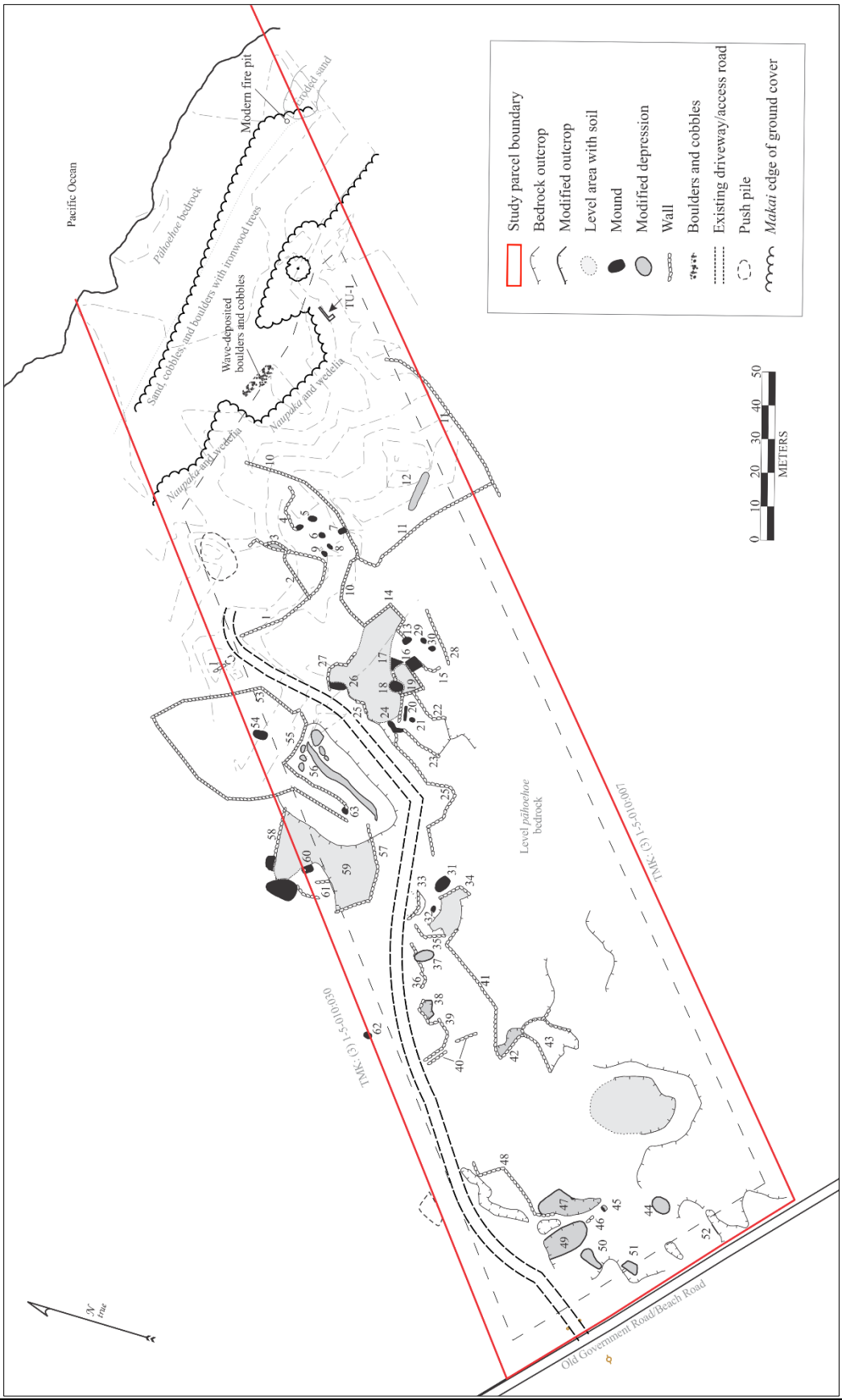


Figure 5. Site location map.

A mound is a collection of stones with an irregular surface. The functional distinction among types of mounds is contextual rather than formal. Mounds found in clusters around rock-free areas with soil accumulations are considered to be agricultural clearing features. Mounds can range considerably in size, although in the current study area all twenty-two of the mounds were generally less than six meters across and less than one meter tall. These interpretations are based on both Direct Ethnographic Analogy (Ellis 1963; Fornander 1919–1920; Handy and Handy 1991), and interpretations from prior archaeological studies (Allen 2001; Cordy 2000; Kirch 1985).

Nine of the bedrock depressions within the project area are considered stand-alone features. These features were recorded as modified depressions (see Table 2). The modified depressions are generally less than 10 meters in diameter that have been modified by piling or stacking of cobbles around their outside edges. Typically, these cobbles have been cleared from within the depressions to access the soil found beneath. The modified depressions at Site 30712 are all interpreted to be planting features.

Three cleared soil area were interpreted to be archaeological features within Site 30712 (see Table 2). These areas were distinctly cleared of rock, exposing soil accumulations. Two of these cleared soil areas are located next to outcrops that have been modified with the cleared stones. The third cleared soil area is enclosed by a small rock wall. Other areas with soil on the ground surface were observed in the study area, but none of these exhibited modifications or other evidence of alteration by humans. While it is possible that those soil areas were also used for agriculture, the lack of corroborating evidence resulted in the omission of those areas from the list of archaeological features.

Three modified outcrops were recorded at Site 30712 (see Table 2). At a modified outcrop, unlike a mound, the stone collection is usually not freestanding and depends on the bedrock formation for support. The type and size of the stones used in these features is a function of the immediately available source materials. The stones are either stacked, piled, or a combination of both. At modified outcrops the size of the stone collection must be significantly smaller than the size of the bedrock formation, otherwise the feature is considered a mound. The surface of these features are usually irregular with sloped sides. Modified outcrops often have incorporated bedrock protruding from them. Occasionally, if the stones are stacked against a vertical bedrock formation, the stacked edges will also approach vertical. All three modified outcrops recorded at Site 30712 are adjacent to soil filled depressions, and are considered to be features that were created during the clearing of the soil areas for planting.

One alignment was recorded at Site 30712 (see Table 2). Alignments are single course constructions that are considerably longer than they are wide. The function of the alignment within the project area is uncertain, and it may be that it was intended as the base for a taller wall that was never completed, or perhaps that it was once taller but was dismantled and the cobbles were used elsewhere.

Detailed descriptions of each of the features recorded at Site 30712 follow below. Their locations, relative to the project area boundaries and one another, are depicted in Figure 34.

Table2. Site 30712 features.

Feat. #	*Formal type*	*Functional type*	*Dimensions (m)*
1	Wall	Planting	36.0 x 1.5
2	Wall	Planting	18.0 x 1.2
3	Cleared soil area	Planting	3.7 x 2.7
4	Wall	Planting	20.0 x 1.3
5	Mound	Agricultural clearance	2.9 x 2.8
6	Mound	Agricultural clearance	2.3 x 2.2
7	Mound	Agricultural clearance	4.4 x 2.4
8	Mound	Agricultural clearance	2.6 x 2.2
9	Mound	Agricultural clearance	2.2 x 0.6
10	Wall	Agricultural boundary wall	70.0 x 1
11	Wall	Agricultural boundary wall	80.0 x 2
12	Modified depression	Planting	8.0 x 5.0
13	Mound	Agricultural clearance	2.8 x 1.8

table continues

Table 2. Site 30712 features (continued).

Feat. #	*Formal type*	*Functional type*	*Dimensions (m)*
14	Wall	Agricultural field wall	20.0 x 1.3
15	Wall	Agricultural clearance	31.0 x 2.0
16	Mound	Agricultural clearance	2.6 x 2.2
17	Mound	Agricultural clearance	2.9 x 1.8
18	Mound	Agricultural clearance	2.4 x 2.2
19	Wall	Agricultural clearance/boundary	10.0 x 1.5
20	Mound	Agricultural clearance	3.5 x 1.3
21	Mound	Agricultural clearance	1.6 x 1.0
22	Wall	Agricultural clearance	15 x 1.2
23	Wall	Agricultural clearance/ boundary	15.0 x 1.0
24	Mound	Agricultural clearance	3.5 x 2.6
25	Wall	Agricultural clearance/ boundary	60.0 x 2.3
26	Mound	Agricultural clearance	4.8 x 3.4
27	Wall	Agricultural clearance/boundary	10.0 x 1.0
28	Wall	Planting	13.0 x 0.7
29	Mound	Agricultural clearance	2.5 x 1.3
30	Mound	Agricultural clearance	1.8 x 0.8
31	Mound	Agricultural clearance	3.8 x 3.4
32	Mound	Agricultural clearance	1.0 x 1.0
33	Wall	Agricultural clearance/boundary	9 x 0.3
34	Modified outcrop	Agricultural clearance	2.9 x 1.2
35	Wall	Boundary	5.5 x 0.9
36	Wall	Boundary	14.2 x 2.3
37	Modified depression	Planting	4.3 x 3.0
38	Modified depression	Planting	2.3 x 3.8
39	Wall	Agricultural boundary	20.0 x 1.3
40	Alignment	Indeterminate	20.0 x 0.5
41	Wall	Agricultural boundary	41.0 x 1.0
42	Modified depression	Planting	2.3 x 5.8
43	Modified outcrop	Planting	14.0 x 9.0
44	Modified depression	Planting	4.2 x 8.8
45	Modified depression	Planting	2.4 x 0.8
46	Wall remnant	Agricultural boundary	1.9 x 0.8
47	Modified outcrop and cleared soil area	Planting	2.1 x 0.8
48	Wall	Planting	36.0 x 0.5
49	Modified outcrop	Planting	4.7 x 0.3
50	Modified depression	Planting	2.5 x 1.9
51	Modified depression	Planting	1.0 x 0.5

table continues

Table 2. Site 30712 features (continued).

Feat. #	*Formal type*	*Functional type*	*Dimensions (m)*
53	Wall	Agricultural boundary	29 x 0.9
54	Mound	Agricultural clearance	4.5 x 2.8
55	Wall	Agricultural boundary	14.0 x 0.9
56	*Pāhoehoe* excavations	Planting	14.0 x 38.0
57	Wall	Agricultural boundary	48.0 x 0.8
58	Wall remnant	Agricultural boundary	14.0 x 0.3
59	Cleared soil area	Planting	15.0 x 17.0
60	Mound	Agricultural clearance/planting	6.0 x 5.0
61	Wall remnant	Agricultural boundary	4.0 x 0.6
62	Mound	Planting	0.6 x 0.5
63	Mound	Agricultural clearance/planting	5.2 x 3.7

end of table

Feature 01

Feature 01 is a wall (Figure 35) located in the northern, *makai* portion of the study area among a concentration of other associated agricultural features (Features 2-10, see Figure 34). The wall begins outside of the current study area on Parcel 030 and extends east for 4.0 meters (Figure 36), at which point it has been disturbed by the existing driveway/access road. The rocks from the disturbed portion of the wall are piled (Figure 37) at the end of this wall segment. The wall resumes on the other side of the driveway/access road for approximately 30.0 meters, then curves to the northwest for an additional 20 meters. It is constructed of small to large boulders and cobbles that have been loosely stacked 3-4 stones high to a maximum height of 1.5 meters, and ranges in width from 0.8 to 1.5 meters. Feature 01 wall appears to have suffered collapse overtime, and the east-west running segment of the wall has retained the majority of its stacking. No cultural material was observed in and around the feature. Feature is interpreted to be an agricultural boundary wall.

Feature 02

Feature 02 is a wall (Figure 38) abutting Feature 01 (see Figure 34), that extends across the bend in Feature 01 to define an enclosed planting area. The wall is constructed of small to large cobbles that have been loosely stacked two to four stones high to a maximum height of 60 centimeters, and is 18 meters long with a maximum width of 1.2 meters. Feature 02 abuts Feature 01 roughly 17 meters from that wall's western end. The wall is in relatively fair condition, but has suffered some collapse. No cultural material was observed in or around the feature. Feature 02 is interpreted to be an agricultural boundary wall.

Feature 03

Feature 03 is a cleared soil area (Figure 39) enclosed by a low wall that extends off the eastern side of Feature 01, roughly 7 meters in from the northern end of Feature 01 (see Figure 34). The low wall is constructed of small boulders and small to large cobbles that have been loosely piled. It measures 3.7 meters long (north to south) by 2.7 meters wide (east to west) with a maximum exterior height of 80 centimeters. The soil area inside the wall measures 2.2 meters by 2.0 meters, and is distinguished from the surrounding area by the presence of soil. The feature is in fair condition and has suffered some collapse over time. No cultural material was observed in or around the feature. Feature 03 is interpreted to be a planting area.

Feature 04

Feature 04 is a wall (Figure 40) located approximately eight meters east of Feature 03 (see Figure 34). The surrounding landscape has been heavily modified and consists of a concentration of agricultural mounds and walls with areas of open soil. Feature 04 is approximately 20 meters long with a maximum width of 1.3 meters and is constructed of small boulders and small to large cobbles that have been loosely stacked 3-5 stones high. The southern end of the wall becomes wider than the rest and has a more mounded appearance. No cultural material was observed in or around the feature. Feature 04's proximity to other agricultural features suggest that the wall was built from cleared stones and functioned to define a planting area.

Figure 35. Site 30712 Feature 01, view to the southeast.

Figure 36. Site 30712 Feature 01 segment located on Parcel 030, view to the east.

Figure 37. Site 30712 Feature 01 push pile at existing driveway, view to the west.

Figure 38. Site 30712 Feature 02, view to the south.

Figure 39. Site30712 Feature 03 planting area, view to the south.

Figure 40. Site 30712 Feature 04 mounded southern end, view to the northwest.

Feature 05

Feature 05 is a mound (Figure 41) located roughly 2.3 meters east of the southern end of Feature 04 (see Figure 34). Feature 05 is constructed of small to large cobbles that have been loosely piled on the ground surface. It is roughly oval-shaped, with an overall length of 2.9 meters (northeast to southwest) and a width of 2.8 meters (northwest to southeast), with a maximum height of 77 centimeters. It is in good condition. No cultural material was observed in or around the feature The surrounding ground surface is level and clear of rock, suggesting that Feature 05 is an agricultural clearance mound.

Feature 06

Feature 06 is a mound (Figure 42) located approximately three meters southwest of Feature 05 (see Figure 34). The mound is constructed of small to large cobbles that have been loosely piled on ground surface. It is roughly oval-shaped and measures 2.3 meters long (east to west) by 2.2 meters wide (north to south) and has a maximum height of 70 centimeters. The mound is in good condition, with some collapse of its sides evident. No cultural material was observed in or around the feature. The surrounding terrain consists of relatively level soil areas and is clear of rock, suggesting that Feature 06 is an agricultural clearance mound.

Feature 07

Feature 07 is a low mound (Figure 43) located 3.4 meters southeast of Feature 06 (see Figure 34). Feature 07 is constructed of small to large cobbles that have been loosely piled on the ground surface. The mound is roughly rectangular in shape and measures 4.4 meters long (north to south) by 2.4 meters wide (east to west) with a maximum height of 70 centimeters. There is a 50-centimeter wide circular depression in the top of the mound (Figure 44). This depression may have been intentionally constructed, or it may have been formed by the roots of a plant growing in the mound. The surrounding ground surface is clear of rock and consists of open areas of soil. No cultural material was observed in or around the feature. The surrounding terrain consists of relatively level soil areas and is clear of rock, suggesting that Feature 07 is an agricultural clearance mound, or, if the depression in its top was intentional, a planting feature.

Figure 41. Site 30712 Feature 05 mound, view to the southeast.

Figure 42. Site 30712 Feature 06 mound, view to the northwest.

Figure 43. Site 30712 Feature 07 mound, view to the northwest.

Figure 44. Site 30712 Feature 07 depression in the top of the mound, view to the northwest.

Feature 08

Feature 08 is a low mound (Figure 45) located approximately 3.4 meters northwest of Feature 07 (see Figure 34). Feature 08 is constructed of small to large cobbles that have been loosely piled on ground surface. The mound is roughly oval-shaped and measures 2.6 meters long northeast to southwest by 2.2 meters wide northwest to southeast and has a maximum height of 63 centimeters. The mound is in fair condition. No cultural material was observed in or around the feature. The surrounding terrain consists of relatively level soil areas and is clear of rock, suggesting that Feature 08 is an agricultural clearance mound.

Feature 09

Feature 09 is a low rock mound (Figure 46) located approximately 1.2 meters west of Feature 08 (see Figure 34). Feature 09 is constructed of small to large cobbles that have been loosely piled on top of the ground surface (figure 1). It measures 2.2 meters in diameter and a maximum height of sixty centimeters. The mound is in poor condition due to a Ficus tree growing within it. No cultural material was observed in or around the feature. The surrounding terrain consists of relatively level soil areas and is clear of rock, suggesting that Feature 09 is an agricultural clearance mound.

Feature 10

Feature 10 is a rock wall (Figure 47) that extends roughly north to south to the east of Features 01 through 09 (see Figure 34). Its southern end abuts Feature 14. The wall is constructed of small boulders and small to large cobbles that have been loosely stacked on the ground surface. It measures approximately 70 meters long (north to south) and averages 1 meter wide, with heights ranging from 60 to 87 centimeters. The wall is in fair condition and has retained a good amount of its stacking. The terrain immediately surrounding the wall is clear of rock and consists of level soil areas. Its length, construction style, and location suggests that Feature 10 may have functioned as a field wall defining the eastern boundary of a small field system containing Features 01-09.

Figure 45. Site 30712 Feature 08 mound, view to the southwest.

Figure 46. Site 30712 Feature 09, view to the south.

Figure 47. Site 30712 Feature 10, view to the east.

Feature 11

Feature 11 (Figure 48) is a rock wall abutting Feature 10 and extending to the southeast across the study area boundary (see Figure 34). From its junction with Feature 10, the wall extends to the southeast for approximately 30 meters, where it crosses to the parcel boundary. On the adjacent parcel (Parcel 007), the wall continues for an additional 10 meters. At this point, the wall turns to the northeast and extends another 40 meters, at which point it terminates. A short (five meter) segment of wall extents to the southwest as well. The wall is constructed of small boulders and small to large cobbles that have been loosely stacked to a maximum height of 1.5 meters. It ranges in width from 1.4 to 2.0 meters. Feature 11 is in fair condition, having partially collapsed along its entire length. No cultural material was observed in or around the feature. The ground surface immediately surrounding the feature is clear or rock and consists of open areas of soil, suggesting that it may have functioned as a field boundary wall.

Feature 12

Feature 12 (Figure 49) is a modified depression located approximately five meters northeast of Feature 11 (see Figure 34). A natural bedrock depression has been modified by loosely stacking small to large cobbles around its perimeter, and by arranging cobbles inside the depression to divide it into five irregularly-shaped "cells" (Figure 50) The cells contain soil and a small amount of cobble-sized rubble. Feature 12 measures roughly eight meters long (northeast to southwest) and 5 meters wide (northwest to southeast). The cells average two meters wide and range in depth from 40 to 90 centimeters. A small bedrock overhang (see Figure 50) with a narrow opening is present along the southern edge of Feature 12, and extends beneath southern. The entrance to the overhang is roughly 70 centimeters tall and 60 centimeters wide. Inside the overhang is a chamber measuring 1.4 meters across, with a ceiling that stands two meters above its floor. The floor of the chamber is level, clear of rock, and contains a humus deposit estimated to be twenty centimeters deep. A second, smaller overhang (see Figure 50) is located on the western edge of the depression. The entrance to this overhang is 50 centimeters tall and 60 centimeters wide. Inside the overhang is a chamber measuring roughly 1.2 meters across with a ceiling that stands roughly 1 meter above its floor. The floor beneath this overhang is level, clear of rock, and contains less than ten centimeters of humus. No cultural material was observed in or around the depression, nor was any observed within the overhangs. Feature 12 is interpreted to be a planting feature.

Figure 48. Site 30712 Feature 11 (at right), view to the northeast.

Figure 49. Site 30712 Feature 12 modified depression, view to the east.

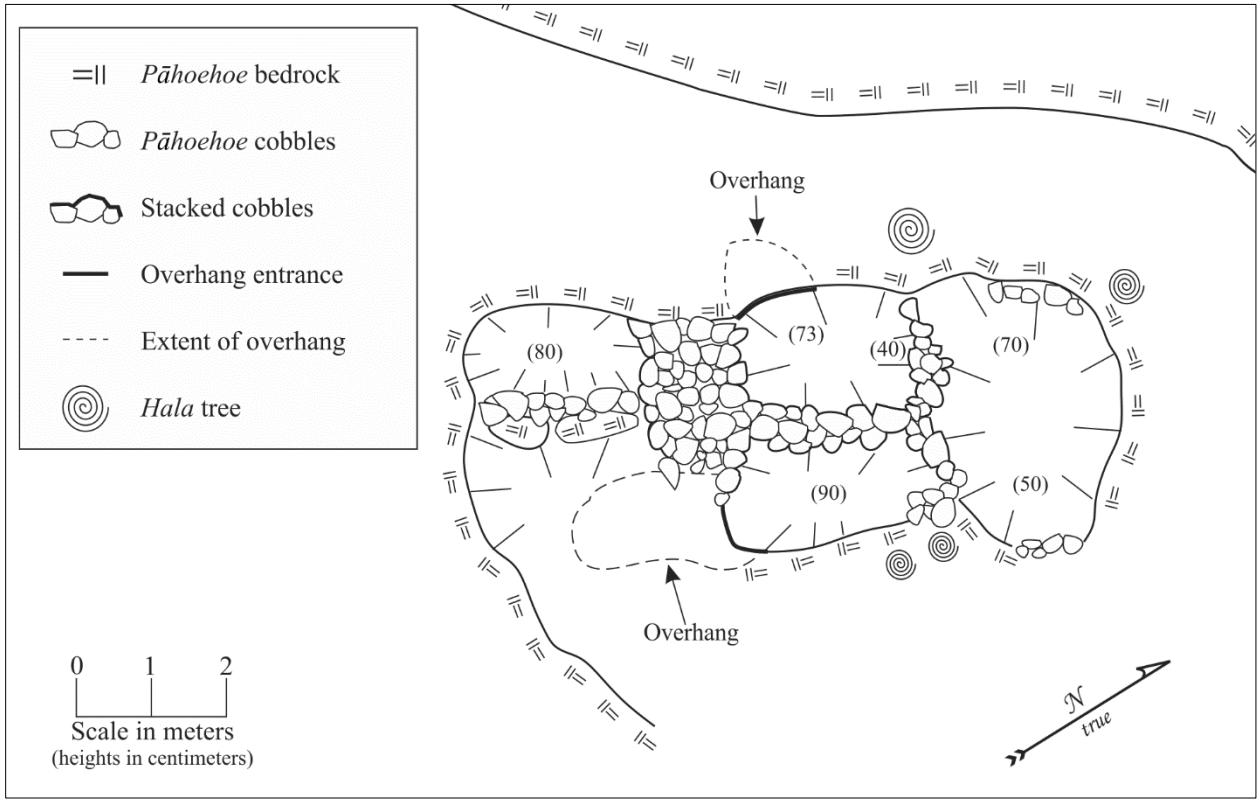


Figure 50. Site 30712 Feature 12 plan view.

Feature 13

Feature 13 is a mound (Figure 51) located in a cluster of agricultural features (Features 13 through 30) situated *mauka* of Features 1 and 11 near the center of the study area (see Figure 34). Feature 13 constructed of loosely piled small to large. It is roughly oval-shaped and measures 2.8 meters long (east to west) by 1.8 meters wide (north to south) with a maximum height of 90 centimeters. The surrounding terrain consists of relatively level soil areas and is clear of rock. No cultural material was observed in or around the feature. Feature 13 is interpreted to be an agricultural clearance mound.

Feature 14

Feature 14 is a low wall (Figure 52) that partially encloses an open soil area (see Figure 34). Feature 14's northern end adjoins Feature 10, from whence it extends toward the east for nine meters, then turns south for approximately seven meters, turns to the west for four meters, and then turns to the south for three meters and terminates at Feature 13. Feature 14 is constructed of small to large cobbles that have been loosely piled three to five stones high, although some portions of the wall consist only of a low soil berm. The wall's width ranges from 0.4 to 1.3 meters, and its height ranges from 30 to 90 centimeters. No cultural material was observed in or around the feature. Feature 14 is interpreted to be an agricultural boundary wall defining a planting area to its west.

Feature 15

Feature 15 is a wall (Figure 53) located among a cluster of agricultural features (Features 16, 17, 18, 19, 28, 29, and 30) near the center of the study area (see Figure 34). Feature 15 extends to the south from the southern corner of Feature 16 (a mound) for roughly eight meters, then turns to the southeast for five meters before terminating. It is constructed of loosely stacked small to large cobbles, ranging from 0.6 to 2.0 meters wide and from 60 to 90 centimeters tall. No cultural material was observed in or around the feature. Feature 15 appears to have functioned to define boundaries within the surrounding agricultural complex.

Figure 51. Site 30712 Feature 13 mound, view to the east.

Figure 52. Site 30712 Feature 14 low wall, view to the east.

Figure 53. Site 30712 Feature 15 wall, view to the east.

Feature 16

Feature 16 is a mound (Figure 54) constructed at the northern end of Feature 15 (Figure 34). Feature 16 is constructed of small to large cobbles that have been loosely piled along the end of Feature 15. The northern edge of the mound is stacked. The footprint of the mound is roughly rectangular and measures 2.9 meters long (north to south) by 1.8 meters wide (east to west), with a maximum height of 70 centimeters. No cultural material was observed in or around the feature. Feature 16 is interpreted to be an agricultural clearance mound.

Feature 17

Feature 17 is a mound (Figure 55) located immediately north of Feature 16 (see Figure 34). Feature 17 is constructed of loosely piled small to large cobbles. The footprint of the mound is roughly triangular in shape and measures 2.6 meters long (east to west) by 2.2 meters wide (north to south). The mound has a maximum height of 80 centimeters. No cultural material was observed in or around the feature. Feature 17 is interpreted to be an agricultural clearance mound.

Feature 18

Feature 18 is a mound (Figure 56) of small to large cobbles that have been loosely piled on top of the northern portion of Feature 19 (see Figure 34). Feature 18 measures 2.4 meters long (northeast to southwest) by 2.2 meters wide (northwest to southeast) with maximum height of 130 centimeters. No cultural material was observed in or around the feature. Feature 18 is interpreted to be an agricultural clearance mound.

Feature 19

Feature 19 is a wall (Figure 57) that partially encloses a roughly rectangular area of exposed soil (see Figure 34). Most of Feature 19 is constructed of loosely-piled small to large cobbles; however, some portions are little more than a low soil berm. Beginning at Feature 16, the wall extends to the southwest for 10 meters, then turns northwest for 7 meters, and then turns to the west for 8 meters before terminating. The wall measures 1.5 meters wide (north to south) with a maximum height of 70 centimeters. No cultural material was observed in or around the feature. Feature 19 is interpreted to be an agricultural boundary feature defining the adjacent planting area.

Figure 54. Site 30712 Feature 16 mound, view to the southwest.

Figure 55. Site 30712 Feature 17 mound, view to the south.

Figure 56. Site 30712 Feature 18 mound, view to the west.

Figure 57. Site 30712 Feature 19 wall, view to the northwest.

Feature 20

Feature 20 is a mound (Figure 55) located along the edge of a slightly raised section of bedrock outcrop roughly three meters south of Feature 19 (see Figure 34). Feature 20 is constructed of loosely-piled small boulders and small to large cobbles. Feature 20 measures 3.5 meters long (east to west) by1.3 meters wide (north to south), with a maximum height of 70 centimeters. No cultural material was observed in or around the feature. Feature 20 is interpreted to be an agricultural clearance mound.

Feature 21

Feature 21 is a mound (Figure 59) located one meter south of Feature 20 (see Figure 34). The mound is constructed of loosely-piled small to large cobbles. The mound measures 1.6 meters long (north to south) by 1 meter wide (east to west) with a maximum height of 60 centimeters. No cultural material was observed in or around the feature. Feature 21 is interpreted to be an agricultural clearance mound.

Feature 22

Feature 22 is a wall (Figure 60) that abuts the center of Feature 19 (see Figure 34). The wall is constructed of loosely-piled small to large cobbles. The wall extends toward the south from Feature 19 for approximately 15 meters, where it terminates at a slightly raised bedrock outcrop. Feature 22 has a maximum width of 1.2 meters and a maximum height of 75 centimeters. No cultural material was observed in or around the feature. The wall was likely constructed using stones cleared from the surrounding area and functioned to define a planting area within the larger agricultural complex.

Feature 23

Feature 23 is a wall (Figure 61) located southwest of Feature 21, extending between a mound (Feature 24) and a bedrock outcrop (see Figure 34). The wall is constructed of small to large cobbles that have been loosely stacked along the edge of an exposed bedrock outcrop. The wall is 15.0 meters long and ranges between 0.6 and 1.0 meters wide. It varies in height from 20 to 77 centimeters. It is in fair condition, in some places appearing only as a low soil berm. No cultural material was observed in or around the feature. Feature 23 was likely built with rocks cleared from adjacent planting area, and is interpreted to be an agricultural boundary wall.

Figure 58. Site 30712 Feature 20, view to the east.

Figure 59. Site 30712 Feature 21 mound, view to the northeast.

Figure 60. Site 30712 Feature 22 wall, view to the southeast.

Figure 61. Site 30712 Feature 23 wall, view to the southwest.

Feature 24

Feature 24 (Figure 62) is a mound located on a bedrock outcrop at the northern end of Feature 23 (see Figure 34). It is constructed of loosely-piled small to large cobbles. The mound is roughly triangular in footprint and measures 3.5 meters long (north to south) by 2.6 meters wide (east to west) and 1.1 meters tall. The southern side of the mound is partially collapsed. No cultural material was observed in or around the feature. Feature 24 is interpreted to be an agricultural clearance mound.

Feature 25

Feature 25 is a wall (Figure 63) that parallels the bulldozed access road approximately four meters west of Feature 23 (see Figure 34). The wall extends generally north/south. Its northern end terminates at feature 26 mound. The constructed segments of the wall consist of small to large cobbles that have been loosely stacked along a raised bedrock outcrop edge, and some portions of the wall are only bermed soil. The feature measures approximately 60 meters long (north to south) and ranges in width from 0.9 meters to 2.3 meters and in height from 60 to 190 centimeters. No cultural material was observed in or around the feature. Feature 25 was likely built with rocks cleared from surrounding planting areas, and functioned to define the boundary of those areas.

Feature 26

Feature 26 is a mound (Figure 64) located adjacent to, and just east of the bulldozed access road (see Figure 34). The mound is constructed of loosely-piled small to large cobbles and small boulders. It measures 4.8 meters long (east to west) by 3.4 meters wide (north to south), with a maximum height of 180 centimeters. No cultural material was observed in or around the feature. Feature 26 is interpreted to be an agricultural clearance mound.

Feature 27

Feature 27 (Figure 65) is a wall extending from Feature 26 to the bulldozed access road. It is constructed of stacked small to large cobbles. .The wall measures 10 meters long and ranges in width from 0.5 to 1.0 meters, with a maximum height of 60 centimeters. No cultural material was observed in or around the feature. The area immediately surrounding the wall is clear of rock and consists of open areas of soil. Feature 27 was likely built with rocks cleared from surrounding planting areas, and functioned to define the boundary of those areas

Figure 62. Site 30712 Feature 24 mound, view to the south.

Figure 63. Site 30712 Feature 25, view to the northwest.

Figure 64. Site 30712 Feature 26 mound, view to the northwest.

Figure 65. Site 30712 Feature 27 wall, view to the southeast.

Feature 28

Feature 28 is a wall (Figure 66) built along the edge of the level *pāhoehoe* area, south of Features 29 and 30 (see Figure 34). The wall extends roughly northeast to southwest for approximately 13 meters, and is constructed of loosely-piled small to large cobbles. The wall has maximum width of 0.7 meters and a maximum height of 38 centimeters. In concert with Feature 15, the wall partially encloses a planting area containing soil and two clearance mounds (Features 19 and 30). No cultural material was observed in or around the wall. Feature 28 was likely built with rocks cleared from the adjacent planting area, and functioned to define the boundary of those areas.

Feature 29

Feature 29 is mound (Figure 67) located approximately 2 meters west of Feature 28 (see Figure 34). The mound measures 2.5 meters long (northeast to southwest) and 1.3 meters wide (northwest to southeast) with a maximum height of 45 centimeters. It is constructed of very loosely piled cobbles, but appears to be in poor condition due to disturbance by the growth of strawberry guava trees. No cultural material was observed in or around the feature. Feature 29 is interpreted to be an agricultural clearance mound.

Feature 30

Feature 30 is a mound (Figure 68) located along the edge of a small outcrop 1.5 meters south from feature 29 (see Figure 34). It is constructed of loosely piled small to large cobbles. The mound measures 1.8 meters long (northeast to southwest) by 0.8 meters wide (northwest to southeast) with a maximum height of 46 centimeters. No cultural material was observed in or around the feature. Feature 30 is interpreted to be an agricultural clearance mound.

Figure 66. Site 30712 Feature 28 low wall, view to the southwest.

Figure 67. Site 30712 Feature 29 mound, view to the south.

Figure 68. Site 30712 Feature 30 mound, view to the south.

Feature 31

Feature 31 is a mound (Figure 69) located at the *makai* end of a cluster of agricultural features (Features 31 through 43) located between 75 and 150 meters *makai* of Old Government Road (see Figure 34). Feature 31 is constructed of small to medium-sized cobbles and measures 3.8 meters long, 3.4 meters wide, and 70 centimeters tall. The mound is in fair to good condition with minimal signs of collapse. No cultural material was observed in or around the feature. Feature 31 is interpreted to be an agricultural clearance mound.

Feature 32

Feature 32 is a mound (Figure 70) located five meters east of Feature 31 and three meters south of Feature 33 (see Figure 34). It is constructed of small cobbles and has a roughly circular foot print. The mound measures 1.0 meter in diameter and ranges from 30 to 50 centimeters tall. No cultural material was observed in or around the feature. Feature 32 is interpreted to be an agricultural clearance mound.

Feature 33

Feature 33 is a wall (Figure 71) located two meters north of Feature 32, adjacent to the existing driveway/access road (see Figure 34). The wall is constructed of small to large-sized cobbles and incorporates a portion of an exposed bedrock outcrop. The outcrop measures 5.2 meters long by 1.3 meters wide, and ranges from 80 to 100 centimeters tall. The wall is oriented roughly northeast/southwest and measures 8.9 meters long, 0.3 meters wide and 0.7 meters tall. The ends of the wall segment were truncated by the construction driveway/access road, and very likely connected to Feature 36 in the past. No cultural material was observed within or around the wall. Feature 33 is interpreted to be an agricultural boundary wall.

Feature 34

Feature 34 is a modified outcrop (Figure 72) situated two meters south of Feature 31 (see Figure 34). The modification consists of small to large cobbles stacked along the exposed southeastern edge of the outcrop. The feature measures 2.9 meters in diameter and 1.2 meters tall. No cultural material was observed in or around the feature. Feature 34 is interpreted to be an agricultural clearance feature.

Figure 69. Site 30712 Feature 31 mound, view to the northeast.

Figure 70. Site 30712 Feature 32 mound, view to the southwest.

Figure 71. Site 30712 Feature 33, mound (foreground) and wall (background), view to the northwest.

Figure 72. Site 30712 Feature 34 modified outcrop, view to the northeast.

Feature 35

Feature 35 is a wall segment (Figure 73) extending from southwestern end of the bedrock outcrop on which Feature 34 was built (see Figure 34). The wall is constructed of loosely stacked small to large cobbles, and measures roughly 12.3 meters long, 0.9 meters wide and 70 centimeters tall. It extends toward the northwest from the outcrop for 7.5 meters, then to the north for 4.8 meters. No cultural material was observed in or around the wall. Feature 35 is interpreted to be an agricultural boundary wall.

Feature 36

Feature 36 is a wall (Figure 74) located four meters west of Feature 35 and adjacent the existing driveway/access road (see Figure 34). It is constructed of loosely stacked small to large cobbles and is separated into two different sections by a modified outcrop (Feature 37). The eastern section of Feature 36 measures 5.2 meters long, 2.3 meters wide, and ranges from 60 centimeters to 90 centimeters tall. The western section measures 9.0 meters long, 2.3 meters wide, and ranges from 60 centimeters to 90 centimeters tall. Both sections of Feature 36 are partially collapsed. No cultural material was observed in or around the wall. Feature 36 is interpreted to be an agricultural boundary wall.

Feature 37

Feature 75 is a modified depression located adjacent to Feature 36 (see Figure 34). The depression is modified by the addition of a mound to its northwest edge. The mound measures approximately 4.3 meters long, 3.0 meters wide, and 110 centimeters tall. The interior of the depression consists of relatively level bedrock partially covered with leaf-litter and a thin accumulation of soil. The mound appears to have been constructed using rock removed from the floor of the depression. No cultural material was observed in or around the feature. Feature 37 is interpreted to be an agricultural planting feature.

Figure 73. Site 30712 Feature 35 wall remnant, view to the east.

Figure 74. Site 30712 Feature 36 partially-collapsed wall segment, view to the northwest.

Figure 75. Site 30712 Feature 37 modified depression, view to the northwest.

Feature 38

Feature 38 is a modified depression (Figure 76) located five meters southwest of Feature 37 (see Figure 34). The depression is modified by the addition of stacked cobbles along its western and eastern edges. The stacked cobbles extend for 7.0 meters and range from 20 to 170 centimeters tall. Along the eastern edge of the depression, the stacked cobbles extend for 3.0 meters and are 70 centimeters tall. The stacked cobbles appear to have been removed from the from the floor of the depression. No cultural material was observed in or around the feature. Feature 38 is interpreted to be an agricultural planting feature.

Feature 39

Feature 39 is a wall (Figures 77 and 78) adjacent to Feature 38 and paralleling Feature 40 (see Figure 34). It is constructed of loosely piled small to large cobbles and measures approximately 10.0 meters long, 1.3 meters wide, and 50 centimeters tall. Most of Feature 39 has been disturbed by with *hala*, *laua'e*, and strawberry-guava. No cultural material was observed in or around the feature. Feature 39 is interpreted to be agricultural boundary wall.

Feature 40

Feature 40 is a rock alignment (see Figure 78) located one meter to the southwest of Feature 39 (see Figure 34). It is constructed of small to medium cobbles ranging in size from 30 to 50 centimeters. The alignment parallels the southwestern end of Feature 39 for 10.2 meters, is interrupted by a four-meter gap, and then resumes for another 6.0 meters. No cultural material was observed in or around the feature. The function of Feature 40 is indeterminate. Its proximity to Feature 39 suggests that it may have defined a boundary between planting areas, while the space between the two features may have served as a walkway through the agricultural complex.

Figure 76. Site 30712 Feature 38 modified depression, view to the northwest.

Figure 77. Site 30712 Feature 39 northern termination of the wall, view to the southeast.

Figure 78. Site 30712 Features 39 (wall) and 40 (alignment), view to the southeast.

Feature 41

Feature 41 is a wall (Figure 79) located three meters south of Feature 35 (see Figure 34). It is constructed of stacked small to large cobbles, incorporating exposed bedrock in some places. The wall measures approximately 41 meters long and ranges from 0.7 meters to 1.0 meter wide and 50 to 120 centimeters tall. The wall's condition varies from good to fair, with some portions disturbed by *lau hala*, *laua'e* and strawberry-guava growth. No cultural material was observed in or around the feature Feature 41 is interpreted to be an agricultural boundary wall.

Feature 42

Feature 42 is a modified depression (Figure 80) located at the southern end of Feature 42 (see Figure 34). The depression measures 5.8 meters by 2.3 meters and is modified by the addition of small to large cobbles stacked sporadically along its perimeter. Where they are present, the cobbles are stacked a maximum of 0.6 meters wide and 50 centimeters tall. The depression floor is cleared of rock and is covered with soil. No cultural material was observed in or around the feature. Feature 42 is interpreted to be a planting feature.

Feature 43

Feature 43 is a modified outcrop (Figure 81) located immediately southwest of Feature 42 (see Figure 34). The modifications consist of the addition of small to large stacked cobbles interspersed with exposed bedrock that enclose a 14 meter by 9 meter area. Within this area, the ground surface is relatively level and soil-rich. The stacked cobbles appear to have been removed from the from the floor of the depression. No cultural material was observed in or around the feature. Feature 43 is interpreted to be an agricultural planting feature.

Figure 79. Site 30712 Feature 41 wall, view to the southwest.

Figure 80. Site 30712 Feature 42 modified depression, view to the south/southeast.

Figure 81. Site 30712 Feature 43, modified outcrop, view to the northeast.

Feature 44

Feature 44 is a modified depression (Figure 82) located within a cluster of agricultural features (Features 44 through 52) situated at the *mauka* end of the study area (see Figure 34). The depression measures 8.8 meters by 4.2 meters. The modifications consist of an alignment of small cobbles intermittently spaced along the western edge of the depression. The ground surface within the depression consists of organic debris, exposed bedrock, and some soil accumulation. The cobbles in the alignment appear to have been removed from the floor of the depression. No cultural material was observed in or around the feature. Feature 43 is interpreted to be an agricultural planting feature.

Feature 45

Feature 45 is a modified depression (Figure 82) with a small overhang located twelve meters northwest of Feature 44 (see Figure 34). The depression measures approximately 2.4 meters in diameter and 80 meters deep. The depression has been modified by the removal of rock from its interior to expose soil. The overhang (Figure 80) measures 80 centimeters tall and roughly 2.0 meters long. The overhang was thoroughly inspected for cultural material, and no cultural material was observed in or around the feature. Based on the presence of soil and the proximity to agricultural features, Feature 45 is interpreted to have probably been used as a planting feature.

Feature 46

Feature 46 is a wall remnant (Figure 84) situated three meters northwest of Feature 45 (see Figure 34). This mostly collapsed wall segment is oriented northeast-southwest and is composed of small to medium cobbles. It measures roughly 1.9 meters long, 0.8 meters wide, and 30 centimeters tall. No cultural material was observed in or around the feature. Feature 47 was likely a part of an agricultural boundary wall.

Figure 82. Site 30712 Feature 44 modified depression, view to the south.

Figure 83. Site 30712 Feature 45 modified sink, view to the south.

Figure 84. Site 30712 Feature 46 wall remnant, view to the northeast.

Feature 47

Feature 47 is a modified outcrop and enclosed soil area (Figure 85) located roughly eight meters north of Feature 46 (see Figure 34). The outcrop is modified by the addition of medium to large cobbles stacked along its edge. The cobble stacking measures approximately 2.1 meters long and 8 centimeters tall. The soil area enclosed by the modified outcrop is relatively level and cleared of rock, and measures 18 meters by 7 meters. The stacked cobbles appear to have been removed from level soil area. No cultural material was observed in or around the feature. Feature 47 is interpreted to be a planting area.

Feature 48

Feature 48 is a wall (Figure 86) extending to the northeast from Feature 47 (see Figure 34). It was constructed with small to medium-sized cobbles and incorporates exposed bedrock. The wall measures roughly 36 meters long, 0.5 meters wide, and 110 centimeters tall. The wall is partially collapsed along its entire length. No cultural material was observed in or near the feature. Feature 49 is interpreted to be an agricultural boundary wall.

Feature 49

Feature 49 is a modified outcrop and level soil area (Figure 87) situated roughly five meters southwest of Feature 47 (see Figure 34). The level soil area measures roughly 12 meters by 8 meters. The outcrop borders the soil area on its north and west. It has been modified by the addition of an alignment of loosely-spaced small to medium cobbles measuring 4.7 meters long, 1.0 meter wide, and 30 centimeters tall. No cultural material was observed in or around the feature. Feature 49 is interpreted to be a planting area.

Feature 50

Feature 50 is a modified depression (Figure 88) located roughly two meters south of Feature 49 (see Figure 34). The depression measures roughly 8.0 meters long, 4.0 meters wide, and 30 centimeters deep. It has been modified by the addition of cobbles loosely stacked along the surrounding exposed bedrock. The stacked cobbles appear to have been removed from the floor of the depression, which has a thin covering of soil. No cultural material was observed in or around the feature. Feature 50 is interpreted to be a planting area.

Figure 85. Site 30712 Feature 47, enclosed soil area, view to the northeast.

Figure 86. Site 30712 Feature 48 wall, view to the southwest.

Figure 87. Site 30712 Feature 49 cobble alignment on outcrop, view to the northeast.

Figure 88. Site 30712 Feature 50 modified depression, view to the west.

Feature 51

Feature 51 is a modified depression (Figure 89) situated 10 meters southeast of Feature 50 (see Figure 34). The depression measures roughly 1.0 meter long, 0.5 meters wide, and 0.6 meters tall. The western and southern edges of the depression are defined by a roughly one-meter tall bedrock outcrop. The depression has been modified by placing cobbles extracted from its floor onto a small area (2.5-meters by 2-meters) on the bedrock outcrop. No cultural material was observed in or around the feature. Based on its morphology, the presence of soil in the depression, and its proximity to other planting features, Feature 51 is interpreted to be a planting area.

Feature 52

Feature 52 is a modified outcrop (Figure 90) located 14 meters south of Feature 44 (see Figure 34). The area of modification consists of a single course alignment comprised of small to medium-sized cobbles on top of a bedrock outcrop that measures 4.4 meters long and 0.8 meters tall. Observed roughly one meter east of the single course alignment is another bedrock outcrop however no modifications were observed. The modified and the unmodified bedrock outcrops form a drainage that extends to the northeast/southwest for an unknown distance. Currently, the modified area is overgrown by *lau hala* and strawberry-guava trees. Based on the morphology of the outcrops and the presence of soil, Feature 54 may have functioned as a constructed drainage area or was utilized as a planting area.

Feature 53

Feature 53 is a wall (Figure 91) enclosing a large area containing a *hala* grove eight meters southwest of Feature 01 among a cluster of agricultural features (Features 53 through 61 and Feature 64) (see Figure 34). The wall crosses the northern boundary of the current study area, and about half of the area it encloses is in Parcel 030. The wall is constructed with stacked small to medium cobbles and measures 105.0 meters long, 0.9 meters wide, and ranges from 30 to 80 centimeters tall. In general, the wall is in fair condition (Figure 88), with several sections having partially collapsed. No cultural material was observed in or around the feature. Feature 53 is interpreted to be an agricultural boundary wall.

Figure 89. Site 30712 Feature 51 modified depression, view to the east.

Figure 90. Site 30712 Feature 52 modified outcrop, view to the northwest.

Figure 91. Site 30712 Feature 53 wall encompassing a *hala* grove, view to the northwest.

Feature 54

Feature 54 is a mound (Figure 93) located within the *hala* grove enclosed by Feature 53 (see Figure 34). It is constructed of loosely piled small to medium cobbles. The mound measures roughly 4.5 meters long, 2.8 meters wide, and 130 centimeters tall. Feature 57 is in fair condition, with two *Ficus* trees growing out of it. No cultural material was observed in or around the feature. Feature 57 was most likely created as a clearing mound within the larger planting area defined by Feature 53.

Feature 55

Feature 55 is a wall (Figure 94) that abuts the northwestern end of Feature 53 (see Figure 34). It is constructed of stacked medium to large cobbles. The wall measures 0.9 meters wide and 70 to 110 centimeters tall, and is "L" shaped, measuring 14.0 meters long along its east-west oriented segment and 6.0 meters long on its north-south oriented segment. No cultural material was observed in or around the feature. Feature 55 is interpreted to be an agricultural boundary wall partially enclosing the large planting area in concert with Feature 53.

Feature 56

Feature 56 is a cluster of *pāhoehoe* excavations (Figure 95) and a modified bedrock fissure located on an outcrop southeast of Feature 55 (see Figure 34). The feature occupies a 14-meter by 38-meter area. There are fourteen small *pāhoehoe* excavations created by removing small to large cobble-sized pieces of broken bedrock from the outcrop. The bedrock pieces that were removed are placed around the edges of the excavations (Figure 96). The excavations (Figures 97 and 98) range in diameter from 0.3 to 1.6 meters and are 10 to 30 centimeters deep. The floors of the excavations contain thin layers of soil beneath leaf litter and humus. The bedrock fissure (Figure 99) is situated two meters northeast of Feature 63 and measures approximately 9.7 meters long, one meter wide, and from 60 to 200 centimeters deep. A five meter long portion of its northeastern end is filled with large cobbles. The edges of the shallower portions of the fissure have been modified by the addition of an intermittent cobble alignment. The floor of the fissure contains of some accumulated soil, leaf litter, and humus. No cultural material was observed in or around any of the *pāhoehoe* excavations or the fissure. Feature 56 is interpreted to be a collection of planting features.

Figure 92. Site 30712 Feature 53 wall, view to the south.

Figure 93. Site 30712 Feature 54 mound within the *hala* grove enclosed by Feature 53, view to the northeast.

Figure 94. Site 30712 Feature 55 wall enclosing the *hala* grove (foreground), view to the south.

Figure 95. Site 30712 Feature 56 *pāhoehoe* excavations, view to the east.

Figure 96. Site 30712 Feature 56 detail of small *pāhoehoe* excavation, view to the southeast.

Figure 97. Site 30712 Feature 56 *pāhoehoe* excavation, view to the northwest.

Figure 98. Site 30712 Feature 56 *pāhoehoe* excavation, view to the southwest.

Figure 99. Site 30712 Feature 56 fissure, view to the northwest.

Feature 57

Feature 57 is a wall (Figure 100) that partially encloses a level soil area (Feature 59) southwest of Feature 56 (see Figure 34). The wall is constructed as intermittent three- to five-meter-long segments of stacked small to large cobbles and boulders, and incorporates bedrock outcrops between the stacked segments. Feature 57 measures roughly 48 meters long, 0.8 meters wide, and 60 to 100 centimeters tall. Several of the stacked sections of Feature 57 are partially collapsed while a few remain intact. No cultural material was observed in or around the feature. Feature 57 most likely functioned as an agricultural boundary wall which defined the planting area recorded below as Feature 59.

Feature 58

Feature 58 is a wall remnant (Figure 101) located along the northern end of a level soil area (Feature 59), crossing the boundary between the study area and Parcel 030 (see Figure 34). The feature measures 0.3 meters wide and 10 centimeters tall, and of its approximately 14 meter length, only 1.0 meter of the wall is within the study area. The wall is in poor condition and has mostly collapsed. No cultural material was observed in or around the feature. Feature 58 most likely functioned as an agricultural boundary wall which defined the planting area recorded below as Feature 59.

Feature 59

Feature 59 is a soil-rich area likely used in the past as a planting area (Figure 102) that is enclosed by bedrock ouctrops on its east and west sides and by Features 57 and 58 on its north and south (see Figure 34). The soil area measures 15 meters by 17 meters and has a relatively level ground surface covered with soil. It is likely that rocks were cleared from this area and used to build Features 57, 58, and other nearby features. No cultural material was observed in or around the feature. Feature 59 is interpreted to be a planting area.

Feature 60

Feature 60 is a mound (Figure 103) located on the bedrock above the western side of Feature 59 (see Figure 34). It is constructed of loosely stacked small to medium cobbles and measures roughly 6.0 meters long, 5.0 meters wide, and 100 centimeters tall. No cultural material was observed in or around the feature. Feature 60 is interpreted to be an agricultural clearing mound.

Feature 61

Feature 61 is a wall remnant (Figure 104) that extends to the northwest from Feature 59 toward the study area boundary (see Figure 34). It is constructed of small cobbles and measures approximately 4.0 meters long and 20 to 60 centimeters tall. Feature 61 is in poor condition due to disturbance by *hala* and strawberry-guava roots. No cultural material was observed in or around the feature. Feature 61 is interpreted to be a remnant of an agricultural boundary wall.

Feature 62

Feature 62 is a mound (Figure 105) located approximately fourteen meters northwest of Feature 38 along the study area boundary (see Figure 34). It is constructed of loosely stacked small to medium cobbles on exposed bedrock. The mound measures 1.6 meters in diameter and 50 centimeters tall. No cultural material was observed in or around the feature. Feature 62 is interpreted to be an agricultural clearing mound.

Feature 63

Feature 63 is a mound (Figure 106) located at the southwestern end of Feature 56 (see Figure 34). It is constructed of loosely piled small to large cobbles and measures 6.2 meters long, 5.1 meters wide, and 160 centimeters tall. Observed on the surface of the mound was a pit that measures one meter in diameter and is 0.2 meters deep. For the most part, the mound is in fair condition but is overgrown with strawberry-guava. Based on its attributes and the presence of soil as well as its proximity to Feature 59, Feature 66 was most likely created as a clearing and/or planting mound.

Figure 100. Site 30712 Feature 57, wall enclosing Feature 59, view to the southwest.

Figure 101. Site 30712 Feature 58 wall remnant, view to the north.

Figure 102. Site 30712 Feature 59, overview of enclosed soil-rich area, view to the east/southeast.

Figure 103. Site 30712 Feature 60, overgrown cobble mound, view to the northeast.

Figure 104. Site 30712 Feature 61 wall, view to the southwest.

Figure 105. Site 30712 Feature 62, overgrown cobble mound, view to the west/northwest.

Figure 106. Site 30712 Feature 63, view to the south/southeast.

Test Trench 1

Test Trench 1 (TT-1) was excavated to test whether a line of cobbles (see Figure 34) visible *mauka* of the shoreline in the study area was a portion of Site 18418A, the coastal trail documented previously by Charvet-Pond and Rosendahl (1993) and by Rechtman and Dircks (2013).

During the fieldwork for the current study, an attempt was made to follow the trail from Parcel 029 (north of the current study area), across Parcel 030 (adjacent to the current study area), and into the current study area. Although the trail is visible on Parcel 029 (Figure 107, see Figure 31), on Parcel 030 it is obscured by vegetation and leaf litter. Approximately 30 meters from Parcel 030's northern boundary, the ground surface becomes heavily disturbed by *hala* roots, and the *pāhoehoe* bedrock begins to undulate rather steeply. Beyond this point, no surface indications of the trail were observed.

To estimate where the trail could be expected to cross the current study area, the alignment of the trail (as it appears on Parcel 029) was projected in a straight line across the current study area. This projected alignment crossed the extreme *makai* portion of the current study area, on the *pāhoehoe* sea cliffs. No constructed features or worn footpath was observed along this alignment. *Mauka* of the projected alignment, a roughly linear concentration of cobbles and small boulders (Figure 108) was observed just *mauka* of the beginning of the wedelia ground cover (see Figure 34), which approximates the shoreline of the parcel. The concentration is oriented roughly parallel to the coastal cliff and contains waterworn stones with relatively flat surfaces resembling those found in Site 18481A. Although similar stones deposited by storm surge are present throughout this portion of the study area, the linear configuration and proximity of the stones to the projected trail alignment warranted subsurface testing to determine if they were in fact part of Site 18418A.

Figure 107. Site 18418A, located on Parcel 029, view to the west/northwest.

Figure 108. Exposed cobbles located along the projected alignment of the trail, view to the northwest.

To test this hypothesis, Test Trench 1 (TT-1) (Figure 109) was excavated twenty meters southeast of the exposed linear concentration of stones described above (see Figure 34). Test Trench 1 was initially excavated as 0.5 meter by 5.0 meter trench oriented perpendicular to and centered on the projected alignment of the linear concentration of stones. Vegetation was cleared from the surface of the test trench by hand, exposing a 0-30 centimeter thick layer of humus (Layer I) and root mat overlying bedrock. A thin (2 to 6 cm) layer of 10YR 2/1 Black fine sandy silt with a high organic content and abundant rootlets (Layer II) was present in pockets within the bedrock. No cultural material was observed in Layers I or II. At the *mauka* end of TT-1, two waterworn boulders were observed resting on bedrock. To assess whether these small boulders could be part of Site 18418A, TT-1 was expanded by adding two successive one-meter by one-meter extensions to the western side of the *mauka* end of the trench. Within the extensions, one more small waterworn boulder, apparently broken by impact with the bedrock, and one small subangular boulder were observed resting directly on bedrock (Figures 110 and 111). The bedrock itself was broken by ironwood tree roots.

No stacking or piling of stone was observed within TT-1. The presence of the few small boulders observed in the *mauka* end of the test trench is best explained as a result of storm surge. This same explanation applies to the linear concentration of stones described above. Thus, the results of Test Trench 1 indicate that the linear concentration of stones observed in the wedelia are a natural phenomenon, and are not a remnant portion of Site 18481A. The implication of these results is that the trail traversed the current study area *makai* of the line of ironwood trees, on the *pāhoehoe* sea cliff. Two possible explanations for the absence of constructed trail elements in the study area may be surmised. It is possible that the trail was located on portions of the sea cliff that have since collapsed into the ocean. Alternatively, the relatively smooth and easily traversed sea cliffs in the current study area did not require significant alteration to be used as a trail, and therefore no trail segment was ever built.

Figure 109. Surface of TT-1 stripped of vegetation, view to the northwest.

Figure 110. Base of expanded TT-1 excavation with waterworn boulders (inside string) resting on bedrock, view to the south.

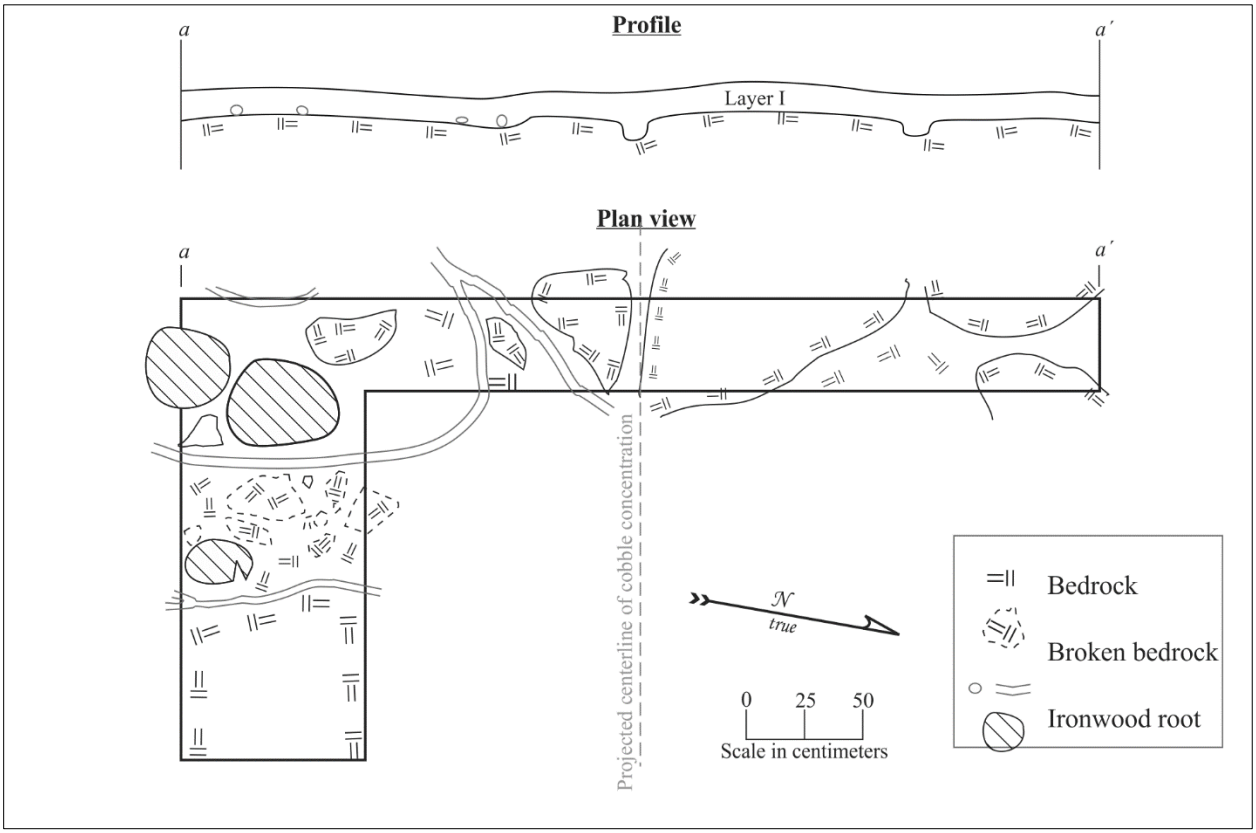


Figure 111. Test Trench 1 plan view.

SUMMARY AND DISCUSSION

The type and distribution of archaeological features within the current study area indicates that this particular portion of the Maku‘u-Pōpōkī-Hālona area was exclusively used for agricultural production. The sixty-three features of Site 30712 generally consist of modifications to, within, or near the soil-filled depressions that occur naturally across the project area (see Figure 34). Ethnohistorical documentation reveals that planting within the low-lying, soil-filled depressions was common in this general region of the Puna District during the Precontact and early Historic Periods. One method of planting described by Handy and Handy (1991) was the *pa-hala* method used for the cultivation of taro, but similar methods could also be applied to other crops. The *pa-hala* method involved excavating holes in *‘a‘ā* lava within a *hala* grove, mulching them with weeds, planting taro cuttings wrapped in *hala* leaves in them, and then covering the holes with *hala* leaves. The leaves were later burned to provide the plant with nourishment (Handy and Handy 1991). Although no *‘a‘ā* lava is present within the current project area, *hala* trees certainly are, and it is easy to envision a similar planting method being employed at the natural, soil filled depressions within the *pāhoehoe* lava.

The current study is the sixth inventory-level survey conducted to date in coastal Maku‘u-Pōpōkī-Hālona (that is, on parcels *makai* and immediately *mauka* of Government Beach Road.) Although the parcels inventoried exhibited varying levels of disturbance, the results of these surveys nonetheless provide a sampling of archaeological features that can be synthesized to build on Ewart and Luscomb’s (1974) initial reconnaissance to create a more complete picture of how the dispersed settlement at Maku‘u was organized. To date, a grand total of 325 archaeological features have been recorded in the coastal Maku‘u area. These features include 192 agricultural features (Table 3), primarily mounds (n=66), walls, (n=65), modified depressions (n=52), terraces (n=41), and modified outcrops (n=32). Non-agricultural features are much less prevalent. Only sixty-one non-agricultural features (Table 4) have been recorded. Of these, forty are associated with habitation, and include walls (n=17), enclosures (n= 8), pavements (n=7), terraces (n=6) and platforms (n=2). The number of ceremonial features is very small at the coast, consisting of only one *heiau* and one petroglyph field (which was located outside of the Clark et al. (2008) study area.). Nine burials were recorded within these parcels as well. The remaining non-agricultural features include boundary and livestock control walls, cairn, a water collection feature, and remnants of a coastal trail (Site 18418A).

As with the current study area, the distribution of agricultural and other features in the coastal Maku‘u-Pōpōkī-Hālona area is clearly a function of the potential of the terrain to capture soil and/or humus created by composting leaf litter and other plant materials (using the *pa-hala* method described by Handy and Handy (1991)). This interpretation is bolstered in the current study area by the lack of agricultural features on the more recently-deposited *pāhoehoe* bedrock (part of the A.D. 1410 lava flow) located in the southeastern portion of the study area. Taken together, the patterning of archaeological features corroborates ethnohistoric accounts of Maku‘u Village as a dispersed coastal settlement surrounded by opportunistic agricultural land use. In the 73.4 acres that have been inventoried in the overall Maku‘u area, the average density of agricultural features recorded to date is 18.9 features per acre, compared to an average of 2.86 habitation features per acre. These figures, of course, are skewed by the nearly complete disturbance observed in the Dircks Ah Sam and Rechtman (2013) study area, and the density of each of these in the past were undoubtedly greater, but similar to that observed by the other studies.

Table3. Summary of agricultural features recorded in coastal Maku‘u-Pōpōkī-Hālona.

Study	*Mounds*	*Modified Depressions*	*Modified Outcrops*	*Terraces*	*Enclosure*	*Planting area*	*Wall*
Barrera and Lerer (1990)*	28	1	-	18	-	2	24
Charvet-Pond and Rosendahl (1993)	7	1	13	4	-	-	-
Clark et al. (2007)	6	31	5	1	1	-	-
Clark et al. (2008)	2	11	11	17	-	-	16
Dircks Ah Sam and Rechtman (2013)**	-	-	-	-	-	-	-
Current study area	22	8	3	-	-	5	24

* Includes subsequent data recovery by Chafee and Spear (1993) and Spear et al. (1995).
** Parcel heavily disturbed

Table4. Summary of non-agricultural features recorded in coastal Maku'u-Pōpōkī-Hālona.

Study	*Habitation*	*Ceremonial*	*Burial*	*Trails and cairns*	*Water collection*	*Livestock control*	*Boundary wall*
Barrera and Lerer 1990*	4	1	4	-	-	-	-
Charvet-Pond and Rosendahl 1993	9	-	-	1	-	2	-
Clark et al. 2007	17	-	1	1	1	-	-
Clark et al. 2008	8	-	4	-	1	-	1
Dircks Ah Sam and Rechtman 2013**	-	-	-	-	-	-	1
Current study area	-	-	-	-	-	-	-

* Includes subsequent data recovery by Chafee and Spear (1993) and Spear et al. (1995).
** Parcel heavily disturbed

With respect to Site 18418A, no evidence of the trail was observed in the current study area. Targeted subsurface testing of a projected trail alignment extrapolated from a nearby linear collection of stones returned negative results. The trail most likely crossed onto the *pāhoehoe* sea cliffs while still on Parcel 030 (immediately adjacent to the current study area to the north), and proceeded along the sea cliff through the current study area. This alignment would have required minimal construction effort and would not have interfered with the agricultural plots located *mauka* of the cliffs. While no direct evidence of the trail was observed during the current study, the current TMK base map appears to have such a trail alignment depicted as a dotted line (Figure 112) proceeding along the coast. Some portions of the coastal cliff, including portions in the current study area, are known to have collapsed during the past century. It is therefore also possible that some of the trail is no longer physically present in the current study area, having fallen into the ocean. With respect to the trail alignment inferred from the TMK map, the entirety of this alignment is located along the shoreline, *makai* of the current study parcel boundary, and thus will not be affected by any future construction activities on the parcel.

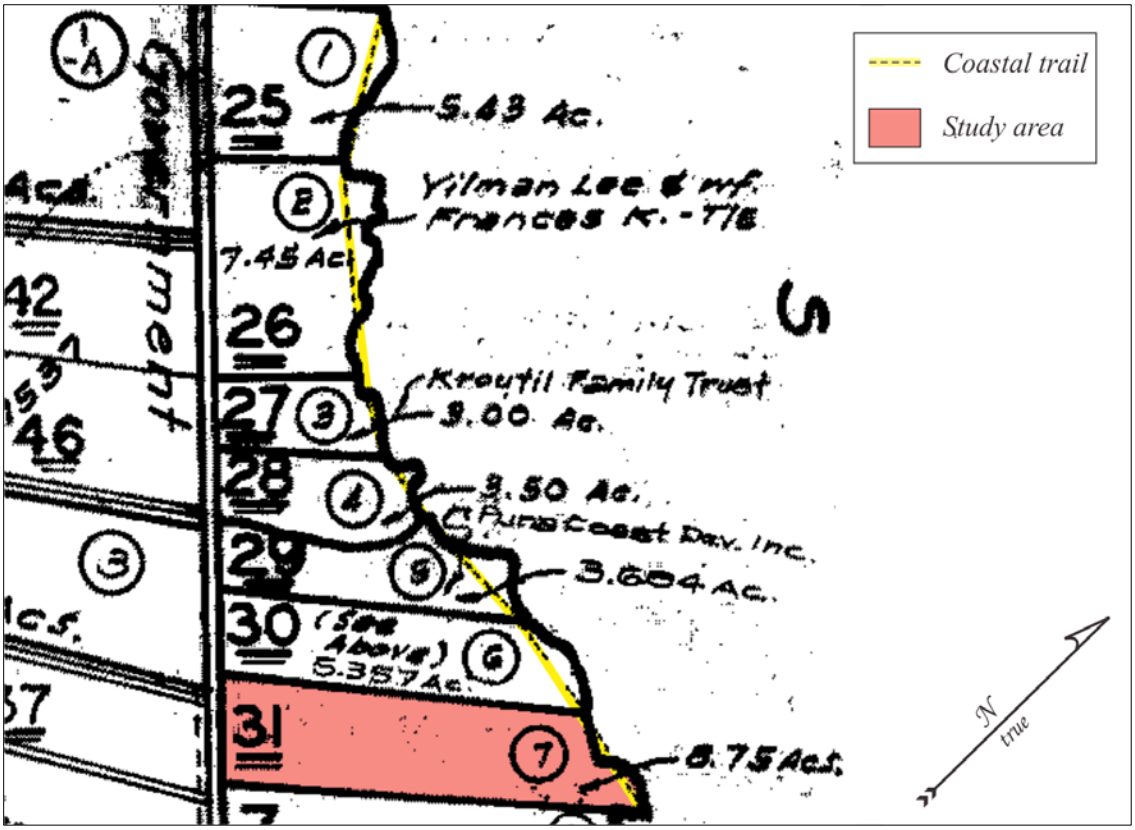


Figure 112. Portion of TMK Plat (3) 1-5-010 indicating the location of a coastal trail.

5. SIGNIFICANCE EVALUATION AND TREATMENT RECOMMENDATION

The recorded archaeological site is assessed for its significance based on criteria established and promoted by the DLNR-SHPD and contained in the Hawai‘i Administrative Rules 13§13-284-6. For a resource to be considered significant it must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

a Be associated with events that have made an important contribution to the broad patterns of our history;

b Be associated with the lives of persons important in our past;

c Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;

d Have yielded, or is likely to yield, information important for research on prehistory or history;

e Have an important traditional cultural value to the native Hawaiian people or to another ethnic group of the state due to associations with traditional 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.

The significance and recommended treatment for the single recorded site is presented in Table 2 and discussed below.

Table5. Site significance and treatment recommendation.

Site #	*Site Type*	*Temporal Affiliation*	*Significance*	*Recommended Treatment*
50-10-45-30712	Agricultural complex	Precontact/Early historic	d	No further work

Based on the results of the current study, Site 30712 is assessed to be historically significant under Criterion d for the information yielded relative to the type and extent of agricultural features in the Maku‘u-Pōpōki-Hālona area. It is argued that the current study has been sufficient to fully document Site 30712 and to exhaust its potential to yield further information important for research on prehistory or history. Therefore, no further historic preservation work is recommended for the site. Additionally, it is the landowner's intention to avoid disturbing the archaeological features during future construction activities, and to incorporate these features without modification into any proposed landscaping.

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APPENDIX A

Transcription of Original

No. 1537, Kapohano, Halona & Popoki Ahupuaa, District of Puna, Island of Hawaii, Vol. 8, pps. 237-238

Helu 1537

Palapala Sila Nui

Ma keia palapala sila nui ke hoike nei o Kamehameha III, ke Alii nui a ke Akua i kona lokomaikai i hoonoho ai maluna o ko Hawaii Pae Aina, i na kanaka a pau, i keia la, nona iho; a no kona mau hope alii, ua haawi lilo loa aku oia ma ko ano alodio ia Kapohano i kona wahi kanaka i manao pono ia ia i kela apana aina a pau e waiho la, ma Halona a me Popoki, Puna ma ka Mokupuni o Hawaii, a penei hoi ka waiho ana o na Mokuna,

E hoomaka ana keia ma kahakai ma ke kihi Akau o keia e pili ana me ka aina o Kea, a e holo ana ma ia aina

Hema 39 1/2° Komohana 24.48 Kaulahao a hiki ma kahi kumu niu, alaila

Hema 37° Komohana 9.40 Kaulahao a hiki ma kahi kumu ulu, alaila

Hema 41 1/2° Hikina 32.24 Kaulahao a hiki ma kahi ahupohaku, alaila

Akau 56 1/2° Hikina 35.20 Kaulahao a hiki ma ke alanui Aupuni, alaila

Akau 37 1/2° Hikina 20.00 Kaulahao a hiki ma kahakai alaila ma kahakai a hiki ma kahi i hoomaka'i.

[page 238]

A maloko o ia Apana 171.00 eka a oi iki aku, emi iki mai paha.

Eia ke kumu o ka lilo ana; ua haawi mai oia iloko o ka waihona waiwai o ke Aupuni i na dala he $52.75. Aka, ua koe i ke Aupuni na mine minerale a me na mine metala a pau.

No Kapohano, ua aina la i haawiia, nona mau loa aku no, ma ke ano alodio, a me kona mau hooilina, a me kona waihona, ua pili nae ka auhau a ka Poe Ahaolelo e kau like ai ma na aina alodio a pau i kela manawa i keia manawa.

A i mea e ikea'i ua kau i ko'u inoa, a me ka sila nui o ko Hawaii Pae Aina ma Honolulu i keia la 20 o Ianuali, 1855.

Inoa}

Kamehameha IV

V.K. Kaahumanu

Keoni Ana

[Land Patent Grant No. 1537, Kapohano, Halona & Popoki Ahupuaa, District of Puna, Island of Hawaii, 171 Acres, 1855]

Translation

No. 1537, Kapohano, Hālona & Pōpoki Ahupua‘a, District of Puna, Island of Hawai‘i, Vol. 8, pps. 237-238

Number 1537

Great Seal Document

In this Great Seal Document, Kamehameha III, the High Chief of God whose blessings are upon the Hawaiian Island Chain, is showing to all people today, for himself and for his lesser chiefs, that he has given an Alodial title to Kapohano his settlement that he rightly thinks to leave in the land section's entirety, in Hālona and Pōpoki, Puna on the island of Hawai‘i, and this is how the boundaries are being put down,

It is starting at the shore at the North extremity adjoining the land of Kea, and it is proceeding along this land

South 39 ½ degrees West 24.48 chains to a coconut tree, then

South 37 degrees West 9.40 chains to a breadfruit tree, then

South 41 ½ degrees East 32.24 chains to a rock mound, then

North 56 ½ degrees East 35.20 chains to the government road, then

North 37 ½ degrees East 20.00 chains to the shore and along the shore to the place of commencement.

[page 238]

This land parcel contains 171.00 acres, give or take.

This is the source of its accruement; he gave $52.75 to the Government Treasury, but, in addition, the Government received all the mineral and metal mines.

This land was given to Kapohano, his forever, as an alodium, and to his recipients as well as his savings, and taxes were placed on all Alodial titles by those of the Legislature from that time until now.

And for reasons of presentation I have placed my name as well as the seal of the Hawaiian Island Chain in Honolulu on this day, the 20th of January, 1855.

Name}

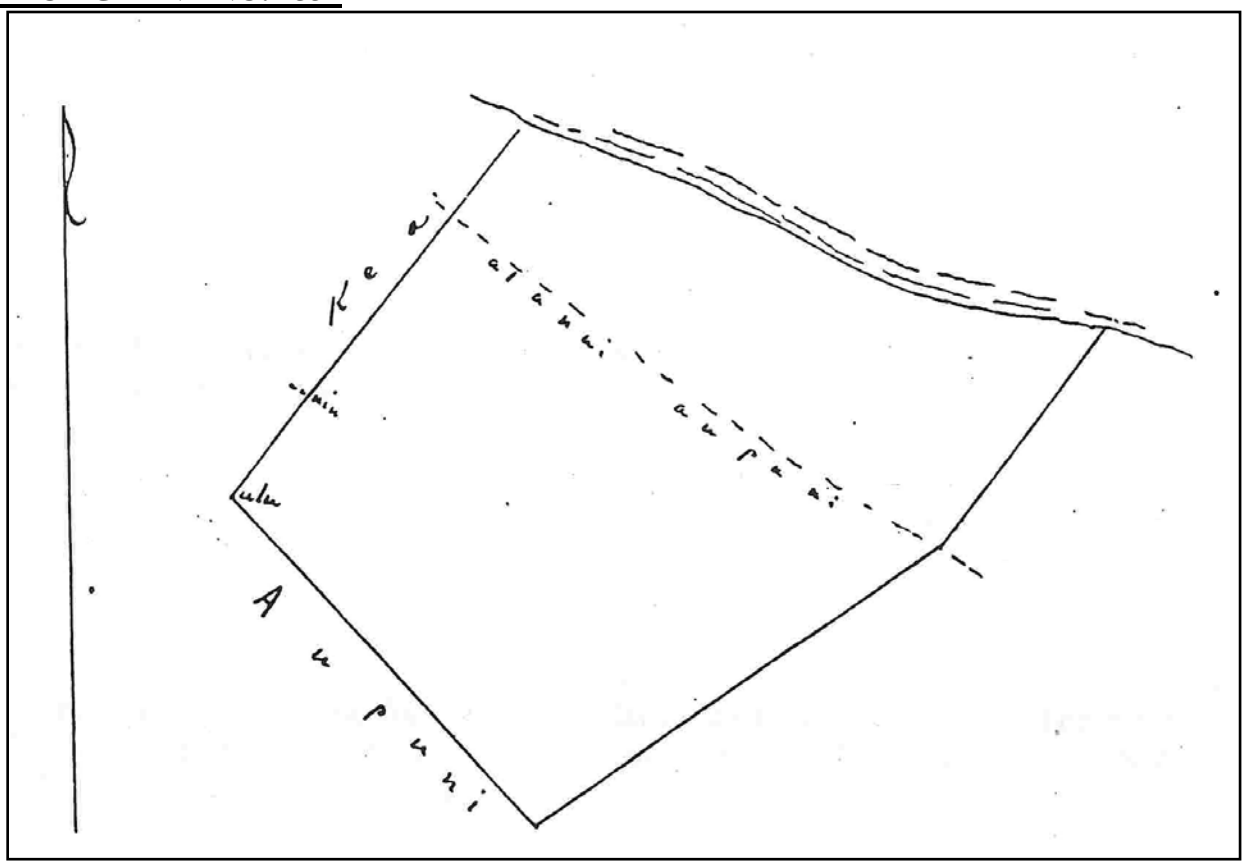
Kamehameha IV

V.K. Ka‘ahumanu

Keoni Ana

[Land Patent Grant No. 1537, Kapohano, Hālona & Pōpoki Ahupua‘a, District of Puna, Island of Hawai‘i, 171 Acres, 1855]

MAP OF GRANT NO. 1537



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Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

APPENDIX 3
Cultural Impact Assessment

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A Cultural Impact Assessment for TMK: (3) 1-5-010:031

Pōpōkī Ahupuaʻa
Puna District
Island of Hawaiʻi

DRAFT VERSION

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A Cultural Impact Assessment for TMK: (3) 1-5-010:031

Pōpōkī Ahupuaʻa
Puna District
Island of Hawaiʻi

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CHAPTERS

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1. INTRODUCTION

At the request of Michael Moore (landowner), ASM Affiliates (ASM) has prepared this Cultural Impact Assessment (CIA) for the proposed single-family residential development of a roughly 8.75-acre Conservation-Zoned property (Tax Map Key [TMK] (3) 1-5-010:031) located in Pōpōkī Ahupua‘a, Puna District, Island of Hawai‘i (Figures 1 and 2). As the current study area is situated within the State Conservation District, the current study is intended to accompany an Environmental Assessment conducted in compliance with HRS Chapter 343 associated with a Conservation District Use Application (CDUA). This CIA was prepared pursuant to Act 50; and in accordance with the Office of Environmental Quality Control (OEQC) *Guidelines for Assessing Cultural Impact*, adopted by the Environmental Council, State of Hawai‘i, on November 19, 1997. As stated in Act 50, which was proposed and passed as Hawai‘i State House of Representatives Bill No. 2895 and signed into law by the Governor on April 26, 2000, “environmental assessments . . . should identify and address effects on Hawaii’s culture, and traditional and customary rights . . . native Hawaiian culture plays a vital role in preserving and advancing the unique quality of life and the ‘aloha spirit’ in Hawai‘i. Articles IX and XII of the state constitution, other state laws, and the courts of the State impose on governmental agencies a duty to promote and protect cultural beliefs, practices, and resources of native Hawaiians as well as other ethnic groups.”

Below is a study area description followed by a selection of traditional and historical accounts that provide a culture-historical context for the current assessment. This contextual discussion also includes the results of prior cultural and archaeological investigations that have been conducted in the immediate study area vicinity. A summary of consultation is provided next, followed by a discussion of potential cultural impacts and the appropriate actions and strategies necessary to mitigate any such impacts.

STUDY AREA DESCRIPTION

The current study area consists of 8.75 acres of undeveloped land located in Pōpōkī Ahupua‘a, Puna District, Island of Hawai‘i (see Figures 1 and 2). The parcel is located southeast of the Hawaiian Paradise Park residential subdivision between the old Government Road (the Government Beach Road) and the coast at elevations ranging from 15 to 65 feet above sea level. It is bounded along its *makai* edge (to the northeast) by sea cliffs, to the northwest by a privately-owned, undeveloped parcel (Parcel 030), to the southwest by a privately-owned, undeveloped parcel (Parcel 007), and along its *mauka* edge by the old Government Road.

Terrain within the project area slopes gently to the northeast, and the underlying geology consists primarily of *pāhoehoe* lava flows that originated from Kilauea Volcano 450 to 750 years ago (Wolfe and Morris 1996). A small finger of younger (dated to A.D. 1410) *pāhoehoe* has been mapped at the *makai* end of the property, and soils in this area overlying the older flow are classified as Opihikao extremely rocky muck (Sato et al. 1973). This soil typically consists of a thin layer of very dark brown, strongly acidic muck about three inches thick that is generally underlain by *pāhoehoe* lava bedrock. The muck is rapidly permeable, and the lava is very slowly permeable, but water moves rapidly through cracks in the lava bedrock. Runoff is slow, and the erosion hazard is slight. Roots are matted over the *pāhoehoe* lava, but they can penetrate cracks to a depth of two feet (Sato et al. 1973). Sato et al. (1973) classify the soils over the younger *pāhoehoe* flow as Lava flows, *pāhoehoe*, which is a miscellaneous land type typically bare of soil. This area typically receives 60 to 100 inches of rainfall annually, and has a mean annual air temperature that ranges between 70 and 77 degrees Farenheit (USDA 2017).

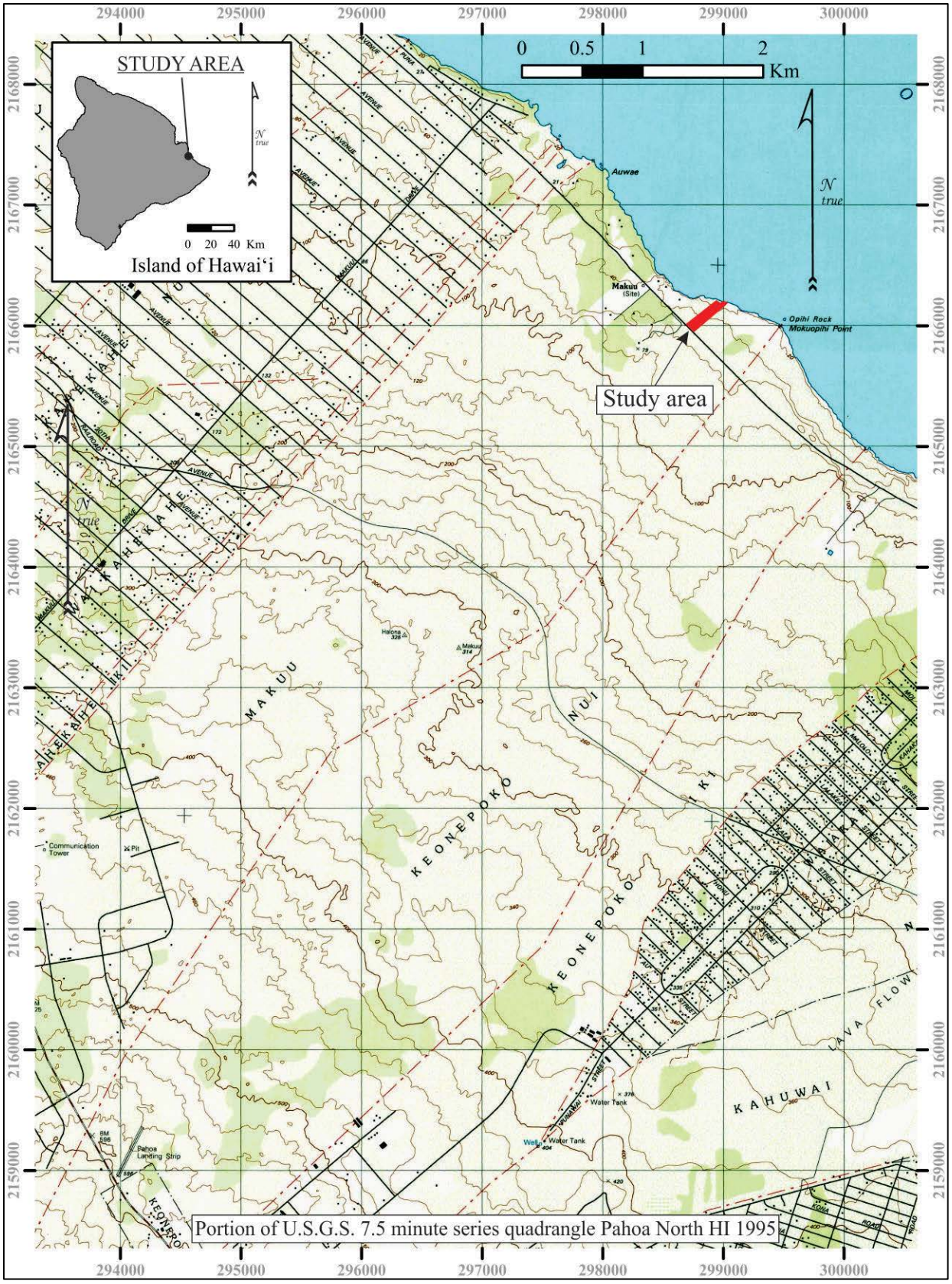

Figure 1. Study area location.

Figure 2. TMK: (3) 1-5-010 showing current study parcel (031) shaded red.

2. BACKGROUND

This section of the report contains a synthesis of prior cultural and historical research relevant to the current study. This contextual discussion includes oral traditions and first-hand historical accounts recorded by visitors and missionaries related to Pōpōkī Ahupua‘a and the greater Puna area. Also included, is a discussion of land use practices and a review of the findings from prior cultural investigations conducted in the study area vicinity. This information is presented to provide a comprehensive understanding of the cultural significance of the area and to identify any potential traditional cultural properties, practices, or beliefs that may be or have been associated with the study area.

LEGENDARY REFERENCES TO THE STUDY AREA VICINITY AND PUNA DISTRICT

As the Hawaiian people had no written language throughout the Precontact Period, traditional *mo‘olelo* (stories, tales, and myths) and *‘ōlelo no‘eau* (proverbs and sayings) were passed down orally from one generation to the next. Despite its perceived lack of importance with respect to the emerging political history of Hawaiian leadership, the Puna region is often portrayed in legends associated with the goddess Pele and god Kāne (Maly 1998). Puna’s association with Pele is strong and goes back many years because of the region’s relatively young geological age and ongoing volcanic activity. However, the association with Kāne is perhaps more ancient still. Kāne, ancestor to both chiefs and commoners, is the god of sunlight, fresh water, verdant growth, and forests (Pūku‘i 1983). It is said that before Pele migrated to Hawai‘i from Kahiki, there was “no place in the islands . . . more beautiful than Puna” (ibid.:11).

‘Ōlelo No‘eau

Many *‘ōlelo no‘eau* speak of Puna, and most mention the land, covered in inky lava left in Pele’s furious wake and the atmosphere, which was sweetly scented with the heavenly fragrances of *hala*, *maile*, and *lehua* blossoms. The following selection of *‘ōlelo no‘eau* are reproduced as they appeared when they were interpreted and published by Mary Kawena Pūku‘i (1983) in a book titled *‘Ōlelo No‘eau, Hawaiian Proverbs & Poetical Sayings.* The selection below focuses on coastal Puna references and is organized thematically. It begins with sayings that refer to the people of Puna and their lifestyles, followed by proverbs that refer to the environs and flora of the district, including *‘awa* and breadfruit, and ends with references to Pele.

> *Ha‘alele i Puna na hoaloha e.*
> Left in Puna are the friends.
> Said of one who has deserted his friends. Originally said of Hi‘iaka when she left Puna. (Pūku‘i 1983:50)
>
> *Hao‘e na ‘ale o Hōpoe i ka ‘ino.*
> The billows of Hōpoe rise in the storm.
> His anger is mounting. Hōpoe, Puna, has notoriously high seas. (ibid.:57)
>
> *He moku ‘āleuleu.*
> District of ragamuffins.
> Said by Kamehameha’s followers of Ka‘ū and Puna because the people there, being hard-working farmers, lived most of the time in old clothes. (ibid.:90)
>
> *Lilo i Puna i ke au a ka hewahewa, ho‘i mai ua piha ka hale i ke akua.*
> Gone to Puna on a vagrant current and returning, finds the house full of imps.
> From a chant by Hi‘iaka when she faced the lizard god Pana‘ewa and his forest full of imps in a battle. It was later used to refer to one who goes on his way and comes home to find things not to his liking. (ibid.:216)
>
> *Ka ua Līhau o Pāhoa.*
> The Līhau rain of Pāhoa.
> The icy cold rain of Pāhoa, Puna, Hawai‘i (ibid.:170)
>
> *Mai ka lā ‘ō‘ili i Ha‘eha‘e a hāli‘i i ka mole o Lehua.*
> From the appearance of the sun at Ha‘eha‘e till it spreads its light to the foundation of Lehua.

Haʻehaʻe is a place at Kumukahi, Puna, Hawaiʻi, often referred to in poetry as the gateway of the sun. (ibid.:224)
Pōʻele ka ʻāina o Puna.
The land of Puna is blackened [by lava flows]. (ibid.:292)

Ka makani hali ʻala o Puna.
The fragrance-bearing wind of Puna
Puna, Hawaiʻi, was famed for the fragrance of *maile*, *lehua*, and *hala*. It was said that when the wind blew from the land, fishermen at sea could smell the fragrance of these leaves and flowers. (ibid.:158)

Puna maka kōkala.
Puna of the eyelashes that curve upward like the thorns of the pandanus leaves.
The placenta of a newborn was buried under a pandanus tree so that the child's eyelashes would grow long like the pandanus thorns. (ibid.:301)

Ka ua moaniani lehua o Puna.
The rain that brings the fragrance of the *lehua* of Puna.
Puna is known as the land of fragrance. (ibid.:172)

Maʻemaʻe Puna i ka hala me ka lehua.
Lovely is Puna with the *hala* and the *lehua*.
Refers to Puna, Hawaiʻi. (ibid.:221)

Puna pāia ʻala i ka hala (Puna, with walls fragrant with pandanus blossoms)
Puna, Hawaiʻi, is a place of *hala* and *lehua* forests. In olden days the people would stick the bracts of *hala* into the thatching of their houses to bring some of the fragrance indoors. (ibid.::301)

Nani Puna pō i ke ʻala.
Beautiful Puna, heavy with fragrance.
Praise for Puna, Hawaiʻi, where the breath of *maile*, *lehua*, and *hala* blossoms are ever present. (ibid.:248)

Puna, kai nehe i ka ulu hala.
Puna, where the sea murmurs to the *hala* grove. (ibid.:300)

Niuniu Puna, pō i ke ʻala.
Puna is dizzy with fragrance.
Puna is a land heavily scented with the blossoms of *hala* and *lehua*. (ibid.:252)

ʻUlu pilo.
Stinking breadfruit.
A term of contempt for the *kauwā* of Puna, Hawaiʻi, comparing them to rotted breadfruit. (ibid.:314)

ʻAwa kau lāʻau o Puna.
Tree-growing *ʻawa* of Puna.
Tree-grown *ʻawa* of Puna was famous for its potency. It was believed that birds carried pieces of *ʻawa* up into the trees where it would grow. (ibid.:29)

Puna, ʻāina ʻawa lau o ka manu.
Puna, land of the leafed *ʻawa* planted by the birds. (ibid.:300)

Ke one lauʻena a Kāne.
The rich, fertile land of Kāne.
Puna, Hawaiʻi, was said to have been a beautiful, fertile land loved by the god Kāne. Pele came from Kahiki and changed it into a land of lava beds, cinder, and rock. (ibid.:191)

Ka wahine ʻai lāʻau o Puna.
The tree-eating woman of Puna.
Pele. (ibid.:177)

Lohiʻau Puna i ke akua wahine.
Puna is retarded by the goddess.
Refers to Pele, ruler of volcanoes. The lava flows she pours into the district retard the work and progress of the people. (ibid.:217)

Makaʻu ka hana hewa i ka uka o Puna.
Wrongdoing is feared in the upland of Puna.
Wrongdoing in the upland of Puna brings the wrath of Pele. (ibid.:228)

Weliweli Puna i ke akua wahine.
Puna dreads the goddess.
Puna dreads Pele. Said of any dreaded person. (ibid.:321)

Selected *Mele* of Puna

As shown in some of the *ʻōlelo noʻeau* presented above, Puna was known for its sweet-smelling *hala* and *lehua* groves. The fragrant breezes of Puna were also celebrated in Hawaiian *mele* (songs). One such mele, *Ke Haʻa Lā Puna i ka Makani*, accompanied the very first recorded *hula* of the Pele and Hiʻiaka saga (Kanahele and Wise 1989) and is reproduced below:

Ke haʻa lā Puna i ka makani
Haʻa ka ulu hala i Keaʻau
Haʻa Hāʻena me Hōpoe
Haʻa ka wahine
ʻAmi (ʻoni) i kai o Nānāhuki
Hula leʻa wale
I kai o Nānāhuki

Puna is dancing in the breeze
The *hala* groves at Keaʻau dance
Hāʻena and Hōpoe dance
The woman dances
[She] dances at the sea of Nānāhuki
Dancing is delightfully pleasing
At the sea of Nānāhuki

ʻO Puna kai kūwā i ka hala
Pae i ka leo o ke kai
Ke lū lā i nā pua lehua
Nānā i kai o Hōpoe
Ka wahine ʻami i kai o Nānāhuki
Hula leʻa wale
I kai o Nānāhuki

The voice of Puna resounds
The voice of the sea is carried
While the *lehua* blossoms are being scattered
Look towards the sea of Hōpoe
The dancing woman is below, towards Nānāhuki
Dancing is delightfully pleasing
At the sea of Nānāhuki (1989:iii)

An excerpt of another *mele* sung by Pele's sister Hiʻiaka, as she traversed a trail through the Panaʻewa forest, tells of the intoxicating effects of a potent *ʻawa* variety found in Puna,

Ka wai mukiki ale lehua a ka manu,
Ka awa ili lena i ka uka o Ka-liʻu,
Ka manu ahaʻi lau awa o Puna:
Aia i ka laau ka awa o Puna.
Mapu mai kona aloha iaʻu—
Hoolaau mai ana iaʻu e moe,
E moe no au, e-e!

O honey-dew sipped by the bird,
Distilled from the fragrant lehua;
O yellow-barked awa that twines
In the upper lands of Ka-liʻu;
O bird that brews from this leafage
Puna's bitter-sweet awa draught;—
Puna's potentest awa grows
Aloft in the crotch of the trees.
It wafts the seduction to sleep,
That I lock my senses in sleep!
(Emerson 1915:31)

The following excerpt is from the same *mele* sung by Hiʻiaka, which describes the fires of her sister Laka, the goddess of *hula* and Puna District:

Aia la, lele-iwi o Maka-hana-loa!
Oni ana ka lae Ohi‘a,
Ka lae apane, mauka o ka lae Manienie,
I uka o Ke-ahi-a-Laka:
Oni ana ka lae, a me he kanaka la
Ka leo o ka pohaku i Kilauea.
Ha‘i Kilauea, pau kekahi aoao o ka mahu nui,
Mahu-nui-akea.
E li‘u mai ana ke ahi a ka pohaku.
No Puna au, no ka hikina a ka la i Hae‘eha‘e.

See the cape that’s a funeral pyre;
The tongue of ohi‘a’s grief-smitten.
Beyond, at peace, lies Maniē;
Above rage the fires of Laka.
The cape is passion-moved; how human
The groan of rocks in the fire-pit!
That cauldron of vapor and smoke –
One side-wall has broken away –
That covers the earth and the sky:
Out pours a deluge of rock a-flame.
My home-land is Puna, sworn guard
At the eastern gate of the Sun. Emerson (1915:31)

Pelehonuamea in Puna

Most closely associated with the powerful and temperamental volcanoes of Hawai‘i, Pele was perhaps both feared and respected equally by the people of the islands. Nimmo relates that, “although the actual worship of Pele was most important in the districts of Hawai‘i that experienced active volcanism, the mythology of the goddess was widespread throughout the Hawaiian Islands” (1990:44). And that, “there is no evidence that Pele was worshipped extensively beyond the volcano area of Hawai‘i, although her mythology was apparently widespread throughout the Hawaiian Islands and members of her family were important in ritual throughout the archipelago” (ibid.).

Kalākaua (1972) indicates that active worship of Pele was ongoing between the 12th and 19th centuries, and that the abolition of the *kapu* system in the late 19th century had little to no effect on this practice, which remains ongoing. In addition to being revered as a goddess, Pele was also worshipped as an *‘aumakua* (ancestor god/guardian spirit) by her descendants. According to Nimmo, “most Hawaiians living in the volcano areas of Hawai‘i, the districts of Ka‘ū, Puna, and Kona, at the time of European contact traced their ancestry to Pele” (1990:43). Pele appears throughout Hawaiian mythology and history; tales of Pele’s migration from Kahiki to Hawai‘i abound. Beckwith relates:

> The Pele myth is believed to have developed in Hawai‘i, where it is closely associated with aumakua worship of the deities of the volcano, with the development of the hula dance, and with innumerable stories in which odd rock or cone formations are ascribed to contests between Pele and her rivals, human or divine. The myth narrates the migration or expulsion of Pele from her distant homeland and her effort to dig for herself a pit deep enough to house her whole family in cool comfort or to exhibit them in their spirit forms of flame and cloud and other volcanic phenomena. (1970:168)

Kalākaua places the arrival of Pele and Hi‘iaka during the reign of Kamiole, or more specifically, in approximately A.D. 1175, and notes that “every tradition refers to them as deities at the time of their arrival at Hawai‘i” (1972:140). When Pele arrived on the shores of Puna, she discovered that a fire god by the name of ‘Ai La‘au already had jurisdiction of Hawai‘i Island. Westervelt explains:

> When Pele came to the island Hawai‘i, she first stopped at a place called Ke-ahi-a-laka in the district of Puna. From this place she began her inland journey towards the mountains. As she passed on her way there grew within her an intense desire to go at once and see Ai-laau, the god to whom Kilauea belonged, and find a resting-place with him as the end of her journey. She came up, but Ai-laau was not in his house. Of a truth he had made himself thoroughly lost. He had vanished because he knew that this one coming toward him was Pele. He had seen her toiling down by the sea at Ke-ahi-a-laka. Trembling dread and heavy fear overpowered him. He ran away and was entirely lost. When Pele came to that pit she laid out the plan for her abiding home, beginning at once to dig up the foundations. She dug day and night and found that this place fulfilled all her desires. Therefore, she fastened herself tight to Hawai‘i for all time. (1916:3)

According to Kalākaua, Pele’s “favorite residence was the vast and ever-seething crater of Kīlauea, beneath whose molten flood, in halls of burning adamant and grottoes of fire, she consumed the offerings of her worshippers and devised destruction to those who long neglected her or failed to respect her prerogatives” (1972:139). Ho‘oulumāhiehie (2006) indicates that on her way to Kīlauea, Pele initially carved out a crater called Malama just inland of her landing place at Keahialaka. Pele was dissatisfied with this crater, and proceeded to feverishly excavate two more craters called Pu‘ulena and Pohoiki, both of which she was also displeased with and abandoned as she continued her pursuit for a suitable home.

Hōpoe the Dancing Stone

A tale of jealousy and spite is recounted in the legend *Hopoe the Dancing Stone*, published by Westervelt (1916). Pele called upon each of her sisters to fetch her dream lover Lohi‘au from Kaua‘i. Knowing Pele’s tempestuous temper, each feared possible repercussions and refused to go. After being denied by all but one sister, Pele rumbled her home, the volcano, sending out burning smoke and vapors, impatiently beckoning her very last option. At long last, her youngest sister, Hi‘iaka appeared to her, adorned in beautiful lei made by her dearest friend Hōpoe who she had abandoned at the seashore upon hearing her sister’s call. Hōpoe was a skilled and graceful *hula* dancer, and had spent much time teaching Hi‘iaka old Hawaiian *hula* until she became exceptional herself. She also taught her how to make beautiful flower *lei*, and the pair very much enjoyed their time together.

The irascible Pele demanded that Hi‘iaka travel to Kaua‘i to fetch Lohi‘au, and sent her on her way with stern instructions. Hi‘iaka was not to take him as her own husband, she was not to touch him, and she was to take no longer than 40 days on her journey. While Hi‘iaka agreed to her sister’s demands, she realized that in her absence, Pele would become incensed with a burning and vehement fury and destroy whatever she desired. So Hi‘iaka set forth two stipulations; her beloved *‘ōhi‘a* and *lehua* groves were to be spared from destruction, and Pele was to protect Hōpoe in her absence. Pele agreed to Hi‘iaka’s requests, and Hi‘iaka departed on her journey to retrieve Pele’s lover. In a sympathetic act, Pele bestowed a share of her power upon Hi‘iaka so that she would be protected against the supernatural dangers she would undoubtedly meet along the way.

Hi‘iaka hadn’t ventured very far when she realized that the volcano had begun to smoke thickly, trailing towards Hōpoe’s home of Kea‘au. It was long before the smolder of smoke burst into a scorching fire. Filled with a sense of dread and sensing that her sister had betrayed her promise, Hi‘iaka continued her journey. Days passed slowly, utterly too slowly for Pele, but Hi‘iaka finally found Lohi‘au. By this time, Pele was furious. She shook the earth with great ferocity and heaved her lava in a torrent of devastation, annihilating Hi‘iaka’s *‘ōhi‘a lehua* forest, obliterating all of Puna, and finally cornering Hōpoe as she lingered by the sea:

> Hopoe was the last object of Pele’s anger at her younger sister, but there was no escape. The slow torrent of lava surrounded the beach where Hopoe waited death. She placed the garlands Hiiaka had loved over her head and shoulders. She wore the finest skirt she had woven from lauhala leaves. She looked out over the death-dealing seas into which she could not flee, and then began the dance of death. (Westervelt 1916:94)

In her death, Hōpoe was transformed. She was rebirthed as a stone, carefully balanced alongside the sea where she could continue her graceful dance throughout the centuries when touched by the soft breeze or the rumbling of the earth. And Hi‘iaka, her heart bitter with her sister’s betrayal, brought Lohi‘au back to Pele, faithfully as she swore she would.

The *Pōhaku* of Kumukahi

The Dancing Stone of Hōpoe is not the only physical evidence of Pele’s wrath found in Puna. In the tale of *Pele and the Chiefs of Puna,* Westervelt (1916) tells the story of Pele’s vengeful spirit against Kumukahi. a tall, strong, and handsome Puna chief, who relished playing traditional Hawaiian games. In the middle of playing one day, he was approached by an elderly woman who commanded he allow her to play. Not realizing that the old woman was actually Pele, who he had only seen in her younger and more alluring form, the chief mocked her scornfully. Pele’s temper flared at his contempt and she pursued him as he fled to the ocean. Cornered, Kumukahi was swallowed by a torrent of lava unleashed by Pele who also heaped fractured lava upon him. His fortune, much like Hōpoe, was to remain eternally as a great *pōhaku* (stone) at the seashore where he marked the easternmost extremity of Hawai‘i known today as Cape Kumukahi.

Seven other storied stone monoliths are present in the immediate vicinity of Cape Kumukahi. June Gutmanis (1986) was informed by Mary Kawena Pūku‘i that these named stones are the physical forms of Kumukahi’s former wives. Makanoni (“speckled face”) marked the beginning of a cool season and the end of summer, Kanono (“very-red-sunburn”) indicated the first day of winter when struck by the rising sun, and Paupoulu (“skirt-made-of-breadfruit-bark”) implied the beginning of summer when struck by the rising sun (Gutmanis 1986). Additionally, there are several other stones nearby that represent Kumukahi’s other wives: Hanakaulua (“Take-plenty-of-time-to-work”), Haehae (“Rent-assunder”); Haula (“Fall Leaves”), and Kahinaakala, (“Sunrise”) (ibid.). These stones are less explicit in their functions, but allegedly also mark astronomical events such as solstices and equinoxes.

Kumukahi and the rocky point that bears his name are featured in another legend, as told by Pūku‘i (Green and Beckwith 1926). Kumukahi is portrayed as a god and kin of Pele who made the easternmost point on Hawai‘i Island his home, upon his and Pele’s from their home in Tahiti. Kumukahi was a shapeshifter, able to transmogrify from a

mortal man to a *kolea* (plover) at will, and could inhabit spirit mediums (*haka*) inducing miracles to occur. It was to this god, embodied by "a red stone at the extreme end of the point" that offerings were left by the sick seeking healing, and likewise by those paying reverence to the sun (Beckwith 1970:119). For those who were ill and wished to obtain healing, a very specific protocol for presenting offerings is required:

> . . . As it is essential for such an offering that the extreme point [of Kumukahi] be reached and before sunrise, the patient had to be paddled early in the morning in a canoe, accompanied by a priest and carrying an offering in the shape of a whole pig if the patient can afford it, otherwise a fish called *nukunuku-puaa*, or "pig-snout," together with squid, *olena* root, *awa* drink, and other articles all wrapped in *ti* leaves. At the exact point of the reef, the priest holds the offering and chants,
>
> *E hoopakele i na pulapula mai no ino mai,* Deliver your progeny from evil
> *A e hoopomaikai mai, i nap ono a pau* And bless in all good things.
>
> Then the offering is dropped quickly into the water and the canoe paddled swiftly away. Neither priest nor patient could look back, else "he has his labor for his pains," (Green and Beckwith 1926:188-189)

The significance of Kumukahi as a *wahi pana*, or sacred place, is also evident in its incarnation as a *leina a ka ʻuhane* (leaping place for souls) where the death of the physical body results in the separation of its spirit which is subsequently accompanied by its *ʻaumakua* (family or personal ancestral gods) on a journey to the underworld. It is there that the *ʻaumakua* help guide their keep into either Milu (a place of darkness also referred to as *ka lua o Milu*) or Wākea (a place of light). Beckwith describes this leaping place for souls thusly:

> . . . There is a place of the dead, reached at some leaping place, with which is connected a branching tree as roadway of the soul. Elaborations enter into these basic ideas as a result of the part conceived to be played by the aumakua in protecting and sheltering the soul and leading it to its aumakua world.
>
> The worst fate that can befall a soul is to be abandoned by its aumakua and left to stray, a wandering spirit (kuewa) in some barren and desolate place, feeding upon spiders and night moths. Such spirits are believed to be malicious and to take delight in leading travelers astray; hence the wild places which they haunt on each island are feared and voided. . . (1970:154)

ʻAumakua Manō of Puna

Ancestral deity worship was a quintessential spiritual practice of the Native Hawaiians of old, and it stands today as a heritable custom, belief, and connection to the past preserved by rich oral traditions. While *pōhaku* were sometimes represented as *ʻaumakua*, they were not the only focus of personification and reverence. Martha Beckwith (1917) relates that *ʻaumakua* worship was also directed towards certain animals, trees, flowers, insects, and natural phenomena who were half god and half human and communicated through mediums, possessed by their spirits. Beckwith continues:

> His utterances are not his own but are the means by which, together with dream and vision, the spirit of the *aumakua* counsels his protégé. In order that the *aumakua* may be strong enough to act as his part as helper, he must receive offerings of prayer, and of sacrifice in the shape of food and drink called "feeding the spirit." (ibid.:506)

Additionally, *ʻaumakua* served as intermediaries and played an important role in guiding the soul in the underworld, and were capable of leading them into the desirable and peaceful Wākea region or the miserable depths of Milu. Therefore, it was vital to maintain good relations with *ʻaumakua*. Emerson states, "Every family had its *aumakua*, to whom each individual owed allegiance and worship, and from whom he expected aid and guidance in all the affairs of life" (1892:22).

Of significance are *ʻaumakua manō* (shark deities) who are frequently worshipped in coastal areas of Hawaiʻi such as the current study area vicinity in Puna. *ʻAumakua manō* are considered as both a friend and protector of their *kahu* while at the same time associated as *kauwā* (slaves/servants) because of their obligatory servitude (Beckwith 1917; Emerson 1892). A legendary battle took place on Oʻahu between various legendary *ʻaumakua manō*. A number of these *ʻaumākua manō* were associated with Puna. For instance, Kane-i-kaupaku and Kane-mahuna were simply said to be "of Puna;" while Hika-welo-ula, also of Puna, was "son of the *Kau* shark, *Ke-alii-kaua* and of *Ahia*, a woman of *Kalapana*. At birth he was covered with red tapa, the kind called *pukohukohu*, and became a red shark;" like many *ʻaumākua manō*, Hika-welo-ula could transform into a man when on land (Beckwith 1917:512). The following excerpt provides additional details collected by Emerson about two other *ʻaumākua manō* from Puna:

> ***Ke-alii-holo-i-ka-moana*** (the chief sailing over the ocean) (k) lives in *Kekaha*, *Puna*, from *Ka-lai-o-kawili* in *Apua* district to *Ka-lai-o-wili-ea in Panau-nui*. "He began life a human child living on land, was a *kaukau-alii* (low chief) under *Iwakakaoloa*, the blind chief of *Puna*. He was an expert fisherman, frequenting the sea in a canoe. At death, wrapped in *Kapa-ahu-na-lii*, he was cast into the sea at *Kealakomo* and became a shark-god of the class called *akua-noho* who were supposed to 'dwell with or be over men as guardians. (ibid. 511)
>
> ***Ka-pani-la*** (the shutting out of the sun) (k) is so named "because his enormous bulk would obscure the sun should he come to land. He is the largest of the sharks. His usual haunts extended from the point *Ka-lae-o-lamaulu* in *Kapoho*, *Puna*, to *Kumukahi* point in *Kapele."* (ibid. 512)

The Heart Stirring Story of Ka-Miki

A traditional *mo'olelo*, "The Heart Stirring Story of Ka-Miki" (*Kaao Hooniua Puuwai no Ka-Miki*), originally appeared in *Ka Hoku o Hawai'i* (a Hawaiian language newspaper) between 1914 and 1917. This tale tells of the two supernatural brothers, Ka-Miki and Maka-'iole, who were skilled *'ōlohe* (competitors/fighters) and their travels around Hawai'i Island by way of the ancient trails and paths (*ala loa* and *ala hele*), seeking competition with other *'ōlohe.* As described by Maly:

> The narratives were primarily recorded for the paper by Hawaiian historians John Wise and J.W.H.I. Kihe (with contributions from Steven Desha Sr.). While Ka-Miki is not an ancient account, the authors set the account in the thirteenth century (by association with the chief Pili, who came to Hawai'i with Pā'ao). They used a mixture of local stories, tales, and family traditions in association with place names to tie together fragments of site specific history that had been handed down over the generations. Thus, while in many cases, the personification of individuals and their associated place names may not be "ancient," the site documentation within the "story of Ka-Miki" is of both cultural and historical value. (Maly 1998:17)

A portion of the legend set in Puna, published between October 21 and November 18, 1915 and translated by Maly (1998:17-25), describes many people and places within the district, and is summarized below. During an expedition through the uplands of Puna, Ka-Miki and Maka-'iole encountered a man named Pōhakuloa who was intensely working on a large *koa* log. They were headed to Kea'au, but had lost their way. They stopped and asked Pōhakuloa for directions, but he was startled by the unexpected appearance of the brothers, and replied impolitely. Taunts were exchanged between the two parties, which led to a physical altercation. It was at this point, that Pōhakuloa realized that these two men were extraordinarily skilled as well as spiritually protected, and he admitted his defeat. Pōhakuloa wished to prepare a meal and drink of *'awa* with his newfound friends, and solicited the help of his brother in law, an *'ōlohe* chief named Kapu'euhi. However, Kapu'euhi had plans of his own. He intended to compete with and conquer the brothers, but was defeated by them instead. Kapu'euhi was infuriated by his defeat, and by Pōhakuloa's refusal to aid in retaliation against Ka-Miki and Maka-'iole.

Kapu'euhi invited the brothers back to his house to partake in a meal and a particularly potent type of *'awa*, scheming to get them drunk. Unbeknownst to Ka-Miki and Maka-'iole, this was common practice for Kapu'euhi, who often housed weary travelers, intoxicated them with *'awa*, then killed them and stole their belongings. Kapu'euhi waged a bet with the brothers; if they couldn't drink five cups of the *'awa*, then he would throw them out and they would be at the mercy of the Puna forest. Ka-Miki and Maka-'iole agreed, and counteracted his bet with one of their own; if they were able to drink five cups, they would throw Kapu'euhi out of his own house. The brothers prayed and chanted to their ancestral goddess, and were able to consume the entire quantity of *'awa* without getting drunk. As agreed upon, Kapu'euhi was thrown out. Stunned, and angered that he was thwarted once again, Kapu'euhi requested assistance from Kaniahiku (a much feared Puna *'ōlohe* and forest guardian) and her grandson Keahialaka. "At that time, Keahialaka was under the guardianship of Pānau and Kaimū, and he enjoyed the ocean waters from Nānāwale to Kaunaloa, Puna" (*Ka Hoku o Hawai'i* October 28, 1915; translated by Maly 1998:20), which Maly suggests is symbolic of controlling those regions.

Together, Kapu'euhi and Kaniahiku conspired to lead the brothers deep into the Puna forest, where Kaniahiku would be able to murder them, all the while maintaining the façade that they were taking them to the *'awa* grove of Mauānuikananuha. Once Ka-Miki and Ka-'iole were well within the domain of Kaniahiku, she created a dark and murky environment, spreading gloomy mists and an overgrowth of twisted vegetation intended to ensnare the brothers. Ka-Miki and Maka'iole were overcome, and left for dead by Kapu'euhi, who made his way back to safety, led by Kaniahiku's sister. They prayed to their ancestor, Ka-uluhe-nui-hihi-kolo-i-uka for help. All at once, her presence

became apparent, and the brothers were able to continue on to the *ʻawa* grove. Another attempt by Kaniahiku to kill the brothers was made, however, Ka-uluhe's protection over them was too strong, and she failed.

Ka-Miki and Ka-ʻiole realized that Kapuʻeuhi had deceived them and had been in affiliation with Kaniahiku. They were angered, and trapped him in the *ʻawa* grove. In an effort of retaliation, Kaniahiku summoned for her grandson, Keahialaka, and readied herself for a battle. Ka-Miki and Maka-ʻiole reprimanded Kaniahiku for her deceitful actions, which only served to anger her even further. Aggressively, Kaniahiku attacked Ka-Miki with her tripping club and spear, but Ka-Miki was far too elusive for her. He swiftly evaded each attempt at injury made on his behalf. In desperate need of assistance, Kaniahiku beckoned to Keahialaka by playing her nose flute, urging him to hurry to her side. Although Keahialaka was strong and skillful in the arts of *ʻōlohe*, he was all too easily overcome by Ka-Miki. His grandmother was also captured, in an attempt to free him from Ka-Miki.

Kaniahiku was astounded at the dexterity of the brothers. Their skill was incomparable to any other *ʻōlohe* she had ever encountered, and even her own skill paled in comparison, for she had never been defeated. All at once she surrendered to Ka-Miki and Makaʻiole, who in turn released her and her grandson. Back at Kaniahiku's house, a meal was prepared, the *ʻawa* of Kaliʻu was enjoyed, and the gods were honored with offerings. Kaniahiku requested that the brothers take Keahialaka with them as they continued their journey on the *ala loa*, declaring that if they did, they would be welcomed wherever their travels took them in Puna. Ka-Miki and Makaʻiole approved of this request, and took Keahialaka on as their companion. Together, the three men journeyed throughout various districts of Hawaiʻi island, and competed in many *ʻōlohe* competitions.

Band of *ʻŌlohe*

Pūkuʻi and Green (1995) relate another legend related to *ōlohe* that takes place in a seaside cave near Waha'ula Heiau in Puna. In this tale, the *ʻōlohe* (skilled fighters) are referred to as a "class of robbers who understand the art of bone-breaking [*lua*]" and "pluck out all their hair and oil their bodies for wrestling in order to give no hold to an antagonist" (ibid.:165). According to the legend, an elderly *ʻōlohe* named Kapuaʻeuhi and his two charming daughters were known to prey upon travelers. For, Kapuaʻeuhi's daughters were adept at *lua*, a specialized hand-to-hand combat that delivers broken/dislocated bones and inflicts extreme nerve pain to ill-fated victims. Together, the trio lured unsuspecting wanderers into their seaside cave to meet their deaths crushed beneath suspended stones. Upon the advice of a *kahuna* (priest/sorcerer), the family of one of their victims sent two men to assassinate the *ʻōlohe* tribe. In Kapuaʻeuhi's absence, the men located both daughters, slaughtered them after a struggle, and hid their bodies. Then, the men waited patiently at the cave entrance for Kapuaʻeuhi so that they could slaughter him too. Upon his return, Kapuaʻeuhi entered the cave and inquired about his missing daughters. The two men feigned ignorance but Kapuaʻeuhi suspected something sinister had happened. He invited the pair of men into the cave to trap them beneath the heavy suspended stones, but the men were already aware of the trap and declined the invitation. Kapuaʻeuhi grappled with the men in an attempt to kill them, but he succumbed to their strength and was overcome.

The Legend of Halemano

The subject *ahupuaʻa* of Pōpōkī is specifically mentioned in the *Legend of Halemano*, the tale of a romance between Halemano of Oʻahu and the beautiful and forbidden princess Kamalālāwalu (Kama) of Puna. Kama lived under a strict *kapu* (taboo) that kept her from leaving her home or having visitors and companionless except for her brother Kumukahi. Her parents had promised her as the wife of either the Hilo or the Puna King upon reaching maturity. The hero of this story, Halemano was a son of Oʻahu, "perfect in form" and "subject to dreams" (Fornander 1918-1919:228). Kama appeared to Halemano in his dreams and he fell deeply in love with the image of her without knowing her name. He became so utterly obsessed and lovesick that he could not bear to eat and he became so weak that he finally died. Halemano's sister, Laenihi, a shape-shifting sorceress, was off in search of a wife for Halemano at the time of his death, but upon hearing of his passing, she returned home to him. Laenihi restored her brother to life and upon his restoration, he revealed to his sister how he had died:

> "It is because of a woman. This is the manner of her appearance [in my dreams]: she is very beautiful; her eyes and body are perfect; she has long, straight, black hair; is tall, dignified, and seems to be of very high rank like a chiefess." Laenihi again asked him: "What is the nature of her outward dress?" "Her dress seems to be scented with *pele* and *mahuna* of Kauai, and her pa-u is made of some very light material dyed red. She wears a hala wreath and a lehua wreath on her head and around her neck." Laenihi then said: "It is in Puna and Hilo that the lehua blossoms are found. It is in Puna that the *ouholowai* of Laa and the *pukohukohu* are found; therefore, your lover must be a woman of Puna; she is not of the west. If it is Kamalalawalu, the woman I heard so much of while in Puna, then she must be very beautiful indeed." Laenihi then again asked: "How do you meet her?"

> Halemano replied: "When I fall asleep we meet very soon after, and you could hear us talk if you should listen; even now you could hear us if I fall asleep." Laenihi then said: "Yes, you may go to sleep now. If you should meet your lover, ask her to give you her name and the name of the land in which she lives." (ibid.:230)

Halemano fell asleep and met Kama again in his dream world and she told him that she hailed from Kapoho, Puna. When he awoke, he told his sister of his dream. Laenihi changed herself into a *laenihi* fish and journeyed to Puna to find Kama Once there, Laenihi used her powers to cause the great *unuloa* wind to blow at Kaimū, thus causing the surf to swell and drawing Kama and Kumukahi to surf the waves. After the surf died down, Laenihi swam up to Kama and she collected the little *laenihi* fish, which she kept in a calabash of salt water as a plaything for her brother. Thus, Laenihi was able to access the forbidden princess. Shortly thereafter, Laenihi transformed herself into a woman, calling herself Nawahinemakaakai, and convinced Kama to give her wreath and *pāʻū*, which she took to Halemano as proof of their meeting. Upon seeing Kama's possessions, Halemano was inspired to go to Hawaiʻi himself but Laenihi insisted he win her over first by appealing to Kama's brother. Thus, Halemano ordered his people to make various playthings (wooden idols and chickens, *koieie* floaters, and kites) for Kumukahi. He also ordered "that a red canoe be prepared and red men be had to paddle the canoe" and that "the men should be provided with red paddles and the canoe must be rigged with red cords" (Fornander 1918-1919:234). Lastly, Halemano ordered "that a large and a small canoe be provided" (ibid.). The legend continues as follows, with a specific mention of the subject *ahupuaʻa*:

> After these different things were ready they set out for Puna, Hawaii. Upon their arrival off of Makuu and Popoki, two small pieces of lands next to Puna, the kite was put up. When the people on the shore saw this flying object they all shouted with joy. (ibid.)

Their shouting drew Kumukahi out onto the beach where he became enthralled by the gifts he saw there, according to plan. Since Kama could not refuse her dear brother's wishes, she agreed to come down to the beach and eventually onto Halemano's canoe, and the pair were paddled off to Oʻahu.

PRECONTACT PŌPŌKĪ AHUPUAʻA AND THE GREATER PUNA DISTRICT

The current study area is located within the *ahupuaʻa* of Pōpōkī, which translates literally as "ti leaf bundle" (Pūkuʻi et al. 1974), in the traditional *moku-o-loko* or district of Puna, which comprises some fifty *ahupuaʻa* on the eastern/windward shores of Hawaiʻi Island, situated largely on the slopes of Kīlauea Volcano (Figure 3). The district of Puna was the site of the first *luakini heiau* (sacrificial ceremonial structure), which was attributed to the powerful *kahuna* Pāʻao who is believed to have arrived from *Kahiki* during the 13th century (Cordy 2000). Pāʻao built the *heiau* for his god Ahaʻula and named it after him Wahaʻula; he is also credited with introducing specific *kapu* imported from whence he came across the open ocean. The location of Wahaʻula Heiau now lies beneath a lava flow.

In the book, *Native Planters in Old Hawaii*, Handy and Handy describe Puna as an agriculturally fertile land that has been repeatedly devastated by lava flows. Writing during the 1930s, they relate that:

> The land division named Puna—one of the six chiefdoms of the island of Hawaii said to have been cut (*ʻoki*) by the son and successor of the island's first unifier, Umi-a-Liloa—lies between Hilo to the north and Kaʻu to the south, and it projects sharply to the east as a great promontory into the Pacific. Kapoho is its most easterly point, at Cape Kumukahi. The uplands of Puna extend back toward the great central heights of Mauna Loa, and in the past its lands have been built, and devastated, and built again by that mountain's fires. In the long intervals, vegetation took hold, beginning with miniscule mosses and lichens, then ferns and hardier shrubs, until the uplands became green and forested and good earth and humus covered much of the lava-strewn terrain, making interior Puna a place of great beauty. . .
>
> …One of the most interesting things about Puna is that Hawaiians believe, and their traditions imply that this was once Hawaii's richest agricultural region and that it is only in relatively recent time that volcanic eruption has destroyed much of its best land. Unquestionably lava flows in historic times have covered more good gardening land here than in any other district. But the present desolation was largely brought about by the gradual abandonment of their country by Hawaiians after sugar and ranching came in… (Handy et al. 1991:539-542)

As Pōpōkī encompasses *mauka* agricultural and forest resources and *makai* fisheries, residents were once able to procure nearly all that they needed to sustain their families and contribute to the larger community from within the land division. The *ahupuaʻa* resources in turn helped support the *aliʻi* that ruled the District of Puna (Maly 1998).

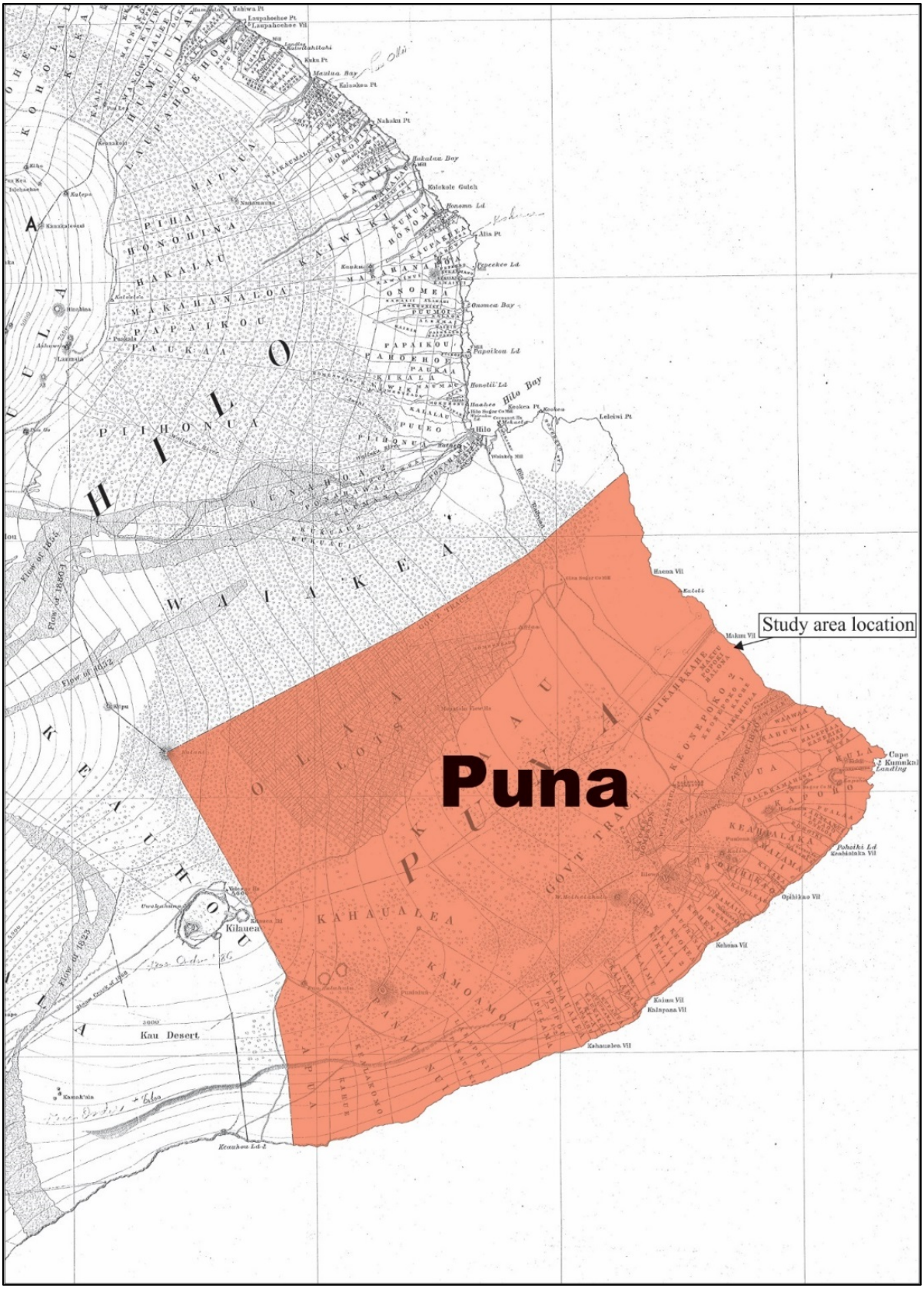

Figure 3. Portion of Hawai‘i Registered Map No. 2060 (by John M. Donn in 1901).

The Precontact population of the Puna District lived in small settlements along the coast where they subsisted on marine resources and agricultural products. The villages of Puna, McEldowney notes, were similar to those of the Hilo District, and they:

> …comprised the same complex of huts, gardens, windbreaking shrubs, and utilized groves, although the form and overall size of each appear to differ. The major differences between this portion of the coast and Hilo occurred in the type of agriculture practiced and structural forms reflecting the uneven nature of the young terrain. Platforms and walls were built to include and abut outcrops, crevices were filled and paved for burials, and the large numbers of loose surface stones were arranged into terraces. To supplement the limited and often spotty deposits of soil, mounds were built of gathered soil, mulch, sorted sizes of stones, and in many circumstances, from burnt brush and surrounding the gardens. Although all major cultigens appear to have been present in these gardens, sweet potatoes, ti (*Cordyline terminalis*), *noni (Morinda citrifolia*), and gourds (*Lagenaria siceraria*) seem to have been more conspicuous. Breadfruit, pandanus, and mountain apple (*Eugenia malaccensis*) were the more significant components of the groves that grew in more disjunct patterns than those in Hilo Bay. (McEldowney 1979:17)

Located along the coast, the study area falls within the Coastal Settlement Zone (Zone I) as described by McEldowney (1979:15-18). While this model is largely based on early historical accounts, it also considers environmental variables and human resource needs, and offers insights into the prehistoric past (Burtchard and Moblo 1994). Houses where families lived were often found clustered around sheltered bays (McEldowney 1979). In their refinement of the model as it applies to Puna, Burtchard and Moblo elaborate on McEldowney's concept of the Coastal Settlement Zone:

> As with her model, [the Coastal Settlement Zone] includes coastal terrain to about one half mile inland. This is the zone expected to have the greatest density and variety of prehistoric surface features in the general study area. Primary settlements are expected in places where agriculturally productive sediments (principally well-weathered *ʻaʻā* flows) co-occur with sheltered embayments and productive fisheries. Settlements within this zone are expected to be logistically linked to inland agricultural and forest exploitation zones accessed through a network of upslope-downslope (*Mauka-makai*) trails. Larger settlements and resource acquisition areas may have been connected by cross-terrain trail networks. (1994:26)

Over time, as the populations of desirable coastal locations increased, early Hawaiians expanded their settlements into upland regions and more marginal areas of Puna. As competition for resources intensified, so too did political competition that resulted in conflict and further expansion into upland areas as political exiles sought asylum in remote places and hidden lava tubes (Burtchard and Moblo 1994). By the seventeenth century, large areas of Hawaiʻi Island were controlled by a few powerful *aliʻi ʻai moku*. Barrère (1959) suggests that the chiefs of the Puna District did not figure prominently into the Precontact political strife and turmoil on Hawaiʻi Island. Barrère writes:

> Puna, as a political unit, played an insignificant part in shaping the course of history of Hawaii Island. Unlike the other districts of Hawaii, no great family arose upon whose support one or another of the chiefs seeking power had to depend for his success. Puna lands were desirable, and were eagerly sought, but their control did not rest upon conquering Puna itself, but rather upon control of the adjacent districts, Kau and Hilo. (1959:15)

ʻUmi a Līloa, a renowned *aliʻi* of the Pili line, is often credited with uniting the Island of Hawaiʻi under one rule (Cordy 1994). Kamakau reports that, at this time, "Hua-ʻa was the chief of Puna, but Puna was seized by ʻUmi and his warrior adopted sons… Hua-ʻa was killed by Piʻi-mai-waʻa on the battle field of Kuolo in Keaʻau, and Puna became ʻUmi-a-Liloa's" (1992:17-18). Umi's reign lasted until around ca. A.D. 1620, and was followed by the rule of his son, Keawenui a ʻUmi, and then his grandson, Lonoikamakahiki (Cordy 1994). In A.D. 1754, after many bloody battles, Kalaniʻōpuʻu, the *aliʻi ʻai moku* of Kaʻū, defeated his main rival Keaweʻōpala in South Kona and declared himself ruler over all of the island of Hawaiʻi (Kamakau 1992). Kalaniʻōpuʻu had one of his residences in Puna, (Beaglehole 1967).

Around 1780, Kalaniʻōpuʻu proclaimed that his son Kiwalaʻō would be his successor, and he gave the guardianship of the war god Kūkaʻilimoku to Kamehameha (Fornander 1996; Kamakau 1992). At this time, a Puna chief named ʻĪmakakoloa rebelled because he was tired of the incessant and exorbitant demands of Kalaniʻōpuʻu, and mounted an uprising against him. Upon hearing of the uprising, Kalaniʻōpuʻu immediately went from Kohala to Hilo to quell the rebellion. As a chief who loved the people of Puna, who revered him, ʻĪmakakoloa refused Kalaniʻōpuʻu's demands of the customary tribute. Rather than allow Kalaniʻōpuʻu access to the toils of the people of Puna, "he seized

the valuable products of his district" that included: "hogs, gray tapa cloth (*ʻeleuli*), tapas made of *mamaki* bark, fine mats made of young pandanus blossoms (*ʻahu hinalo*), mats made of young pandanus leaves (*ʻahuao*), and feathers of the *ʻoʻo* and *mamo* birds of Puna" (Kamakau 1992:106). For, ʻĪmakakoloa believed that "his own people who cultivated the ground should be provided with the necessaries of life, before the numbers of the royal court, who lived in idleness" (Elkin 1904:26). Insulted by ʻĪmakakoloa's insubordination, Kalaniʻōpuʻu waged war on him and the Puna chief was forced to flee and hid in Puna for more than a year. Kalaniʻōpuʻu, sworn to vengeance, ruthlessly stalked the fugitive chief and ordered that Puna be burned to the ground. Fornander (1969:202) indicates that the district was "literally laid in ashes" as a result.

HISTORICAL ACCOUNTS OF PŌPŌKĪ AHUPUAʻA AND THE GREATER PUNA DISTRICT

Written accounts penned by early visitors to the Island of Hawaiʻi offer insight into what life may have been like for the Hawaiians of Puna. Such accounts describe Puna as sparsely populated with residential concentrations located along the coast where marine resources were easily accessible. For instance, in March of 1779, after Cook's death, Captain King sailed along the Puna shoreline and described the district as sparsely populated, but verdant and fertile (Maly 1998). The reader is referred to the Archaeological Inventory Survey (Dircks Ah Sam and Barna 2017), prepared by ASM in conjunction with the current investigation, for additional historical accounts that reference the greater Puna district. The following discussion focuses on traditional natural resource procurement and agricultural practices as well as changes in land use over time. Prior to the *Māhele* of 1848, historical narratives portray Puna as a district still heavily rooted in tradition and only marginally impacted by foreign influence. While subsequent accounts reveal a sharp decline in the native population, with Hawaiians maintaining marginalized communities outside of the central population centers.

Traditional Agricultural Practices of the Puna District

Puna is a dynamic land of rebirth that can support abundant vegetation despite its appearance as a desolate landscape under constant threat of the fires of Pele. In 1836, Reverend Titus Coan traveled to Puna and recorded the following observations of the lava covered coastline and verdant uplands:

> Its shore line, including its bends and flexures, is more than seventy miles in extent. For three miles inland from the sea it is almost a dead level, with a surface of pahoehoe or field lava, and *a-a* or scoriaceous lava, interspersed with more or less rich volcanic soil and tropical verdure, and sprinkled with sand-dunes and a few cone and pit-craters. . . Everywhere the marks of terrible volcanic action are visible. The whole district is so cavernous, so rent with fissures, and so broken by fiery agencies, that not a single stream of water keeps above-ground to reach the sea. All the rain-fall is swallowed by the 10,000 crevices, and disappears, except the little that is held in small pools and basins, waiting for evaporation. The rains are abundant, and subterranean fountains and streams are numerous, carrying the waters down to sea level, and filling caverns, and bursting up along the shore in springs and rills, even far out under the sea. Some of these waters are very cold, some tepid, and some stand at blood heat, furnishing excellent warm baths. There are large caves near the sea where we enter by dark and crooked passages, and bathe by torchlight, far underground, in deep and limpid water.
>
> Puna has many beautiful groves of the cocoa-palm, also breadfruit, pandanus, and ohia, and where there is soil it produces under cultivation besides common vegetables, arrowroot, sugar-cane, coffee, cotton, oranges, citrons, limes, grapes, and other froots [sic]. On the highlands, grow wild strawberries, cape gooseberries, and the ohelo, a delicious berry resembling our whortleberry. (Coan 1882:39-40)

In addition to the agricultural resources listed above, the barrenness of surrounding lava flows was not a limiting factor for the cultivation of sweet-potato or *ʻuala*, which requires practically no soil to flourish. Its propagation is discussed in detail by many nineteenth and early twentieth century visitors to the district, who describe seeing the *ʻuala* growing from mounds of lava stones. In the following passage, published under the title "Hawaii-Nei" in *Harper's Magazine*, Charles Nordhoff (1873a:382-402) describes the vegetation of Puna and mention early commercial coffee production in the district. Nordhoff also provides observations of the narrow coastal trail "across unceasing beds of lava" that "was actually hammered down to make it smooth enough for travel" in some places (1873a:401). According to Nordhoff, "most of the lava is probably very ancient, though some is quite recent, and ferns and guava bushes and other scanty herbage grow through it" (ibid.). Nordhoffs narrative continues thusly,

> . . . after a descent to the sea-shore, you are rewarded with the pleasant sight of groves of cocoa-nuts and umbrageous arbors of pandanus, and occasionally with a patch of green. Almost the whole of the Puna coast is waterless. . .
>
> It will surprise you to find people living among the lava, making potato patches in it, planting coffee and some fruit trees in it, fencing in their small holdings, even, with lava blocks. Very little soil is needed to give vegetation a chance in a rainy season, and the decomposed lava makes a rich earth. But, except the cocoa-nut, which grows on the beach, and seems to draw its sustenance from the waves, and the sweet-potato, which does very well among the lava, nothing seems really to thrive. (ibid.).

In another installment titled "Hawaii-Nei-II" Nordhoff (1873b:544-559) speaks again of the lack of fresh-water in Puna and that Dr. Coan had told him about how Native Hawaiians collected freshwater for his use during his missionary tour "from the drippings of dew in caves" (1873b:550). For, "wells are here out of the question, for there is no soil except a little decomposed lava, and the lava lets through all the water which comes from rains" compounded by the lack of mountain streams (ibid.). Nordhoff also presents the following observations of the communities in Puna as well as traditional sweet potato planting methods:

> There are no fields, according to our meaning of the word. Yet formerly the people in this district were numbered by thousands: even yet there is a considerable population, not unprosperous by any means. Churches and schools are as frequent as in the best part of New England. Yet when I asked a native to show me his sweet-potato patch he took me to the most curious and barren-looking collection of lava you can imagine, surrounded too, by a very formidable wall made of lava, and explained to me that by digging holes in the lava where it was a little decayed, carrying a handful of earth to each of these holes, and planting there in a wet season, he got a very satisfactory crop. Not only that, but being desirous of something more than a bare living, this man had planted a little coffee in the same way, and had just sold 1600 pounds, his last crop. (ibid.)

Although *ʻuala* was cultivated widely, Handy suggests that it does not appear to have been a staple food of Puna, a district which was "most famous for its breadfruit" (1940:190). Handy opines:

> . . . Despite the fact that sweet potatoes were planted almost universally and many patches are still maintained, the Puna natives seem to regard this vegetable with little interest, probably because Puna people prided themselves upon and relished their breadfruit, and also because potato was nowhere and at no time the staple for this rainswept district. (1940:165)

Breadfruit (*ʻulu*) was a *kinolau* (physical manifestation) of the goddess Haumea, the "patron of childbirth," and the principle staple food of Puna where it was most famous (Beckwith 1970:283; Handy et al. 1991). Careful and gentle propagation was required, which entailed the removal and replanting of the root sucker cutting while ensuring it remained within its original, undisturbed soil casing. With respect to *ʻulu* as a sustainable food source, Handy et al. explain that, "except in Puna, Hawaii, breadfruit was wholly secondary to taro and sweet potato as a staple. I am told that in Puna in a good year, breadfruit may be eaten for 8 months of the year, beginning with May "(1991:152).

Although *ʻulu* appears to have been the preferred source of sustenance for residents of Puna, taro (*kalo*) rivaled it as a staple food source. Puna's lack of flowing streams made growing wetland *kalo* impossible. Despite this freshwater stream deficit, Puna received plentiful rainfall throughout the year, which made the cultivation of dryland *kalo* possible, even along the coast as far north as Hilo (Handy 1940). Handy et al. relate that, "the wet and sometimes marshy pandanus forests from Kapoho through Poho-iki to ʻOpihikao used to be planted with taro in places" (1991:541). The method of planting dryland taro in the lowland forests of Puna is described by Handy et al. as the "*pa-hala* (pandanus clearing) method" (1991:104) and was advantageous for it did not require the constant weeding necessitated in better soils. The Pa-hala planting process is as follows:

> . . .Make holes in the *ʻaʻa* (broken lava) by taking out some of the stones. Be sure that the place chosen is in a *pu hala* grove, to save the labor of hauling *hala* branches into the patch later on. Fill the hole with whatever weeds can be found and leave them there for six weeks or more. The weeds will rot and make soil. When the weeds have rotted away, the taro *huli* are wrapped in *lau hala* (*hala* leaves) to keep them moist and are planted. When there or four leaves have appeared on each *huli*, then that is the tame to cut down the *pu hala* to let in the sun. The branches of the *hala* are cut off and the patch covered with them until this is not a trace of the taro to be seen. This is left until sufficiently dry to set on fire. The fire does not hurt the taro much as the *huli* are already well rooted. The *hala* reduced to ashes, give the taro the needed nourishment and they grow so tall that a man can be hidden under their leaves. (Handy et al. 1991:104–105)

The *pa-hala* method of cultivating dryland *kalo* in Puna could also be practiced on grass-covered slopes rather than directly atop lava; however, cultivation in grassy areas did require burning off the surface organics prior to planting (Handy 1940). Additionally, *kalo* could be opportunistically planted in depressions left by toppled over *hāpu'u* fern trunks found at higher elevations, such as lands *mauka* of the current study area (Handy et al. 1991:51).

The pandanus tree known as *pū hala* or *hala* (Figure 4) was valued for its fragrance and harvested for more utilitarian purposes. The inhabitants of Puna were recognized for their skilled *lauhala* (pandanus leaf) weaving. The dried leaves were used to plait *lauhala* mats for thatching onto house rafters and walls in a method typically employed in Puna and the neighboring district of Hilo in the absence of *pili* grass. Plaited *lauhala* was also used for pillows, fans, floor coverings, canoe sails, baskets, and occasionally as clothing (Handy 1940; Handy et al. 1991; Summers 1999). According to Fornander (1918-1919), two styles of *lauhala* mats were associated with Puna; the *makali'i*, a braided, small-stranded mat, and the *puahala* or *hīnano*, made from the male pandanus blossom. The latter was highly valued, and ". . .is only made in Puna where the hala tree is very abundant. It is a regular article of trade among the natives who greatly prize it as a choice mat to sleep on" (Summers 1999:17).

Figure 4. Man standing in a Puna *pū hala* grove in 1888 (Brigham and Stokes 1906:28).

William T. Brigham, former Director of the Bernice Pauahi Bishop Museum, described seeing the natives of Puna weaving the mats for which the district was famous, as follows:

> Puna was a famous region for hala mats, and in 1864, the author, when journeying through the district with that noble missionary the Reverend Titus Coan, saw many a party in the curious open caves (caused by a breakdown of the lava crust in some of the many streams of lava, ancient and recent, that form much of the surface of Puna) busily engaged in weaving mats, a work for which the comparative coolness and dampness of the caves was most suited. (1906:29)

Brigham's account continues with a report of depopulation in the district a mere twenty-five years after his first visit and concludes with observations of the impact the sugar industry and development on the Puna District in the early 1900s:

> A quarter of a century later in traveling the same road with a younger companion the scene was greatly changed: the caves were there, the hala trees were there, but the inhabitants had gone, and for sixty miles there was nothing but a few deserted churches and some aged breadfruit trees to tell that once people had lived there. Fifteen years later the scene had again changed owing to the opening of roads and the cultivation of sugarcane, but the present inhabitants were not the old natives, and the mat making is only here and there continued when there is a chance to sell to the foreigner. (Brigham and Stokes 1906:29)

Hala was significant on a spiritual level as well, Handy (1993) conveys the significance of the *hala*, which played a role in the protection of a newborn baby's placenta (*'iewe*). *Hala* groves were abundant in Puna, and concealing the

ʻiewe high up in the leaves prevented it from being pilfered. The people of Puna were sometimes referred to as *maka kōkala* (thorny eyes) by the inhabitants of the neighboring district of Kaʻū, correlating the spined leaves of the *hala* with the long eyelashes of the baby whose *ʻiewe* it was sheltering, providing a "bright keen look" (Handy 1993; Pūkuʻi and Elbert 1986:160). Maly relates, "to this day, Puna is known for its growth of *hala*, and the floors and furniture of some of the old households are still covered with fine woven mats and cushions. Weaving remains an important occupation of many native families of Puna." (1998:6).

In addition to these resources, other crops such as coconut (*niu*) and *ʻawa* were cultivated in Puna. *Niu* thrived in coastal Puna and is frequently mentioned in historical accounts. With respect to varieties, Handy et al. (1991) list only two: the *niu hiwa* (particularly used for ceremony, medicine, and cooking), and the *niu lelo* (used primarily for nonreligious purposes). Water from the *niu* was palatable and flavorful. It could also be utilized on a spiritual level by priests practicing divination. The raw meat was edible, and could be scraped out of the shell with a large *ʻopihi* to be eaten as is or incorporated into the preparation of various sweets including *haupia* (*haukō*), *kūlolo, and piʻepiʻe ʻulu*. Besides being utilized for human consumption, coconut meat could also be used to feed animals. Handyet al. explained:

> In some localities in Puna, pigs were taught to open their own coconuts. When the owners of the pigs expected to be absent for some time, they husked a quantity of the nuts, leaving a strip of husk on each one about two inches in width. When a pig wanted to open a nut, he grasped it by this strip of husk and dashed it against a rock. Thus the pigs were assured of fresh food until the owners returned. (1991:174)

The meat of the coconut could also be crafted into fresh coconut oil; Handy et al. describe the process thusly:

> In Puna, *manoʻi* or coconut oil was made as follows: The fresh gratings, with *maile* or other *kupukupu* (any odoriferous plant) to give fragrance, were placed in a container in the hot sun. When the oil separated away from it, the mass was squeezed through *ahuawa* and the refuse (*oka*) thrown away. The oil was used for anointing the body and hair and washing the hair. (1991:192)

Coconuts also provided husk fibers to plait sennit *ʻaha* (cordage) to be used for lashing house timbers, adzes, and canoe parts, making food containers (*ʻumeke*) and the main body of the *pahu hula* drum. The shell could be cut in half to be used for drinking, medicinal, or ceremonial cups, using leaf stems and midribs to clean pig intestines, make brooms, shrimp snares, and for stringing *kukui* nuts to be burned as candles, plaiting leaflets to make fans and playing balls for children, and using the end of the leaf as *kapu* markers along the coastline or to frighten fish out from under ocean ledges (Handy et al. 1991). The method of propagating *niu* involved burying a sprouted nut on top of an octopus (*heʻe*) at a hole deep enough to bury it completely. The buried *heʻe* was purported to "give the root a spread and grip like its own and to produce nuts that were bulbous like its head or body (*pu*)" (ibid.:172).

ʻAwa, a plant described as the "cherished narcotic" of the Hawaiian people by Handy et al. (1991:192) was utilized by all socioeconomic classes during the Precontact Period for pleasure, relaxation, and ceremonial purposes. *ʻAwa* was an important element in the treatment of both physical and spiritual ailments in living subjects by *kahuna* (priests). and a crucial ingredient in ritualistic use in which its procurement and preparation were handled with the utmost care. To consume *ʻawa* required careful preparation: first its roots were chewed (pounded in later years) into balls (*mana* or *mana ʻawa*) and then strained with the stem fibers of the *ahuʻawa*. Of all the districts of Hawaiʻi Island, Puna was the most renowned for its *ʻawa*, producing the famous *ʻawa kau laʻau*, which was particularly strong (ibid.)

Another resource utilized in Puna was the endemic *hāpuʻu* tree fern. In an account of a brief stay at a halfway house in 1847, presumably in ʻŌlaʻa, retired sea captain Charles Gelett describes how Hawaiians obtained *pulu* wool from the stalks of the endemic *hāpuʻu* tree fern for commercial and domestic use:

> The fern is very abundant in this region; it grows in some instances fifteen or twenty feet high. From it the pulu is obtained, which is used for beds, pillows, etc., and the root is used for food in seasons of scarcity. (1917:66)

Early Explorer and Missonary Accounts

In 1835, 4,800 individuals were recorded as residing in the district of Puna in the missionary census conducted that year (Schmitt 1973); the smallest total district population on the island of Hawaiʻi. In 1841, missionaries documented the population of Puna at 4,371 and noted that most of the inhabitants lived near the coast (Holmes 1985). That same year, the United States Exploring Expedition under the direction of Commander Charles Wilkes, toured Hawaiʻi Island and travelled through the Puna District. Wilkes produced a map of Puna, which illustrates the coastal trail but shows only a large "Pandanus Forest" covering the lands *mauka* of the study area (Figure 5). Wilkes described the trail between Hilo and Nānāwale (Nanavalie), which is also depicted in Figure 5 as follows:

> In some places they have taken great pains to secure a good road or walking path; thus, there is a part of the road from Nanavalie to Hilo which is built of pieces of lava, about four feet high and three feet wide on the top; but not withstanding this, the road is exceedingly fatiguing to the stranger, as the lumps are so arranged that he is obliged to take a long and short step alternately; but this the natives do not seem to mind, and they pass over the road with great facility, even when heavy laden…(Wilkes 1845, Vol. IV:188-193)

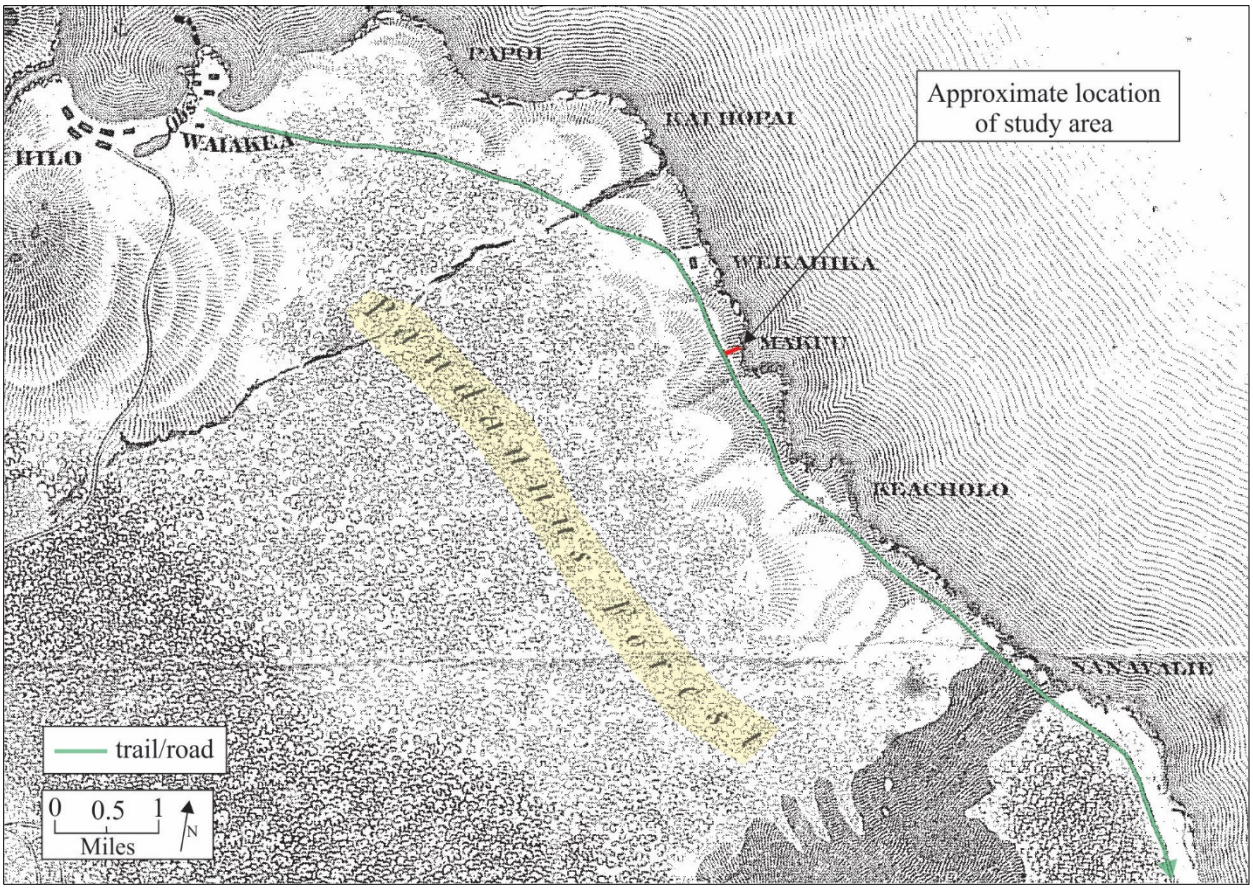

Figure 5. Portion of map titled "Part of the Island of Hawaii, Sandwich Islands, Showing the Craters and Eruptions of May and June 1840, by the U.S.Ex.Ex. 1841" (Wilkes 1845).

In 1846, Chester S. Lyman, visited Hilo, Hawai'i, and stayed with Coan and reported that the district of Puna had somewhere between 3,000-4,000 inhabitants (Lyman ms. Book III:3 in Maly 1998:35). Thus, less than fifty years after the arrival of the first Europeans, the population of Hawai'i was in decline. By 1850, the population of Hawai'i Island had dropped to 25,846 individuals (Schmitt 1973:8). Maly summarizes the reasons for the rapid decline of native populations thusly:

> Overall, historic records document the significant effect that western settlement practices had on Hawaiians throughout the islands. Drawing people from isolated native communities into selected village parishes and Hawaiian ports-of-call, had a dramatic, and perhaps unforeseen impact on native residency patterns, health, and social and political affairs. In single epidemics hundreds, and even thousands of Hawaiians died in short periods of time. (1998:36)

By the mid-nineteenth century, the ever-growing population of Westerners in Hawai'i forced socioeconomic and demographic changes that promoted the establishment of a Euro-American style of land ownership. In 1848 the *Māhele 'Āina* became the vehicle for determining ownership of native lands. The volumes of native registry and testimony collected for *kuleana* claims provide a snap-shot of life in Hawai'i during the middle part of the nineteenth century. Very few claims for *kuleana* were submitted in Puna compared to other districts of Hawai'i. Maly (1998) notes that no other land division of comparable size had fewer claims for *kuleana* from native tenants than Puna, except for the islands of Kaho'olawe and Ni'ihau.

As a result of the *Māhele*, Pōpōkī, along with the immediately adjacent *ahupua'a* of Maku'u and Hālona, were retained as Government Lands in their entirety; thus, no *kuleana* parcels were awarded (Charvet-Pond and Rosendahl 1993:C-2). In addition, the Commissioners of Boundaries (Boundary Commission) never certified the boundaries of Pōpōkī Ahupua'a, which is why it is so often grouped with the neighboring *ahupua'a* of Maku'u and Hālona. These three *ahupua'a* were not depicted individually on any of the cartographic resources reviewed for this study; and in literature, all three are often referenced together as a single unit called Maku'u.

In conjunction with the *Māhele*, the King had authorized the issuance of Royal Patent Grants to applicants for tracts of land that were larger than those generally available through the Land Commission. Between 1852 and 1855, coastal portions of Pōpōkī, Maku'u and Hālona *ahupua'a* were divided and sold as fee simple Land Grants (Figure 6). Grant 1013 was sold to D. Maiau in 1852; Grant 1014 to Kea in 1852; and Grant 1537 to Kapohano(a) in 1855 (Figure 8). The current study area is situated within the southern coastal portion of Grant 1537, which comprises 171 acres and is crossed by the *alanui aupuni* or government road (Maly 1999:67).

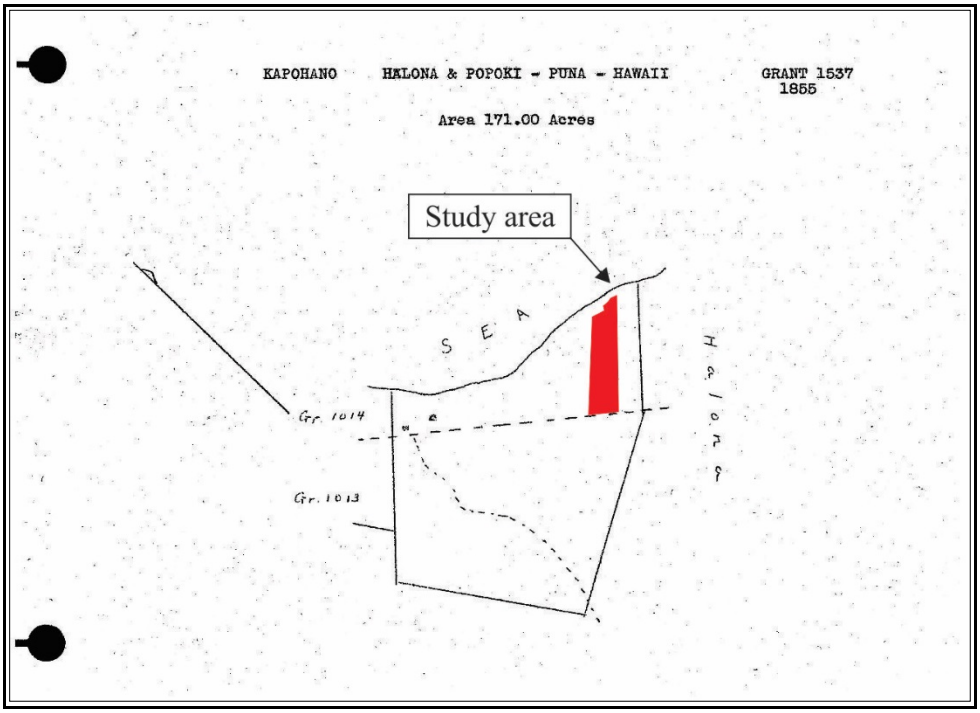

Figure 6. Map of Grant 1537 to Kapohano showing study area within (Kipuka Database).

Around the time that Grant 1537 was sold, Puna's population had suffered a sharp decline. Within a quarter of a century, Puna's population deteriorated by more than half from 4,800 in 1835 to 2,158 in 1860 (Anderson 1865). The Puna district population continued to decrease to a mere 1,043 souls in 1878, and reached an unsurpassed low of 944 persons by 1884 (Thrum 1885 and 1886). Post-Māhele historical accounts of Puna were mostly authored by visitors to the Hawaiian Islands and function more like travelogues. These writings demonstrate a considerable transformation from the almost exclusive traditional native subsistence strategies discussed in earlier chronicles to a new way of life.

Late Nineteenth Century Historical Accounts

In 1866, Samuel Langhorne Clemens, better known as the classic American novelist Mark Twain, toured Hawai'i Island on horseback. During his journey, Twain took a moment to contemplate the curious Puna geology and offers some witty remarks:

> At four o'clock in the afternoon we were winding down a mountain of dreary and desolate lava to the sea, and closing our pleasant land journey. This lava is the accumulation of ages; one torrent of fire after another has rolled down here in old times, and built up the island structure higher and higher. Underneath, it is honeycombed with caves. It would be of no use to dig wells in such a place; they would not hold water—you would not find any for them to hold, for that matter. Consequently, the planters depend upon cisterns.

> The last lava flow occurred here so long ago that there are none now living who witnessed it. In one place it inclosed [*sic*] and burned down a grove of cocoanut trees, and the holes in the lava where the trunks stood are still visible: their sides retain the impression of the bark: the trees fell upon the burning river, and becoming partly submerged, left in it the perfect counterpart of every knot and branch and leaf, and even nut, for curiosity-seekers of a long-distant day to gaze upon and wonder at.
>
> There were doubtless plenty of Kanaka sentinels on guard hereabouts at that time, but they did not leave casts of their figures in the lava as the Roman sentinels at Herculaneum and Pompeii did. It is a pity it is so, because such things are so interesting; but so it is. They probably went away. They went away early, perhaps. However, they had their merits; the Romans exhibited the higher pluck, but the Kanakas showed the sounder judgement. (1913:243-244)

In 1868, two years after Twain visited Puna, a massive volcanic eruption emanating from Mauna Loa volcano shook Hawai‘i Island, bringing with it lava flows, earthquakes and a large *tsunami*. As a result, the landscape of the southern part of the island was forever transformed, and the population of Puna dwindled further. Reverend Coan recorded the following account of the April 2nd eruption:

> …a terrific shock rent the ground, sending consternation through all Hilo, Puna, and Kau. In some places fissures of great length, breadth, and depth were opened… Stone houses were rent and ruined, and stone walls sent flying in every direction…the sea rose twenty feet along the southern shore of the island, and in Kau 108 houses were destroyed and forty-six people drowned…Many houses were also destroyed in Puna, but no lives were lost. During this awful hour the coast of Puna and Kau, for the distance of seventy-five miles subsided seven feet on average, submerging a line of small villages all along the shore. (1882:314-316)

Isabella Bird visited Puna in 1873, and published her vivid first-hand accounts in *The Hawaiian Archipelago: Six Months Among the Palm Groves, Coral Reefs, & Volcanoes of the Sandwich Islands* (Bird 1876). In the following excerpt, Bird provides a meticulously detailed depiction of Puna's lush forests and craggy lava fields:

> At some distance from Hilo there is a glorious burst of tropical forest, and then the track passes into green grass dotted over with clumps of the pandanus and the beautiful eugenia. In that hot, dry district the fruit was already ripe, and we quenched our thirst with it. The "native apple," as it is called, is of such a brilliant crimson colour as to be hardly less beautiful than the flowers. The rind is very thin, and the inside is white, juicy, and very slightly acidulated. We were always near the sea, and the surf kept bursting up behind the trees in great snowy drifts, and every opening gave us a glimpse of deep blue water. The coast the whole way is composed of great blocks of very hard, black lava, more or less elevated, upon which the surges break in perpetual thunder.
>
> Suddenly the verdure ceased, and we emerged upon a hideous scene, one of the many lava flows from Kilauea, an irregular branching stream, about a mile broad. It is suggestive of fearful work on the part of nature, for here the volcano has not created but destroyed. The black, tumbled sea mocked the bright sunshine, all tossed, jagged, spiked, twirled, thrown heap on heap, broken, rifted, upheaved in great masses, burrowing in ravines of its own making, full of broken bubble caves, and torn by *a-a* streams. Close to the track, crystals of olivine lie in great profusion, and in a few of the crevices there are young plants of a fern which everywhere has the audacity to act as the herald of vegetation.
>
> Beyond this desert the country is different in its features from the rest of the island, a green, smiling land of Beulah, varied by lines of craters covered within and without vegetation. For thirty miles the track passes under the deep shade of coco palms, of which Puna is the true home; and from under their feathery shadow, and from amidst the dark leafage of the breadfruit, gleamed the rose-crimson apples of the euginia, and the golden balls of the guava. I have not before seen this exquisite palm to advantage, for those which fringe the coast have, as compared with these, a look of tattered somber, harassed antiquity. Here they stood in thousands, young as well as old, their fronds gigantic, their stems curving every way, and the golden light, which is peculiar to them, toned into a golden green. They were loaded with fruit in all stages, indeed it is produced in such abundance that thousands of nuts lie unheeded on the ground. Animals, including dogs and cats, revel in the meat, and in the scarcity of good water the milk is a useful substitute.
>
> Late in the afternoon we reached our destination, a comfortable frame house, on one of those fine natural lawns in which Hawaii abounds. . . (1876:242-243)

Journalist Henry Martyn Whitney published the very first guide book to the islands in 1875, titled *The Hawaiian Guide Book, For Travelers.* In the 1895 edition, Whitney published the following touristic account of Puna. In this excerpt, he describes crossing through dense forests and the 1840 lava flow as he journeys from Hilo towards Maku'u, located immediately north of Pōpōkī Ahupua'a (emphasis added):

> Puna—This district presents some features which are well worth the exertion which the traveler will have to make in order to see them. The general appearance from the road is sterile, especially in the southern part, where there are considerable tracts covered with lava rock supporting the scantiest of vegetation. The northern part of the district is covered with a dense *lauhala* forest and is thinly inhabited. The road is thus very monotonous. Some eighteen miles from Hilo the country begins to improve, and away from the main road, upon the slopes of the mountain, there are many acres of excellent land, suitable for coffee and fruit growing. The south-eastern part of Puna has some celebrity for its groves of coconuts, the trees being more abundant here than in any other part of the islands. The traces of volcanic action are extremely prominent in this district. The most striking flow is that of 1840, which after pursuing an underground course for many miles suddenly burst forth in the woods and rushed down to the sea, overwhelming a small village in its course. During the great earthquakes of 1868, the southern coast of Puna was lowered. Traces of this may be seen in the stumps of coconut trees which are left sticking up amid the constant surf.
>
> The tourist who plans to go through Puna, should obtain letters for either Kapoho or Pohoiki, where the first night would be spent, and for Kaimu, which should be the second stopping place. The road from Hilo, skirts along the Bay, passes over the Waiakea river and very shortly plunges into a thick belt of forest which extends as far as Keaau, nine and a quarter miles from Hilo. From thence the road goes in almost a straight line through long tracts of *lauhala* groves, with occasional glades affording glimpses of the sea. A few scattered houses are passed and at Makuu, fifteen miles from Hilo, there is quite a little settlement. Some four miles further on the flow of 1840 is crossed. The lava looks almost as fresh to-day, as when it came down fifty years ago. (Whitney 1895:91-92)

John Roy Musick, an American author, visited the Hawaiian Islands not long after Whitney and described the lava trees of Puna. In the following excerpt, Musick also mentions the commercial cultivation of coffee, which was a short-lived industry in Puna during the early twentieth century:

> . . . The lava-flows have left many strange figures in the forest. Trees of lava can be seen. They are supposed to have been made by the molten lava rushing down the hill with such velocity that it splashed up the sides of the trees, and congealed before the wood was burned away. These lava-trees or columns are hollow, and some are supposed to be a hundred years old. Hundreds of these monuments of ancient eruption are to be seen, some fifteen or twenty feet in height. These memorials of a perished forest are both curious and instructive.
>
> . . . Puna is one of the great coffee-producing districts of Hawaii. The coffee grown there is not excelled anywhere in the world. Some of the plantations contain from twenty-five to sixty thousand trees. (1898:170-171)

The Reverend George Leonard Chaney of Salem, Massachusetts, visited Puna on March 18, 1876. Chaney's detailed account describes the distinctive lava-blanketed coast and mentions the presence of wild cattle as well as a meeting house with a dwindling congregation

> Arrived at Kaau [Kea'au], we lunch on boiled eggs and taro, bait our horses and give them a brief nooning, at two o'clock start again for Puna. The student of lava will find every variety on this route, and an abundance of it. Beginning in a vast expanse of *pahoehoe* or satin-stone, it leads to a-a, pumice, and rotten-stone. *Lauhala* forests cover the *pahoehoe*, and now and then as we travel through them wild cattle make their appearance, and acknowledge Mr. L—'s ownership by running rapidly away. Some coco palms succeed the *lauhalas*. All the way the sound of a splendid surf attends us, and occasionally a lock of silvery spray tossed above the rocks hints the ocean beauty which we cannot see. All at once this iron barrier is removed, and we are opposite a beach where the surf rolls up magnificently. At the foot of the black lava sand-hills, beyond this beach, we stop to pick up olivine crystals scattered among the lava pebbles. Then we come to fresh green lands, with the finest specimens of coco palms which we have seen. . . No wonder this district was a favorite dwelling-place of the natives. A respectable settlement still remains. But the large old meeting-house, which stands among the little grass houses as an ostrich might stand with a brood of chickens about her, seems sadly in excess of the probable need of the place. Not many years ago it

> was filled with worshipping congregations. Dr. Coan tells me that he has preached there to an overflowing house; but there will be no crowd this year, altthough all the population around is convened. (Chaney 1880:135-136)

In 1885, Charles Warren Stoddard, an American author, travelled from Hilo to Kīlauea on horseback. In his uncomplicated and candid narrative, Stoddard recounts his stay at a halfway house in ʻŌlaʻa, Puna, giving vivid insight into daily life at that time:

> . . . With the superb poses of a trained athlete, my native swings a fowl by the neck, and very shortly it is plucked and potted, together with certain vegetables of proper affinities. Then he swathes a fish in succulent leaves, and buries it in hot ashes; and then he smokes his peace-pipe. Pipe no sooner lighted, than mouths mysteriously gather—five, ten, a dozen of them, magically assemble at the smell of smoke, and take their turn at the curled shell, with a hollow stalk for a mouth-piece.
>
> Dinner at last. O, fish, fruit, and fowl on a mat, on a floor, in a grass hut evening! How excellent are these—Amen.
>
> Night; supper over; some one twanging upon a stringed instrument of rude native origin. Gossip lags, but darkness and silence and a cigarette are agreeable substitutes.
>
> My native rises haughtily, and lights a lamp that looks very like a diminutive coffee pot with a great flame in the nose of it; he hangs it against a beam, already blackened with smoke, to the peak of the roof. Again, the peace-pipe sweeps the home circle, and is passed out to the mouths of the neighborhood.
>
> The spirit of repose descends upon us; one by one my dusky fellows roll themselves into mummy-like bundles, and lie in a solemn row along the side of the room, sleeping. I, also, will sleep; a great bark-cloth (kapa) that rattles as if it had received seven starchings, is all mine for a covering . . .
>
> Now I will sleep with my face under the kapa, and in an atmosphere of cocoa-nut oil, relieved at intervals by the sulphurous spurt of a match; I do sleep, and find it in spite of every thing highly refreshing. (1897:41-43)

An account titled "The Native Sandwich Islanders" written by Captain C. E. Dutton of the United States Ordnance Corps was published in an 1885 volume of *The Missionary Herald*. Dutton lived briefly in Puna while collecting scientific observations of volcanoes. During his time there, Dutton noted the diminishing numbers of the native population, suggesting abandonment was caused, at least in part, by greater economic opportunities elsewhere thusly:

> There is no portion of these islands where so much of the primitive character of the Hawaiians is retained by the people as in Puna. The district is seldom visited by white people, and I am informed that only two families of whites reside there. The native population is somewhat scanty and has undergone a great decrease within the present century, as in all other parts of the island. This decrease, however, seems to be due more to the emigration of the inhabitants to the large towns, like Honolulu and Hilo, than to the ravages of those diseases which are supposed to be the prime cause of the decay of the Hawaiian race. Many of the natives also go to other parts of the island, where they obtain employment upon the plantations and in other occupations. But those who remain retain considerable of their primitive character, spending the day in lounging, fishing, and visiting, living in grass-houses and subsisting principally upon fish and poi. On the other hand, they are amiable, hospitable, and peaceful to the last degree. They have civilized clothing, but often, as a matter of preference, go about wearing a shirt and malo. . .
>
> I was much pleased at the comparative neatness and order of the grass-houses in which most of the natives still live. The furniture is simple in the extreme. The floor is covered with mats woven of lauhala (pandanus) leaves, and are scrupulously neat. Tables and chairs are seldom used, except as luxuries. Food is eaten *á la turque*, the family sitting cross-legged around the dish of poi. Most households possess crockery, knives, forks, and spoons, but calabashes made from large gourds are still used, and "fingers were invented before forks." I spent an hour watching an old kanaka making a calabash. . . Not a little suggestive were long rows of letters in their envelopes, stuck cornerwise into the slats to which the bunches of grass are tied to form the wall of the house. All natives of suitable age can read and write their own language, for education is compulsory. They correspond most vigorously, and the mail facilities are remarkably good, considering the scanty population and resources of the kingdom. Every week the postboy rides through from Hilo to Kau, via Puna and Kilauea, and back again. The saddlebags are full of letters and weekly newspapers from Honolulu,

> printed in the Hawaiian tongue. This does not sound very barbaric, and in truth the Hawaiian is in all essentials as well civilized as the poor people of England or America. He owns his property in fee; he makes laws, executes and obeys them; he reads and writes; he has but one wife; he tills the soil and tends flocks; sometimes he accumulates wealth and sometimes he does not; he makes his will in due form, dies, and receives a Christian burial. . . All this is seen in Puna, which is no doubt the most primitive district in all the islands. (1885:385-387)

By the last quarter of the nineteenth century, the traditional lifeways of Puna natives had suffered rapid deterioration. This decline was coupled with a shift to more commercial pursuits and the development of associated infrastructure, which ushered in the twentieth century. Nordhoff spoke of this shift from subsistence to profit regarding the cultivation of taro in *Harper's Magazine* as follows:

> In fact, old things are dying out in many ways in the islands, and new things do not always take their place. Even the taro patches have in some places been turned into rice patches; and they are very well fitted for this. Taro is still an article of commerce; but the decreasing number of the native people lessens the demand for poi, and no doubt it will be found profitable to raise more rice and less taro. (1873b:552)

The Study Area Vicinity During the Twentieth Century

The forthcoming discussion will demonstrate how economic interests in Puna shifted from the traditional Hawaiian land tenure system and regional trade networks to the trade of Euro-American cash crops including coffee, sugar, rubber, timber, and cattle ranching. As the Native Hawaiian population continued to decline well into the twentieth century, the traditional agricultural system was largely abandoned in favor of these new economic ventures.

At the close of the nineteenth century, Olaa Sugar Company and Puna Sugar Company began operating in the Keaʻau and Kapoho areas, respectively. Around this time, the directors of Olaa Sugar Company organized the Hilo Railroad Company (HRC) and on June 18, 1900, rail service from Hilo to Keaʻau began (Best 1978). Soon, Puna Sugar Company covered half the cost for a 4-mile expansion of the HRC, which connected Kapoho and Pāhoa. By March 1, 1902, the HRC was making regular stops at the Olaa Sugar Mill, the town of Pāhoa, and in lower Puna. By 1905, Puna Sugar Co. harvests were being ground at the Olaa Mill, and the company was operating as a division of the Olaa Sugar Co. (Dorrance and Morgan 2000). The immediate study area vicinity of coastal Pōpōkī was never planted in cane.

Charles Wickliffe Baldwin (1908) published a detailed description of Puna in the *Geography of the Hawaiian* Island, which included mentions of the HRC and the ʻŌlaʻa cane fields. According to Baldwin (1908), the landings of Puna had all been abandoned by the time of his writing and the railroad extended across Puna to reach Kapoho and Kalapana, and passed through Keaʻau, Mountain View, and Pahoa. In addition, Baldwin stated that a roughly forty-mile section of the coastline "shows evidences of having sunk: cocoanut trees are found below the tide level, or their dead stumps stand out in the sea" (1908:77). Passenger rail service in the Puna District also started to increase around this time. In 1916, the HRC was reorganized as the Hawaiʻi Consolidated Railway (HCR). The route of the railroad across Pōpōkī ca. 1903, *mauka* of the current study area, appears on Hawaiʻi Registered Map No. 2258 (Figure 7). Also visible on Registered Map No. 2258 is a single structure within the boundaries of Grant 1537, located near the coast, *mauka* of a small hill and survey station labeled Opunaha (see Figure 7). It is also of note that on the map, the numbered survey transit stations along the coast were given names of presumed local significance (see Figure 7). A former resident of Makuʻu who resided on Grant 1013, Mrs. Mary Ann Kamahele, recalled that Opunaha was a canoe landing spot, and that Kula (the name given to Transit Station 14) was a *koʻa* (a fishing ground) where *āholehole* were caught (Ewart and Luscomb 1974). As seen on the map (see Figure 7), Transit Station 13, which approximates the southeastern corner of the current study area, is labeled Kahuanui, perhaps a reference to the coastal *pāhoehoe* flat that dominates the area. A coconut grove is also depicted directly across the Government Road from the current study area.

An unmarked *mauka*/*makai* trail extends just outside and parallel to the southern boundary of the current study area and bisects the Government Road and proceeds to the southwest with a branch that veers back down to the ocean. The main alignment of the trail continues south, extending through Keonepoko Iki Ahupuaʻa, crossing the Hilo Railroad and terminating just to the west of the "Section House" buildings. An "old trail" is also visible on the map to the west of the current study area within the northern portion of Grant 1537, immediately *mauka* of the Government Road. This trail extends *mauka* and terminates after it crosses the Hilo Railroad. The government road is labelled as "6-feet wide" on the 1903 map, the same alignment is labeled "Puna Trail" in a 1924 topographic map (Figure 8). Thus, the same alignment was referred to as Puna Trail, *alanui aupuni*, and Government Road interchangeably.

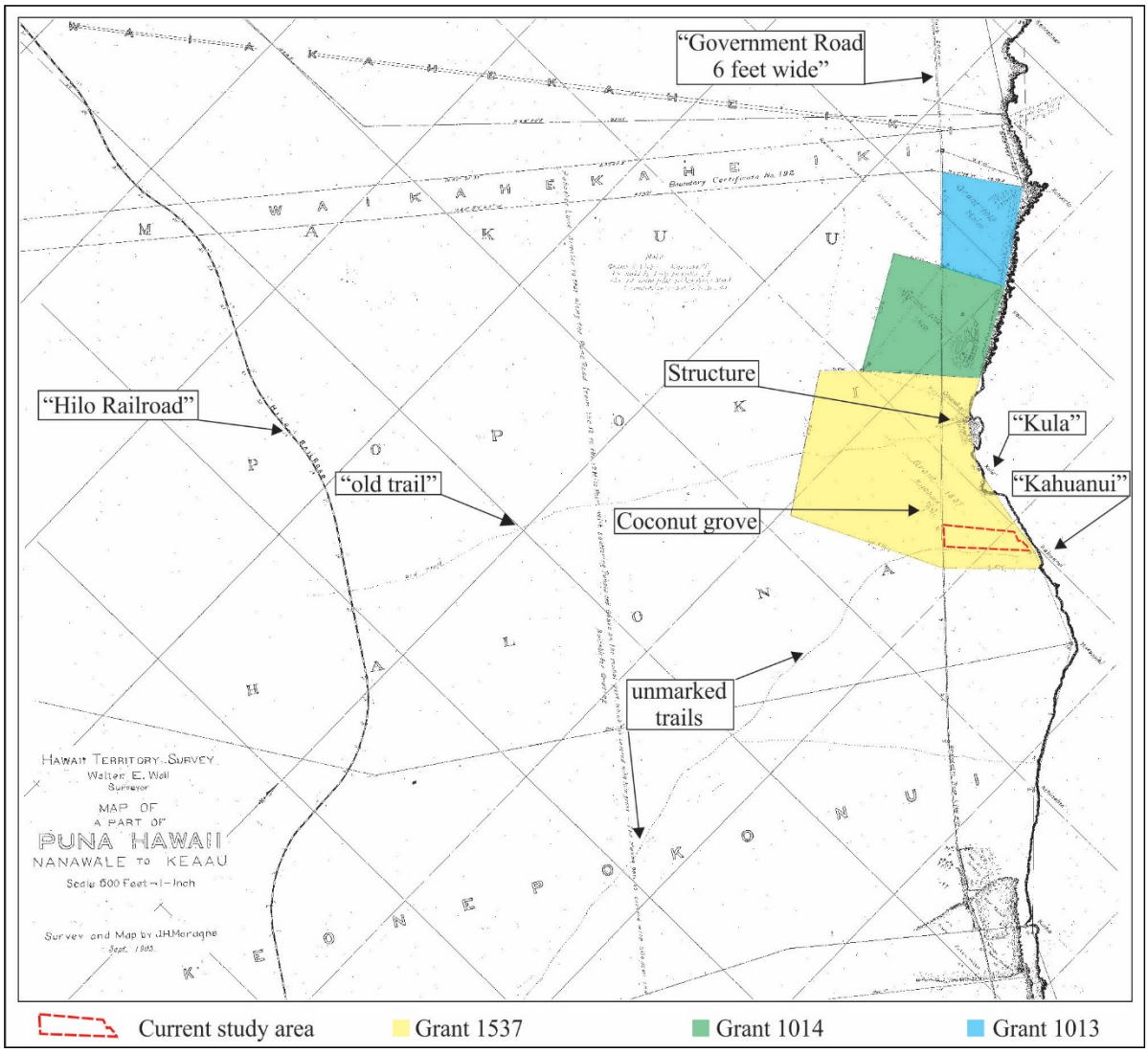

Figure 7. Portion of Registered Map No. 2258

This alignment may have served as the inspiration for the following excerpt from an unauthored touristic article titled, "Curiosities of Puna" published in a 1901 issue of *Paradise of the Pacific* magazine:

> An antiquity shown to tourists is a stone roadway three feet wide and many miles long, moss-grown with age. One section, four miles in extent, is as straight as the most skillful engineer could construct it, a monument of a lost Hawaiian art. A horseback journey through the by-ways of Puna will furnish the traveler with considerable information regarding the primitive customs and styles of the natives, for here the sons of the soil live closer to nature and are more like what the Lord made them than many of their brothers of the settlements, whose minds and bodies have been poisoned by the lusts of civilization. (*Paradise of the Pacific* 1901:11)

Another visitor, American author Henry Kinney (1913) published a comprehensive historical account of his journey through Puna during the early 1900s in his book titled *The Island of Hawaii*. Kinney's account acts as a virtual expedition through the district and includes detailed descriptions of roadways, natural geologic landmarks, and places of industry:

> The district of Puna may, for the sake of clearness, be divided into two sections, the Olaa region, the north half, and Puna proper. The former consists of the great Olaa sugar plantation, and forest which has been partially cleared, while some tracts are used for cattle. The middle part of the district, with Pahoa as the center, is used for extensive lumber operations. The remainder, Puna proper, is covered by forest and old lava flows, most of them covered with vegetation. . .

The main road into Puna is a continuation of the Volcano road which runs from Hilo town, the Puna boundary being about six miles out from Hilo. Hence an excellent road passes through forest and, further south, through cane, to Nine Miles, Olaa, the largest plantation camp on the Island. Near the boundary line may be seen clearings where awa is planted. Just north of the camp a road leads makai to the Shipman ranch headquarters at the beach. It is about four miles long, good and very pretty, passing through cane and then puhala forest. Right by the ocean is a large pond with very cold water. Small craft may effect [*sic*] a landing here in good weather.

. . . the road into Puna proper turns south. It passes through cane and past the homes of the principal plantation officers, and continues over an ancient lava flow, covered with stunted vegetation and used for cattle. (1913:75-79)

Figure 8. Portion of the 1924 UGSG Maku‘u quadrangle (current study area in red).

During the early twentieth century, the *makai* lands of Pōpōkī and neighboring Government Lands became part of Shipman Ranch. Hawai'i Territory Survey Plat Map No. 811 (prepared in 1915) shows that W.H. Shipman, Ltd. held a lease for pasture land of roughly 14,000 acres of Maku'u, Pōpōkī, and Hālona (General Lease No. 854) at an annual rental of $251.00 (Figure 9). The lease, which began on November 25, 1914 and expired on November 25, 1929, excluded the 171-acre Grant No. 1537 to Kapohano within which the current study area is located.

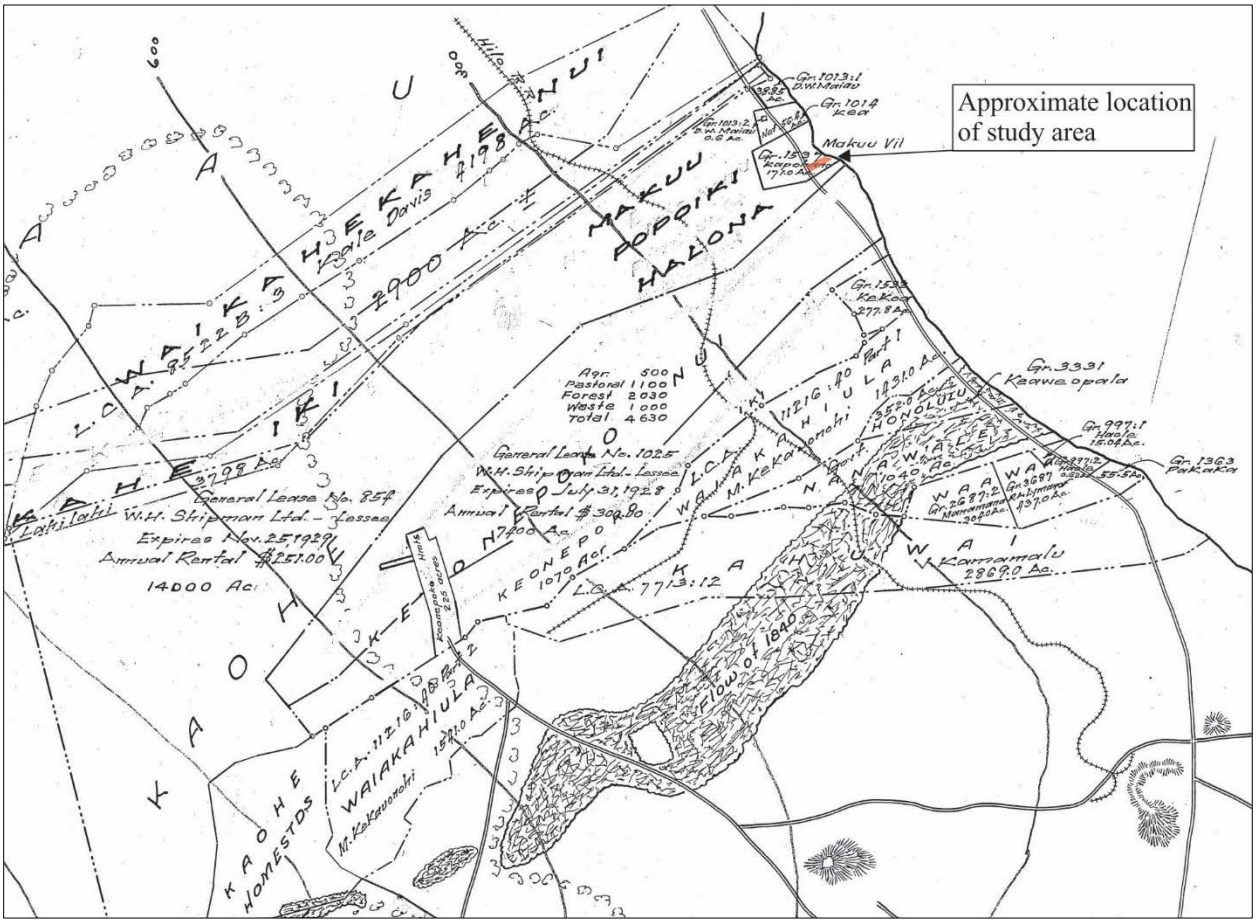

Figure 9. Portion of Hawaii Territory Survey Plat Map No. 811 (ca. 1915) showing the Shipman lease

The following excerpts are taken from an article titled "Motoring on the Island of Hawaii" written by John Ness, and published in the April 1920 issue of *The Mid-Pacific Magazine.* Ness tells of "the enchantment of palm-lined, surf-beaten coast line" (1920:368) found in Puna, and provides various details about industry in the district. He mentions two villages, Kaimu and Kalapana, located at the southern extreme of the district, "whose population numbers no white men and is almost exclusively native" (1920:369), which present the last vestiges of traditional Hawaiian life in the district. His account also mentions a rubber plantation in addition to the cultivation of sugar with small-time farmers also taking advantage of Puna's fecund terrain:

District Very Productive

> The district is by no means an entirely uncultivated forest and lava-clad area. Some of the most productive of the canefields of Olaa plantation and the holdings of many independent planters are found in Puna. Travelers interested in the agricultural and industrial development of the region will find here that the cultivation of cane is not all to which Hawaii's soil and climate are adapted. An interesting rubber plantation is located in this district, while more awa, the native root, is grown and dried in Puna than in any other district in the Islands.
>
> The homesteads of small farmers are scattered along the roads of the district, and vegetables and fruits, especially watermelons, are a feature of the output of Puna's fertile soil.
>
> At Pahoa is the mill of a lumber company, where the ohia and koa, two Hawaiian hardwoods taken from the virgin forests, are manufactured into various forms of lumber. (1920:368)

As is seen in the account above, in addition to commercial sugar cultivation, a short-lived lumber industry thrived in Puna, which lasted from around 1907 until 1916. Kinney also wrote of the timber industry in his account as follows:

> . . . Pahoa, a village which has sprung into prominence since it became the main camp of a lumber company which has a large mill here, where ohia (a hardwood used for railroad ties, flooring, shingles, tools and many similar purposes) and koa (Hawaiian mahogany, a wood used for furniture and fine wood work) is milled in large quantities. (Kinney 1913:75)

In 1908, the Hawaiian Mahogany Lumber Company erected a lumber mill at Pāhoa, which became the Pāhoa Lumber Mill on March 24, 1909. On January 28, 1913, a fire destroyed the mill and most of the lumber; but by October of that same year, the mill was operating again under the name Hawai‘i Hardwood Company. However, the Hawaiian Hardwood Company was forced to close their doors permanently only a few years later, in 1916 (Burtchard and Moblo 1994). The lumber mill was then leased to Olaa Sugar and standard gauge railroad track replaced the old timber railroad, and the timber producing forests were converted to sugarcane fields.

On June 17, 1929, a 500-acre portion of what is referred to as the Ka‘ohe-Maku‘u Government Tract was set aside as Parcel B for the Hawaiian Homes Commission, explicitly excluding Grants 1013, 1014, and 1537, within which the current study area is situated. Copy of Survey Furnished (C. S. F.) Map 5261 shows Parcel B within what is referred to as the Ka‘ohe-Maku‘u-Keonopoko Iki Government Tract (Figure 10).

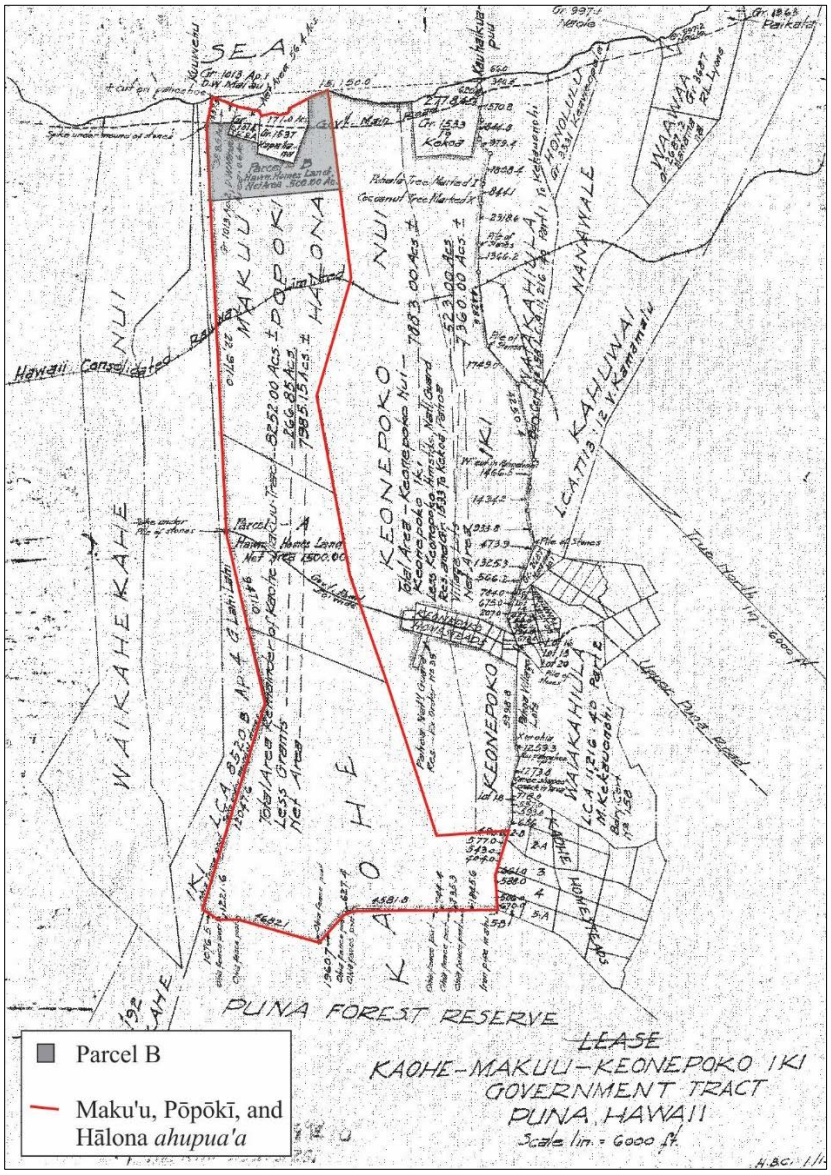

Figure 10. C. S. F. 5261 map, ca. 1929.

During World War II, 640 acres of land within the neighboring *ahupua'a* of Maku'u (within the current Maku'u Farm Lots subdivision) northwest of the current study area were utilized for target practice (USACE 2010). This area, formerly known as the Popoki Target Area, was originally leased to the United States Navy by either W.H. Shipman, Ltd., or the Shipman estate executor, H. Blackshear. By November 1, 1945, the target area was no longer in use and the lease was cancelled.

By 1946, rail travel was becoming less popular and less profitable due to improved roads and increased trucking. In March of that year, stockholders of HCR voted to abandon all railroad operations. This decision was reinforced on April 1, 1946 when a devastating *tsunami* destroyed Hilo Bay, including all the rail lines, a drawbridge in the bay, and part of the Waiākea freight yards. On November 20, 1946, HCR shut down its remaining lines, including all Puna railroad operations, and began auctioning off all its assets.

The 'Ōla'a railroad line remained in operating condition and continued to be used for hauling sugar until December of 1948. In that year, the sugar industry began phasing out its operations in Puna and closed the tracks permanently. Throughout this period of industrial growth and decline in Puna, the coastal portion of Pōpōkī Ahupua'a remained largely undeveloped as demonstrated in the aerial photographs from 1954 and 1977 (Figure 11). Only recently have single-family residences been cropping up on coastal parcels in this area.

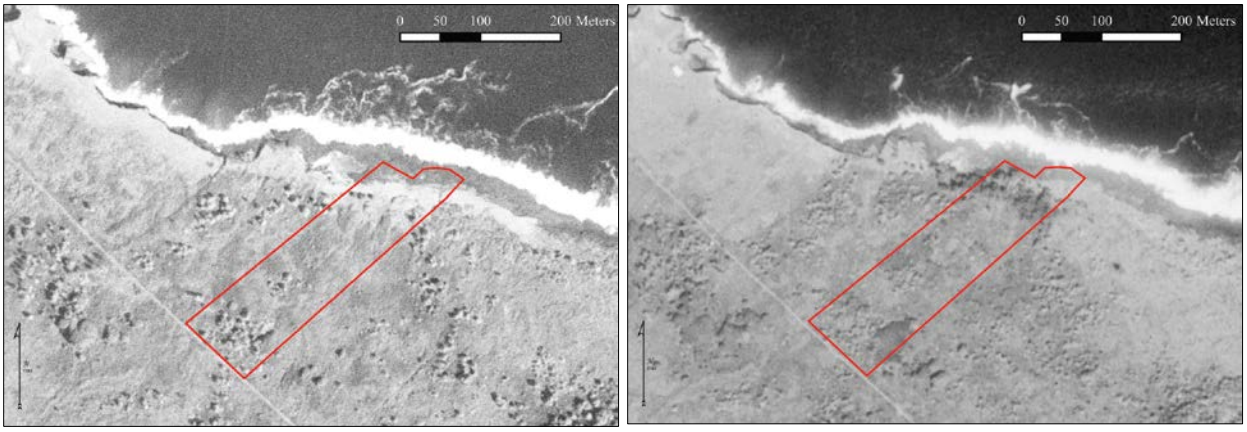

Figure 11. Aerial photograph comparison showing the study area outlined in red in 1954 (left) and 1977 (right).

PRIOR STUDIES

The following discussion summarizes previous studies conducted within the Maku'u-Pōpōkī-Hālona area that are relevant to the current study. For a comprehensive summary of archaeological studies conducted within the study area vicinity, the reader is referred to the AIS (Dircks Ah Sam and Barna 2017) that has been prepared as part of the environmental documentation in compliance with HRS Chapter 343 and the Conservation District permitting.

The earliest coastal survey of cultural resources in the vicinity of the current study area was conducted by Hudson (1932). Hudson attempted to inventory the sites of East Hawai'i Island from Waipi'o Valley to the Ka'ū District for the B. P. Bishop Museum. He recorded a wide range of archaeological features including *heiau*, burials, caves, habitations, trails, and agricultural features during his survey. The route of the survey took him through the coastal portion of Maku'u-Pōpōkī-Hālona. Hudson noted that it was difficult to obtain information about sites in Puna because "most of them are located along the coast between Keaau and Kopoho where no one now lives, and it is difficult to locate descendants of the former Hawaiian population of the area who might be able to shed light on the nature and function of certain sites", and that, "back from the sea the land is under cultivation in cane, used for pasture, or covered with dense vegetation which can be penetrated only with difficulty" (Hudson 1932:304).

A CIA was prepared by Ketner and Rechtman (2011) for a proposed single-family residence on TMK: (3) 1-5-010:032, in Maku'u Ahupua'a. During that study, consultation was conducted with several individuals with genealogical ties to the Maku'u area (see consultation section below). As a result of their study, Ketner and Rechtman (2011) concluded that the proposed development of a single-family dwelling on the parcel would not impact any traditional cultural practices. Furthermore, it was the authors' contention that potential impacts to the Precontact habitation and burial sites documented during the Clark et al. (2008) archaeological study of the parcel would be sufficiently mitigated by the preparation and successful implementation of preservation and burial treatment plans.

Rechtman and Kepa'a (2014) prepared a CIA for a proposed single-family residence on TMK: (3) 1-5-010:028, in Pōpōkī Ahupua'a, three parcels to the northwest of the current study parcel. As part of the study, Rechtman and Kepa'a closely examined information gathered during prior cultural studies in the area, and consulted with a member

of the Maku‘u Farmers Association (see consultation section below). Archival research coupled with information garnered during a previous study conducted by Ewart and Luscomb (1974) indicated the presence of a traditional Hawaiian fishing ground in the waters fronting Maku‘u. As the general shoreline area of Maku‘u has been traditionally utilized for recreational and subsistence purposes, Rechtman and Kepa‘a (2014) opined that the fishing ground could be considered a traditional cultural property, and the use of which could be considered a traditional cultural practice. Additionally, the archaeological fieldwork was conducted by Dircks Ah Sam and Rechtman (2013) on the parcel, which resulted in the identification a Precontact coastal trail segment interpreted as being associated with traditional use of the shoreline. It was concluded by Rechtman and Kepa‘a (2014) that an approved preservation plan for the trail segment should serve to sufficiently mitigate potential impacts, and that adherence to shoreline setbacks would ensure that the proposed development would not affect off-shore traditional places or practices.

ASM conducted an AIS (Dircks Ah Sam and Barna 2017) of the current study area in support of the EA and CDUA process required for the current proposed residential development. Dircks Ah Sam and Barna recorded a single previously unrecorded archaeological site: an agricultural complex (SIHP Site 50-10-45-30712), within the subject parcel. The site comprises sixty-three features that include twenty-two mounds, twenty-two walls and three wall remnants, nine modified depressions, three cleared soil areas, three modified outcrops, one cluster of *pāhoehoe* excavations, and one rock alignment (Figure 12). In addition, a single test trench (TT-1) was excavated by hand to determine if archaeological evidence of a trail (Site 18418A) previously recorded on a nearby parcel was present *mauka* of the shoreline in the current study area. Subsurface testing in TT-1 produced negative results, indicating that Site 18418A does not exist *mauka* of the shoreline in the current study area.

Dircks Ah Sam and Barna (2017) interpreted the site components as agricultural clearing, planting, or boundary features based on the relatively informal and opportunistic construction of the features, their association with soil deposits, and their widespread distribution within the study area. When considered in the context of previous archaeological studies in the coastal Maku‘u-Pōpōkī-Hālona area, the patterning of archaeological features corroborates ethnohistoric accounts of Maku‘u Village as a dispersed coastal settlement surrounded by opportunistic agricultural land use. They assessed Site 30712 as historically significant under Criterion d, only for the information yielded relative to the type and extent of agricultural features in the Maku‘u-Pōpōkī-Hālona area. Dircks Ah Sam and Barna (2017) argued that their study was sufficient to fully document Site 3071; and recommended no further historic preservation work for the site.

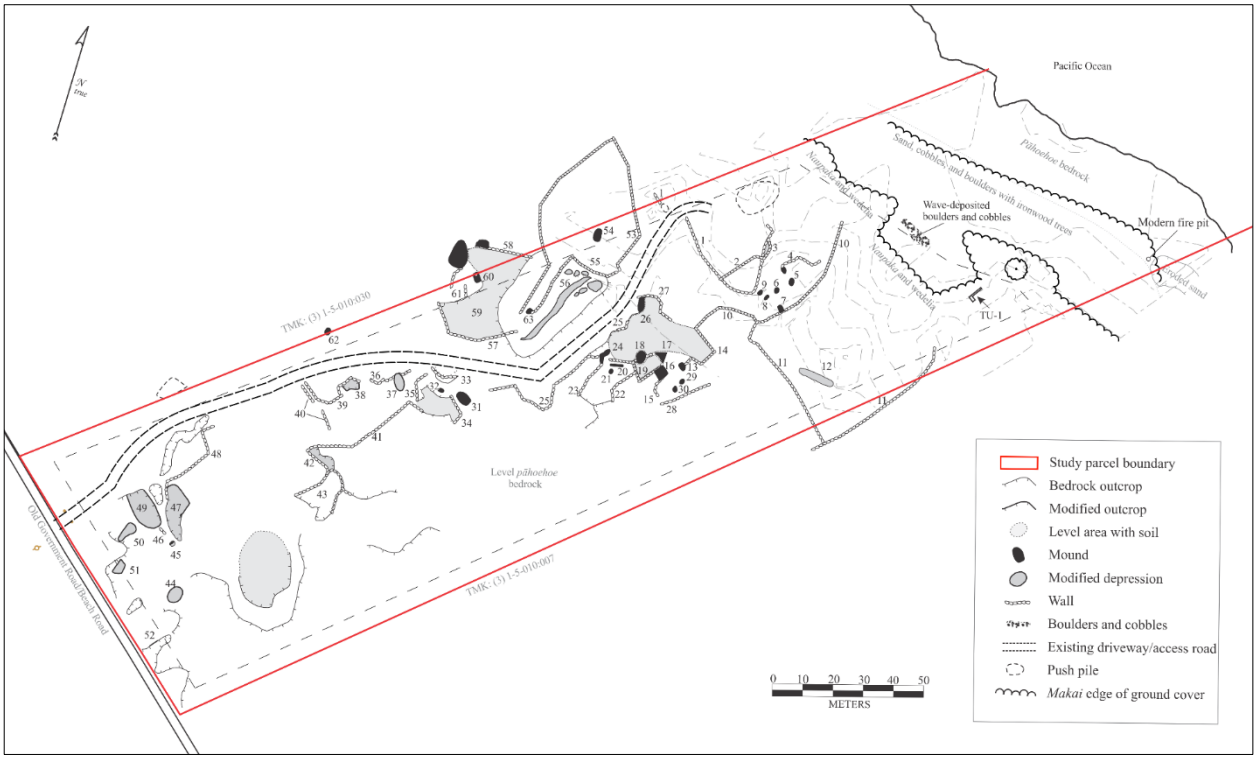

Figure 12. Site location map (Dircks Ah Sam and Barna 2017:45).

3. CONSULTATION

When assessing potential cultural impacts to resources, practices, and beliefs; input gathered from community members with genealogical ties and/or long-standing residency relationships to the study area is vital. It is precisely these individuals who ascribe meaning and value to traditional resources and practices. Community members may also possess traditional knowledge and beliefs that are unavailable elsewhere in the historical or cultural record of a place. As stated in the OEQC Guidelines for Assessing Cultural Impacts, the goal of the oral interview process is to identify potential cultural resources, practices, and beliefs associated with the affected study area.

In an effort to identify individuals knowledgeable about traditional cultural practices and/or uses associated with the current subject property, a public notice was submitted to the Office of Hawaiian Affairs (OHA) for publication in their newspaper, *Ka Wai Ola* (Appendix B). The notice appeared in the October 2017 issue of the publication. As of the date of the current report, no responses have been received from the public notice.

As part of earlier studies (Ewart and Luscomb 1974; Ketner and Rechtman 2011; Rechtman 2003; Rechtman and Kepa'a 2014; Terry 2000), several individuals with ties to the Maku'u, Pōpōkī, and Hālona area were consulted. The information obtained from these earlier consultation interviews that is applicable to the current assessment study is presented below.

In the study prepared by Ewart and Luscomb (1974), they cite notes from a July 4, 1956 interview conducted by Mrs. Violet Hansen with Mary Ann Kamahele (who was 70 years old at the time). Mary Ann Kamahele was described as a member of the only Hawaiian family resident at Maku'u at that time; she was living on Grant No. 1013 (see Figure 19). Mrs. Kamahele provided the following information about two place names in the vicinity of the current study area (see Figure 7): Opunaha was a canoe landing, and Kula was a *ko'a* (a fishing ground) for *āholehole*.

During the EA process conducted for the development of a single-family residence on TMK: (3) 1-5-010:025, located six parcels to the northwest of the current study parcel (see Figure 2) and similarly situated between the old Government Road and the coastal cliffs (see Figure 20), two native Hawaiian individuals with direct ties to the area were interviewed, Ms. Puanani Mukai and Mr. Frank Kamahele (nephew of Ulrich "Sonny" Kamahele). Ms. Mukai was described as the guardian of an adjacent parcel; and Frank Kamahele spent much of his childhood in the area, beginning in 1938. Frank Kamahele described that the use of the area during the early and middle twentieth century centered on farming, ranching, and fishing. Access to the ocean was much easier at that time because the Maku'u cinder cone sloped gently to the rocky beach and was covered with grass. Wave action has since created a steep cliff above the beach, and most fishing is now done from the cliffs. He indicated that landowners in the area have always allowed fishermen access to the cliffs, but did not recall any particular trails or access routes. With respect to other residents in the area, Mr. Kamahele recalled that the coastal area was sparsely populated, partly because the nearest train station was more than a two-mile walk away. The development of the Hawaiian Paradise Park subdivision in the early 1960s connected the Old Government Road (Beach Road) to the current Kea'au-Pāhoa Highway and made access to the area much easier. Terry (2000) reported that neither Mr. Kamahele nor Ms. Mukai identified any specific sites with traditional cultural significance in the area; and with respect to the then proposed and now constructed single-family home on TMK: (3) 1-5-010:025, neither could think of any possible adverse cultural impacts to the area.

As part of the assessment of cultural impacts for the proposed development of TMK: (3) 1-5-010:032 located nine parcels to the northwest of the current project area (see Figure 2), and situated between the old Government Road and the coast (see Figure 20), additional extended members of the Kamahele Family were consulted, Richard Ha and Melani Dominguez. Mr. Ha's grandmother's brother was Ulrich Kamahele; and as Mr. Ha relates in his online blog, "Everyone knew him (Ulrich) as Uncle Sonny, as if there was only one 'Uncle Sonny' in all of Hawai'i." In this same online blog, Mr. Ha prepared a four-part story about his life experiences at Maku'u. Excerpts from these stories are presented to highlight life in the general project area during the middle twentieth century.

> My extended Kamahele family came from Maku'u. When we were small kids, Pop would take us in his '51 Chevy to visit.
>
> He would turn left just past the heart of Pahoa town, where the barbershop is today. We drove down that road until he hit the railroad tracks, and then turned left on the old railroad grade back toward Hilo. A few miles down the railroad grading was the old Maku'u station. It was an old wooden shack with bench seats, as I recall. That is where the train stopped in the old days. A road wound around the pahoehoe lava flow all the way down the beach to Maku'u. That was before there were the Paradise Park or Hawaiian Beaches subdivisions.

> We did not know there was a district called Maku‘u; we thought the family compound was named Maku‘u. Of the 20-acre property, maybe 10 acres consisted of a kipuka where the soil was ten feet deep. The 10 acres on the Hilo side were typical pahoehoe lava. The property had a long oceanfront with a coconut grove running the length of the oceanfront. It was maybe 30 trees deep and 50 feet tall.
>
> The old-style, two-story house sat on the edge of a slope just behind the coconut grove. If I recall correctly, it had a red roof and green walls. Instead of concrete blocks as supports for the posts, they used big rocks from down the beach.
>
> There was no telephone, no electricity and no running water. So when we arrived it was a special occasion. We kids never, ever got as welcome a reception as we got whenever we went to Maku‘u.
>
> And the person happiest to see us small kids was tutu lady Meleana. She was my grandma Leihulu’s mom. She was a tiny, gentle woman, maybe 100 pounds, but very much the matriarch of the family. She spoke very little English but it was never an issue. We communicated just fine.
>
> We could not wait to go down the beach. Once she took us kids to catch ‘ohua—baby manini. She used a net with coconut leaves as handles that she used to herd the fish into the net. I don’t recall how she dried it, but I remember how we used to stick our hands in a jar to eat one at a time. They were good.
>
> She would get a few ‘opihi and a few haukeuke and we spent a lot of time poking around looking at this sea creature and that.
>
> Between the ocean in the front and the taro patch, ulu trees, bananas and pig pen in the back, there was no problem about food. I know how Hawaiians could be self-sufficient because I saw it in action.
>
> The house was full of rolls of stripped lauhala leaves. There were several lauhala trees and one was a variegated type. I don’t recall if it was used for lauhala mats but it dominated the road to the house.
>
> There were lauhala mats all over the place, four and five thick. There was a redwood water tank, and the kitchen water pipe had a Bull Durham bag on the spout as a water filter.

When asked about the proposed development of TMK: (3) 1-5-010:032, Mr. Ha indicated that if the landowner adhered to the Conservation District rules and the treatment plans for the archaeological sites that development of a proposed single-family residence would be fine.

As reported by Ketner and Rechtman (2011), Melani Dominguez has strong genealogical ties to the area having descended from Hawaiians residing in Maku‘u dating from *Māhele* times, and likely Precontact times. Melani‘s personal recollections of the current study area extend back to the late 1970s, when she was a small girl. Melani recalled picking *limu* and fishing with her grandmother Theresa Kamahele down at their property on TMKs: (3) 1-5-010:009 and 010; Grant 1014. She also remembered hearing about a *menehune* trail that meandered through their property *mauka*/*makai*. When asked about the proposed construction of the single-family dwelling on TMK: (3) 1-5-010:032, Melani indicated that she would feel alright about it as long as no cultural sites were impacted.

Consultation was also conducted during the CIA for the proposed development of TMK: (3) 1-5-010:028, which is situated three parcels to the northwest of the current study area. Rechtman and Kepa‘a (2014) contacted members of the Maku‘u Farmers Association, a Department of Hawaiian Home Lands (DHHL) beneficiaries’ entity living and farming tracts of land in the portions of Maku‘u, Hālona, and Pōpōkī that lie inland from the current study area. The president of the association, Paula Keakahuna, was asked about the projected construction of a single-family dwelling on the 3.5-acre, shoreline parcel. She did not feel that the proposed construction of a single-family dwelling on the parcel would impact any of the association’s activities, considering the distance between the DHHL farm lots and the Rechtman and Kepa‘a study area, which is closer to the farm lots than is the current study area.

4. IDENTIFICATION AND MITIGATION OF POTENTIAL CULTURAL IMPACTS

The OEQC guidelines identify several possible types of cultural practices and beliefs that are subject to assessment. These include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The guidelines also identify the types of potential cultural resources, associated with cultural practices and beliefs that are subject to assessment. Essentially these are nature features of the landscape and historic sites, including traditional cultural properties. In the Hawai‘i Revised Statutes–Chapter 6E a definition of traditional cultural property is provided.

> "Traditional cultural property" means any historic property associated with the traditional practices and beliefs of an ethnic community or members of that community for more than fifty years. These traditions shall be founded in an ethnic community's history and contribute to maintaining the ethnic community's cultural identity. Traditional associations are those demonstrating a continuity of practice or belief until present or those documented in historical source materials, or both.

The origin of the concept of traditional cultural property is found in National Register Bulletin 38 published by the U.S. Department of Interior-National Park Service. "Traditional" as it is used, implies a time depth of at least 50 years, and a generalized mode of transmission of information from one generation to the next, either orally or by act. "Cultural" refers to the beliefs, practices, lifeways, and social institutions of a given community. The use of the term "Property" defines this category of resource as an identifiable place. Traditional cultural properties are not intangible, they must have some kind of boundary; and are subject to the same kind of evaluation as any other historic resource, with one very important exception. By definition, the significance of traditional cultural properties should be determined by the community that values them.

It is however with the definition of "Property" wherein there lies an inherent contradiction, and corresponding difficulty in the process of identification and evaluation of potential Hawaiian traditional cultural properties, because it is precisely the concept of boundaries that runs counter to the traditional Hawaiian belief system. The sacredness of a landscape feature is often cosmologically tied to the rest of the landscape as well as to other features on it. To limit a property to a specifically defined area may actually partition it from what makes it significant in the first place. However offensive the concept of boundaries may be, it is nonetheless the regulatory benchmark for defining and assessing traditional cultural properties. As the OEQC guidelines do not contain criteria for assessing the significance for traditional cultural properties, this study will adopt the state criteria for evaluating the significance of historic properties, of which traditional cultural properties are a subset. To be significant the potential historic property or traditional cultural property must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

a Be associated with events that have made an important contribution to the broad patterns of our history;

b Be associated with the lives of persons important in our past;

c Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;

d Have yielded, or is likely to yield, information important for research on prehistory or history;

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.

While it is the practice of the DLNR-SHPD to consider most historic properties significant under Criterion d at a minimum, it is clear that traditional cultural properties would also be significant under Criterion e. A further analytical framework for addressing the preservation and protection of customary and traditional native practices specific to Hawaiian communities resulted from the *Ka Pa‘akai O Ka ‘Āina* v Land Use Commission court case. The court decision established a three-part process relative to evaluating such potential impacts: first, to identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary native Hawaiian rights are exercised; second, to identify the extent to which those resources and rights will be affected or impaired; and third, specify any mitigative actions to be taken to reasonably protect native Hawaiian rights if they are found to exist.

An Archaeological Inventory Survey conducted by ASM Affiliates (Dircks Ah Sam and Barna 2017) of the largely undisturbed current study area identified a single previously unrecorded archaeological site: State Inventory of Historic Places (SIHP) Site 50-10-45-30712, an agricultural complex. Site 30712 is comprised of sixty-three features including twenty-two mounds, twenty-two walls and three wall remnants, nine modified depressions, three cleared soil areas, three modified outcrops, one cluster of *pāhoehoe* excavations, and one rock alignment. Based on the relatively informal and opportunistic construction of the features, their association with soil deposits, and their widespread distribution within the study area, they have all been interpreted as agricultural clearing, planting, or boundary features. When considered in the context of previous archaeological studies in the coastal Maku‘u-Pōpōkī-Hālona area, the patterning of archaeological features corroborates ethnohistoric accounts of Maku‘u Village as a dispersed coastal settlement surrounded by opportunistic agricultural land use.

As a result of the Dircks Ah Sam and Barna (2017) study, it was concluded that Site 30712 was significant under Criterion d. However, the resulting thorough documentation of the site during the study exhausted its potential to yield further information important for research on prehistory or history; thus, no further historic preservation work was recommended. It is the landowner’s intention to avoid disturbing the archaeological features as much as is possible during any future construction activities and to incorporate these features without modification into any proposed landscaping.

Based on the archival research and collected oral information it is recognized that the general shoreline area is and has been used for both recreational and subsistence purposes, and the shoreline practices could be of a traditional cultural nature. While no specific activities were identified for the shoreline fronting the study parcel, strict adherence to shoreline setbacks will ensure that the proposed development of the parcel will not affect existing shoreline access, and thus there will be no impact on any potential shoreline-related and immediate off-shore traditional practices or places.

The projected route of a traditional shoreline trail (Site 18418A) documented on neighboring parcels during previous studies (see Charvet-Pond and Rosendahl 1993 and Dircks Ah Sam and Rechtman 2013) was investigated during the Dircks Ah Sam and Barna (2017) study. A survey of its projected alignment over the water-washed *pāhoehoe* sea cliffs in the extreme *makai* section of the study area did not yield any evidence of its presence. However, *mauka* of the projected alignment, a roughly linear concentration of cobbles and small boulders extending roughly parallel to the shoreline was observed, which was suspected of being associated with the trail. A test trench was excavated roughly twenty meters southeast of the suspect alignment, based on the extrapolated trail route, but produced negative findings. As a result, it was concluded by Dircks Ah Sam and Barna (2017) that although there is no evidence of the trail remaining in the current study area, it may have at one time extended along the coastal cliff which may have collapsed into the ocean in the past century. Furthermore, the alignment of the trail as inferred from the TMK map indicates that it lies *makai* of the study parcel boundary. As such, it will not be affected by any future construction activities on the parcel.

Given the above, it is our conclusion that the proposed development of a single-family residence on TMK: (3) 1-5-010:031 will not result in impacts to any traditionally valued cultural or historical resources nor will it impact on any traditional cultural practices or beliefs.

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APPENDIX A:
Public Notice Published in October 2017 Edition of *Ka Wai Ola*

ASM Affiliates is preparing a Cultural Impact Assessment (CIA) to accompany a Conservation District Use Permit (CDUP) to construct a single-family residence on a roughly 8.75-acre property (TMK: (3) 1-5-010:031) located *makai* of the Government Beach Road in Pōpōkī Ahupua'a and southeast of the Hawaiian Paradise Park residential subdivision in the northeastern Puna area on Hawai'i Island. We are seeking consultation with any community members that might have knowledge of traditional cultural uses of this coastal area; or who are involved in any ongoing cultural practices that may be occurring on the subject property, or in the general vicinity of the subject property, which may be impacted by the proposed single-family residence. If you have and can share any such information please contact Bob Rechtman brechtman@asmaffiliates.com, or Lauren Tam Sing ltamsing@asmaffiliates.com, phone (808) 969-6066, mailing address ASM Affiliates 507A E. Lanikāula Street, Hilo, HI 96720.

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Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

APPENDIX 4
Farm Management Plan

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Moore Single Family Residence and Agroforestry Farm
Conservation District Use Permit Application

AGRICULTURAL MANAGEMENT PLAN

Prepared For: Michael Moore
Prepared by: J M Leonard Planning, LLC

May 2019

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Moore Single Family Residence and Agroforestry Farm Conservation District Use Permit Application

AGRICULTURAL MANAGEMENT PLAN

I. INTRODUCTION

A. Project Location, Setting and Site Characteristics

The approximately 8.75-acre coastal property is located in the State Conservation District, Resource Subzone, in the Pōpōkī Ahupua‘a, Puna District, Island of Hawaii. The property is located *makai* of the Government Beach Road, approximately a mile southeast of the Paradise Park Subdivision and is identified as TMK Parcel: (3) 1-5-010:031. The Hawaiian Beaches Subdivision is located approximately 1.75 miles to the southeast. (See **Site Location and TMK Maps in Figures 1 and 2,** for Reference).

The property is located in an area along the Government Beach Road that could generally be described as a sparsely populated, rural-agricultural area with lots of the various sizes that include a mix of undeveloped and overgrown properties, including the immediately adjacent parcels; scattered farms (used primarily for grazing); and the occasional single-family house.

Elevations across the property range from approximately 10 feet at its lowest point along the coast to about 50 feet above sea-level at the *mauka* boundary with the Government Beach Road. The parcel is bounded along its *makai* edge by a 10 to 15-foot sea cliff, to the northwest and southwest by undeveloped privately-owned parcels, and along its *mauka* edge by the Government Beach Road. The terrain across the property slopes gently to the northeast and the underlying geology consists of *pāhoehoe* lava flows that originated from Kilauea Volcano. Soil conditions primarily consist of a thin layer of strongly acidic muck which is underlain by the *pāhoehoe* lava bedrock. This soil type typically consists of a thin layer of very dark brown, strongly acidic muck about three inches thick that is generally underlain by *pāhoehoe* lava bedrock.

The property as a whole could be described as having three distinct geological and vegetative zones. Fronting the ocean is a broad and relatively level, pahoehoe lava shelf that extends approximately 100 feet inland from a 10 to

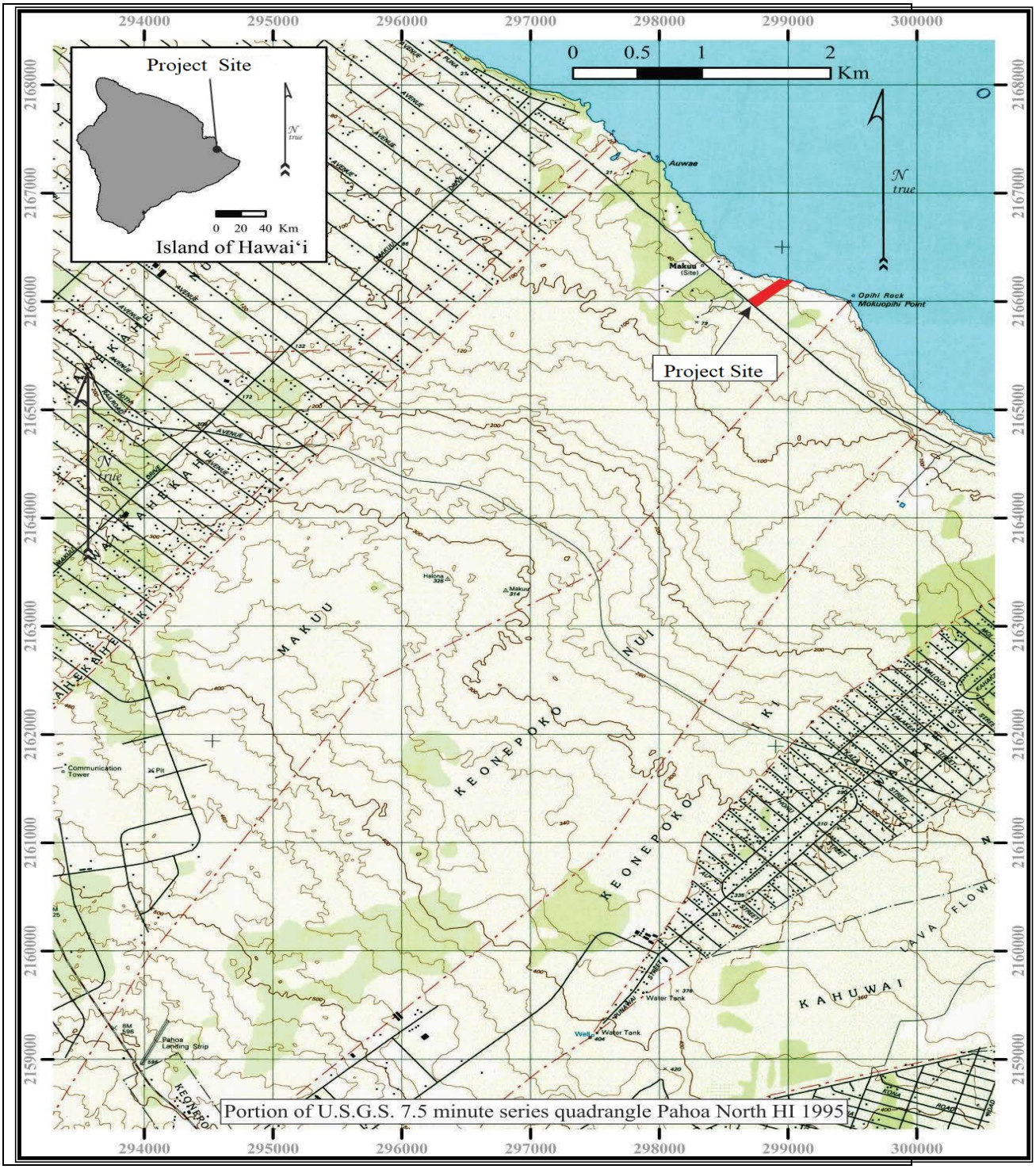

Figure 1
Island and Regional Location Map Agricultural Management Plan
Moore Single Family Residence and Agroforestry

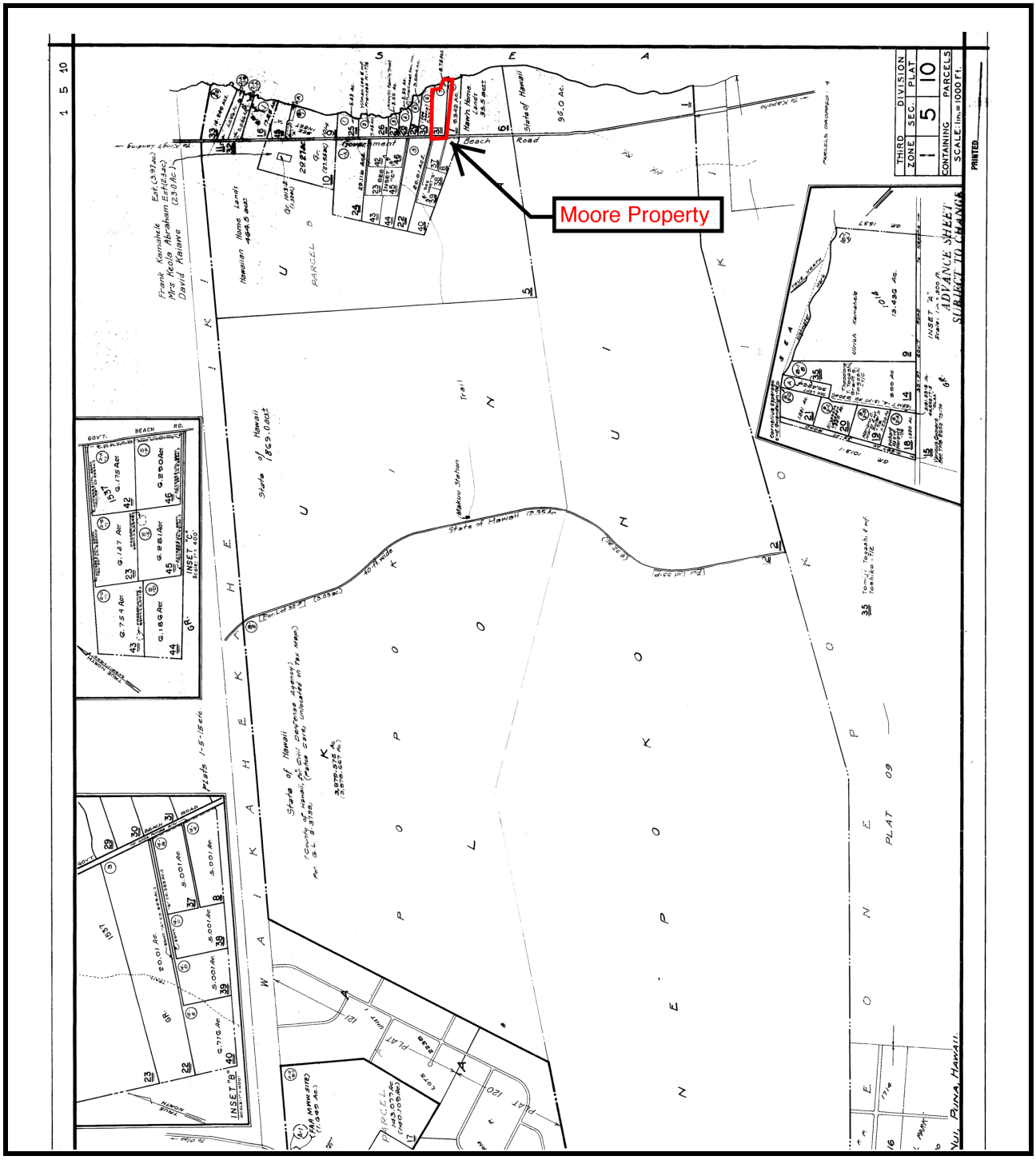

Figure 2
TMK Map (Parcel (3) 1-5-010:031) Agricultural Management Plan
Moore Single Family Residence and Agroforestry

15-foot sea cliff. Inland from the lava shelf is a wide sandy area where the vegetation consists of primarily ironwood (*Casuarina equisetifolia*), tree heliotrope (Tournefortia argentea), false kamani (*Terminalia catappa*), *naupaka* (*Scaelvola cattad*a) wedelia (*Wedelia trilobata*), and guinea grass (*Megathyrsus maximus*). *Mauka* of the sandy area, the ground transitions to an uneven *pāhoehoe* bedrock corresponding primarily to an older Kilauea lava flow that covers much of the remaining area. It is also solely within the *mauka* portion where the proposed farm activities would take place. The vegetation over this *mauka* portion is dominated by invasive species, primarily strawberry guava *(Psidium cattleianum),* melochia (*Melochia umbellata*), octopus (*Schefflera actinophylla*), gunpowder (*Trema orientalis*), albizia (*Falcataria moluccana*) and macaranga (*Macaranga mappa*), interspersed with *hala* (*Pandanus tectorius*), noni (*Morinda citrifolia*), mango (*Mangifera indica*), coconut (*Coco nucifera*), ti (*Cordyline fruticose*), ʻawapui (*Zingiber zerumbet*), and with most portions entangled with maile pilau (*Paederia foetida*), pothos (*Epipremnum aureum*) and *lilikoi* (*Passiflora edulis*) vines.

Also, throughout this portion are found the remnants of numerous archaeological features, which consist entirely of portions of walls and mounds associated with the prior agricultural uses on the property. An Archaeological Inventory Survey (AIS) of the property, conducted by ASM Affiliates, listed the various archaeological features found on the property as a single archaeological site (Site 30712), which is described as an agricultural complex. The Survey report notes that, in that the Site had been fully documented in the course of the archeological inventory survey so as to exhaust its potential to yield further information important for research on prehistory or history, no further preservation work has been recommended for the Site. A copy of the **Archaeological Inventory Survey Report** is included for reference within **Appendix D** of the associated Conservation District Use Permit (CDUP) application for which this Plan has been prepared.

B. Moore Agroforestry Farm: General Goals and Objectives

The property owner, Michael Moore, plans to establish in accordance with this Agricultural Management Plan (Plan), a sustainable agroforestry farm on approximately 6 acres in the *mauka* portion of the property. The Plan seeks to incorporate the majority of the existing historical agricultural features (rock wall enclosures and mounds) found throughout the property, as part of the Plan, in an effort to preserve these features while using portions of these in much the same way they had been used in the past: as enclosures and mounds for growing garden crops in a sustainable and environmentally compatible

manner. In this way, the archaeological features found on the property can resume their original and practical function while serving as a potential educational resource as the land is returned back to its previous agricultural use and historic character. Additionally, the Plan is aimed at affecting a phased transition to the vegetation covering the majority of the property from what is now a nearly complete jungle dominated by invasive trees and vines, especially strawberry guava, melochia, and *maile pilau*, to a more traditional agro-forest environment dominated by natives and traditional fruit trees and plants, including the existing *hala*, coconut, mango (*Mangifera indica*), *noni*, and ti, which would be complemented with breadfruit, avocado (*Persea americana*), banana (*Musa Sp.),* papaya (*Carica papaya*), coffee (*Coffea Sp.)*and citrus (*Citrus Spp*.). *Liliko'i* vines are also occasionally found amongst the existing canopy and are likely to be removed in the course of removing the invasive species and will not be encouraged due to their weedy character and potential threat to the native species on site, particularly the *hala*.

The process for transitioning the existing overgrowth to one that integrates traditional and native plants would be done completely by hand, without any grubbing or grading, and would be maintained in managed sections with the use of foraging livestock, such as goats or sheep. Those native *hala* trees currently found on the property would be preserved, protected and enhanced in this process by removing the invasive species that would otherwise compete with these species.

The coastal portion of the property, comprising approximately 2-acres, would be left in its natural state for the protection of the native coastal species in this area, primarly the *naupaka*, and to serve as a vegetative buffer to minimize potential impacts to the coastal environment. It should be noted that along the *makai* edge of the coastal strand is a band of ironwoods, an invasive species commonly found along these portions of the Puna coast. The owner plans to remove several of the ironwoods hand in order to limit their spread and to create a view and breeze corridor in the area of his planned residence in the northeast portion of the property. Several of the ironwood that would be removed would be replaced with appropriate native and Polynesian species that are especially suited to the coastal environment and commonly found in the area, such as coconut, tree heliotrope (*Tournefortia argentea*), and *hala*. It is also expected that the removal of the ironwood will foster the spread of the existing *naupaka* which is generally found among and directly *mauka* of the ironwood grove.

Overall, the proposed agroforestry farm has been planned with the goal of protecting the natural resources of the site and minimizing the potential

impacts to the environment and surrounding area, while creating a sustainable and productive farm environment for providing food and resources to the Moore family. In meeting these goals, the planned improvements to the property, particularly in reference to the farm operation and management, have been planned in accordance with the following planning objectives:

- Siting improvements in predominately previously disturbed areas and in relation to the existing topography to minimize the amount of grading required;

- Maintaining a protective buffer area in the coastal area aimed at the protection of the native coastal species in this area and to minimize potential impacts to the coastal environment from farm related activities;

- Implementing construction Best Management Practices (BMP's) for erosion and sedimentation control in conjunction with all construction or site improvements related to the Farm operation;

- Implementing a program for the systematic removal and control of the invasive and weedy species that cover much of the property and the long-term monitoring of affected areas aimed at evaluating the effectiveness of the control methods;

- Replanting in areas that are systematically cleared of the weedy species with native and polynesian trees and plants that are traditionally found in the Hawaiian garden, in a manner and with the selection of species so as to be compatible with the planned agricultural activities in the area; and

- Implementing a program of Agricultural Best Management Practices, as described in Section IV this Plan, aimed at maximizing the food and resource production of the Farm while minimizing the potential environmental or health related impacts that could otherwise result from the Farm-related activities.

C. Overview of Agroforestry and Its Application on the Moore Property

Agroforestry is a more modern term used to describe a practice that was integral to traditional Hawaiian farming. It refers simply to the practice of growing trees combined with crops and/or animals in a way that benefits from their interaction. Those farms where agroforestry is applied are sometimes referred to as "food-forests" where trees are grown together in a multi-layered

forest-like planting that includes annual crops that are grown together with small livestock. Often, in the traditional Hawaiian context, ornamental, medicinal, and utilitarian trees and plants, such as *hala*, kukui, coconut, ti, noni, and lei flowers, were included in the mix.

In a more modern context, the term agroforestry can apply to food-forests where compatible trees are used for shade-grown cropping, windbreaks, shading livestock, riparian or coastal protection, and many other practices. These integrated systems can increase productivity, tend to have less pest and disease problems, provide natural weed control and require less fertilizer and outside inputs compared with conventional agricultural. They also provide long-term benefits of soil and watershed protection, while maintaining a forest canopy that is important in sequestering carbon and reducing the build-up of greenhouse gases.

In the case of the Moore property, much of the evidence of the prior agricultural use on the property remains in the form of the many planting mounds and low rock-walls that were used to contain soil and protect garden areas. Also, some of the trees traditionally found in association with the early Hawaiian farms in the area, such as the *hala*, *kukui (Aleurites moluccana)*, mango, coconut, ti, and *noni*, are found interspersed among the invasive trees and vines that currently dominate the landscape. The focus of the proposed Management Plan is aimed at systematically removing the invasive trees and plants and moving toward the protection and enhancement of the native and traditional Hawaiian plants and trees currently found on the property or expected to be found in a traditional Hawaiian farm of the area, such as *hala*, coconut, breadfruit, avocado, coffee, banana, papaya and citrus trees.

The phased transition of the forest canopy will be achieved through the systematic hand-clearing of the invasive trees and plants, in approximately 1 to 1.5-acre segments. Those trees being removed will be cut, chipped and used as mulch onsite, especially in the garden areas and around new tree plantings, to contribute to the soil development, and for water retention and weed control. Tree stumps of the more persistent trees, such as the strawberry guava, gunpowder, and melochia may require spot treatment with a chemical herbicide to effectively control these from re-sprouting or spreading. A spot treatment of the trees at the stump is recommended over a broadcast spray in order to enhance its effectiveness and to limit the potential for environmental drift that could impact other desired trees and plants. This would be followed by a fencing of the selected area with a temporary electrical fencing used to contain grazing animals (principally goats) that will be used to maintain the cleared area from the reestablishment of the invasive or weedy plants. Any

newly planted trees in those areas that have been cleared of the invasive trees and plants will be fenced to protect these during their grow-in period. Those areas with established natives, such as *hala*, will be also protected and enhanced as they are allowed to spread naturally into newly opened areas. In addition to the traditional trees currently found on the property, such as kukui, mango, ti, and coconut, will be added many of the fruit trees commonly found with a Hawaiian garden, such as breadfruit, avocado, banana, papaya, citrus and coffee, especially in association with the gardens areas directly *mauka* of the planned house site, in the central portions of the property, as indicated on the **Site Plan** for the property in **Figure 3**.

II. DESCRIPTION OF PROPOSED AGRICULTURAL ACTIVITIES AND PLANNED SUPPORTING FACILITIES

The planned farm related improvements include planting of fruit trees that are typically found in the Hawaiian garden, including breadfruit, mango, avocado, coconut, banana, papaya, citrus and coffee and an approximately 780 square foot Farm Shed, all of which would be located on the *mauka* portion of the property and would be separated from the coastline by an approximately 270-foot vegetative buffer and an additional 100-foot wide *pāhoehoe* lava shelf that extends to a 10 to 15-foot coastal cliff. Additionally, most smaller tree plantings, such as citrus, banana, papaya and coffee, would be associated with the designated garden areas, which are planned within the areas of the existing low rock wall enclosures. In this way, the remnant agricultural walls will be preserved, maintained and used in much the same way as in the past, as enclosure to retain the soil and protect crops from feral pigs that commonly forage in the area. They will also be used to protect against the potential for soil erosion, especially in the direction of the sea. However, given the topographic separation of the planned agroforestry activities from the ocean, combined with a significant vegetative buffer *makai* of the farming area, there is little or no potential threat of impact of soil erosion to the sea.

As noted above, within the farm area the existing invasive and weedy trees will be removed by hand and disposed of on-site by chipping and composting. Similarly, those weedy vines found among the invasive trees, including the *maile pilau*, pathos (*Eppremnum pinnatum*), and *lilikoi*, will be removed by hand and disposed on site. Those trees to be planted would be placed in individual holes so as to result in minimal ground disturbance. All vegetative cuttings will be composted on site and combined with the wood-chip to be used as mulch around the tree plantings and in garden areas.

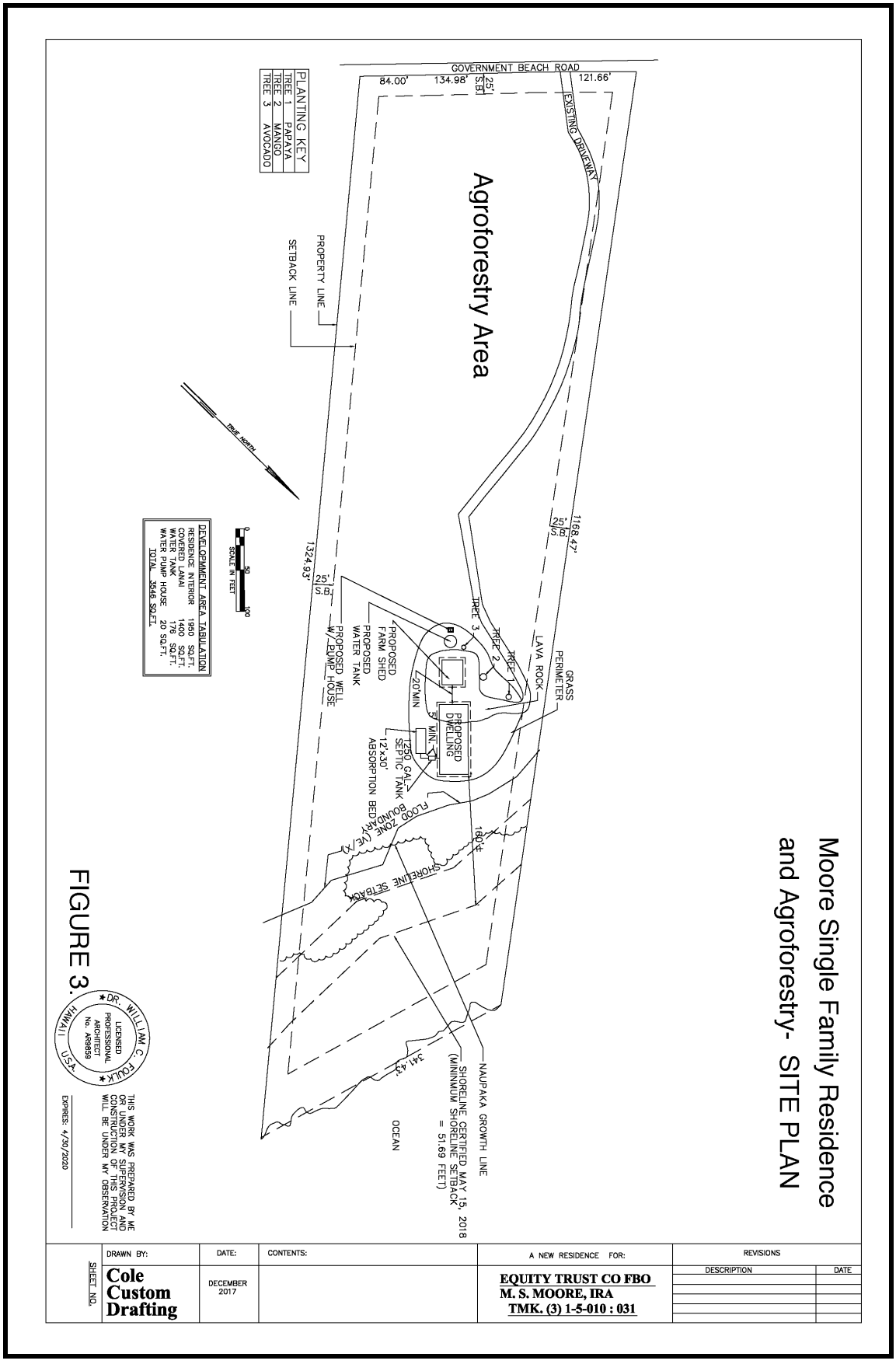
Moore Single Family Residence
and Agroforestry- SITE PLAN
GOVERNMENT BEACH ROAD
84.00'
134.98'
25' S.B.
121.66'
EXISTING DRIVEWAY
Agroforestry Area
PLANTING KEY
TREE 1 PAPAYA
TREE 2 MANGO
TREE 3 AVOCADO
PROPERTY LINE
SETBACK LINE
TRUE NORTH
SCALE IN FEET
50
100
DEVELOPMENT AREA TABULATION
RESIDENCE INTERIOR 1950 SQ.FT.
COVERED LANAI 1400 SQ.FT.
WATER TANK 1176 SQ.FT.
WATER PUMP HOUSE 20 SQ.FT.
TOTAL 3546 SQ.FT.
1324.93'
25' S.B.
168.47'
25' S.B.
TREE 3
TREE 2
TREE 1
LAVA ROCK
GRASS PERIMETER
PROPOSED WELL W/ PUMP HOUSE
PROPOSED FARM SHED
PROPOSED WATER TANK
20' MIN.
5' MIN.
PROPOSED DWELLING
1250 GAL. SEPTIC TANK
12'x30' ABSORPTION BED
FLOOD ZONE BOUNDARY (VE/X)
180'±
SHORELINE SETBACK
341.42'
OCEAN
SHORELINE CERTIFIED MAY 15, 2018
(MINIMUM SHORELINE SETBACK = 51.69 FEET)
NAUPAKA GROWTH LINE
DR. WILLIAM C. FOULK
LICENSED PROFESSIONAL ARCHITECT
No. AR9859
HAWAII, U.S.A.
EXPIRES: 4/30/2020
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION
DRAWN BY:
Cole Custom Drafting
DATE:
DECEMBER 2017
CONTENTS:
A NEW RESIDENCE FOR:
EQUITY TRUST CO FBO
M. S. MOORE, IRA
TMK. (3) 1-5-010 : 031
REVISIONS
DESCRIPTION
DATE
SHEET NO.

FIGURE 3.

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A well site and storage tank, to be used for domestic and agricultural purposes, will also be located in the central portion of the property, *mauka* of the farm shed and adjacent to the planned well and pumphouse. The water storage tank would be sized and outfitted to serve both as a domestic and agricultural water sources and with sufficient reserve capacity and the appropriate fire apparatus fittings to provide fire-flow protection to both the residence and the farm shed. The farm shed will be used to house the farm tools, equipment, animal feed, chemicals, fertilizers and soil supplements, and would provide an "in-field" work area for equipment and tool repair, as well as for mixing soils and soil supplements. A portion of the structure will also include an open shed area to house, feed, and tend animals, when necessary. The **Floor Plan and Elevation Drawings for the Farm Shed** are shown in **Figures 4 and 5**.

III. ASSESSMENT OF AFFECTED NATURAL ENVIRONMENT AND RESOURCES

A. Existing Site Conditions

1. Existing Character and Land Use on the Property

The 8.75-acre property is located between the Government Beach Road on the south side and the shoreline of the Pacific Ocean on the north side, flanked by similarly sized private parcels that currently have no active land uses. The shoreline in this area is neatly defined by the edge of a 10 to15-foot plus high sea cliff, in front of which is a pahoehoe shelf that is bare near the cliff but has grass and ironwood trees more inland, with scattered boulders found throughout the area of the ironwood trees. In the area and directly *mauka* of the ironwood trees is found a strand of the native *naupaka*, as is typical of this area of the Puna coast. The certified shoreline is generally located between 100 and 150 feet *mauka* of the cliff in the area of the ironwood trees and the *makai* edge of the *naupaka* vegetation, where high waves from seasonally high surf have left a debris line, as shown on the Site Plan in Figure 3. *Mauka* of the shoreline, the elevation gradually rises and the partly native shoreline vegetation gives way to mostly weedy vegetation typical of disturbed areas of Puna. Overall, the property can be described as having three distinct zones, the pahoehoe shelf that extends about 150 feet from the coastline; the area of the coastal vegetation including the ironwood trees, coconut palms, and *naupaka* growing among the sandy deposits within the pahoehoe substrate; and the remainder and majority of the property that is *mauka* of

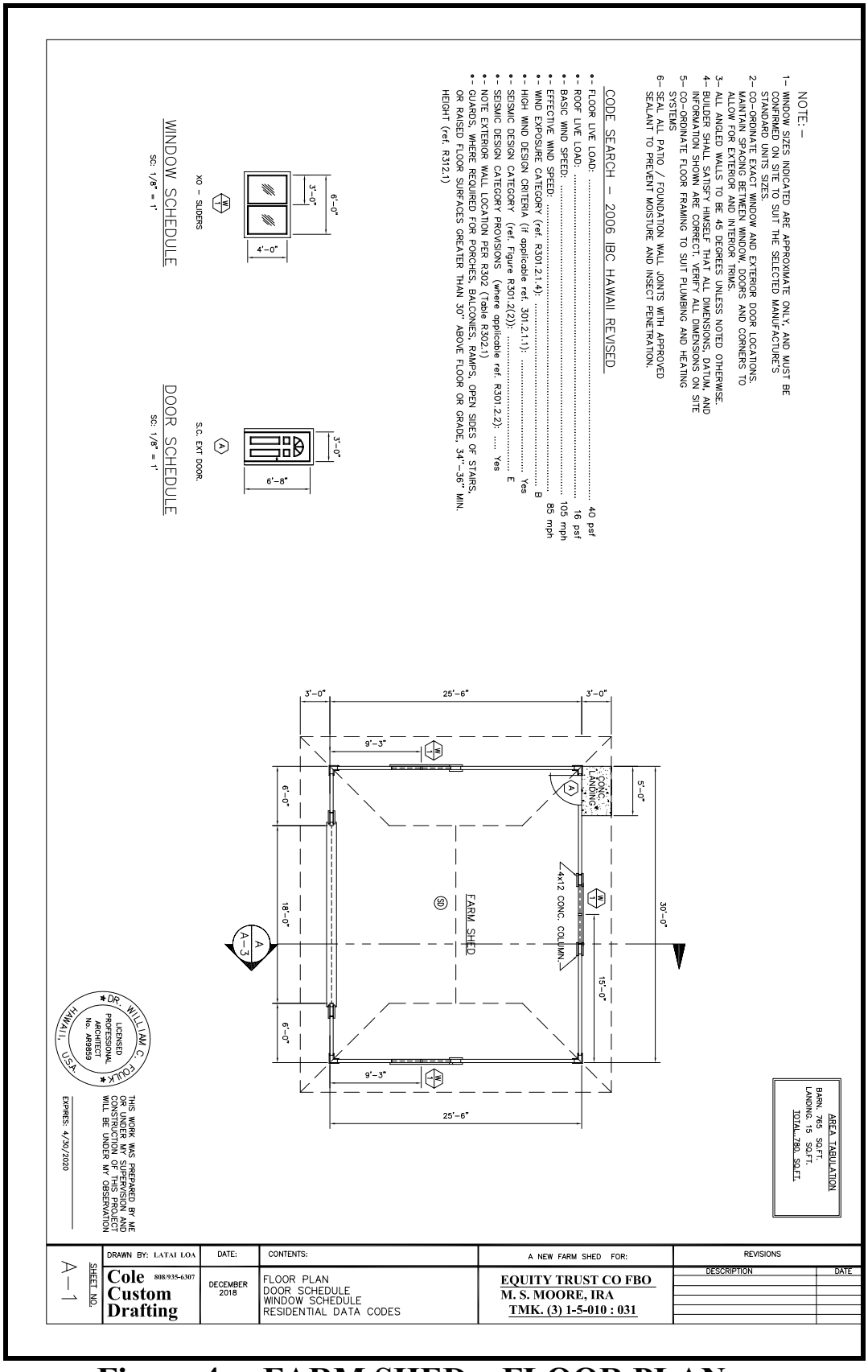

Figure 4. FARM SHED – FLOOR PLAN

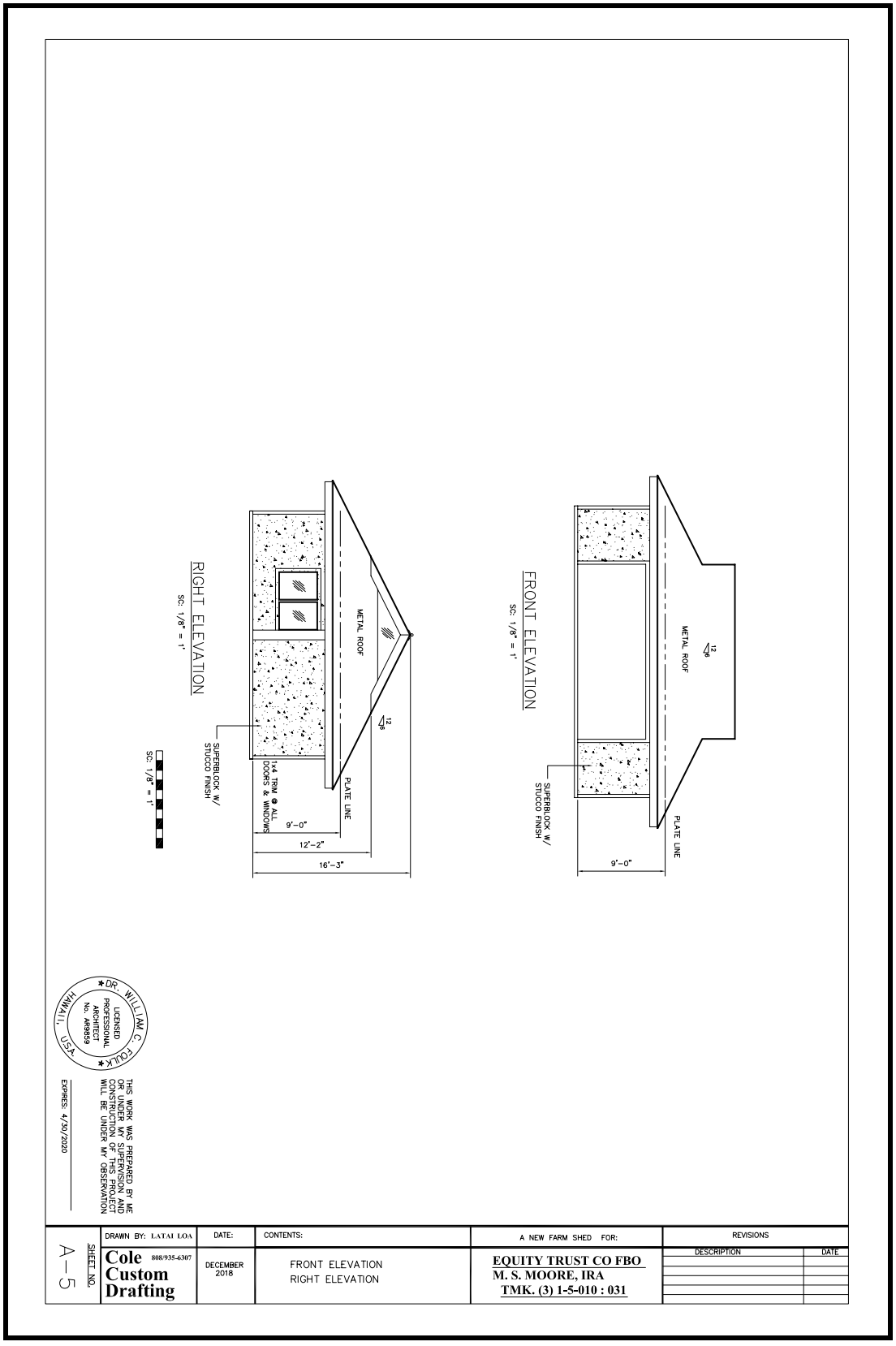

Figure 5. FARM SHED - ELEVATION DRAWINGS

the coastal vegetation, which is nearly completely overgrown with primarily weedy trees and plants, such as the strawberry guava that seems to dominate the landscape, although some patches of the native *hala* are found interspersed in this area. The proposed agroforestry activity would be confined solely to this *mauka* portion. An existing gravel driveway provides access into the property and extends along the northern side of the property from the Government Beach Road to an area of a small clearing located just *mauka* of the coastal vegetation. (See **Figure 6**, which includes **Site Photos** showing the general character of each of these zones). U.S. Geological Survey maps and Google Earth images indicate that elevations on the property vary from about 10 to 50 feet above sea level, with the chosen residential site lying at about 18 feet above sea level. Currently the property is vacant and unused with the exception of the occasional pruning and weeding along the area of the driveway.

2. Geology and Soils

The two *pahoehoe* lava flows that underlie the project site both erupted sometime between 200 and 750 years ago, according to the general geology map of Kilauea by Moore and Trusdell (1991). A field inspection by geologist Dr. Jack Lockwood in the course of preparing a **Coastal Erosion Study** for the property (included as **Appendix C** of the associated Conservation District Use Application) indicates that the younger flow, which extends along the southern edge of the property and does not reach the sea cliff, originated about 335 years ago on Kilauea's East Rift Zone, 16 to 17 miles upslope of the coast. The lava flow that covers the majority of the property and forms the coastline fronting the Property is older – according to Moore and Trusdell, having occurred between 400-700 years ago.

Soil in the area is classified as Opihikao highly decomposed plant material. This is a well-drained, thin organic soil developed over pahoehoe bedrock, and is described as being rapidly permeable, with slow run-off and only a slight potential for erosion hazard. This soil is listed within subclass of VIIs soils, which means it has limitations that make it unsuitable for cultivation and restrict its use to primarily pasture, range, woodland or wildlife (U.S. Soil Conservation Service 1973).

FIGURE 6. Site Photos

View of property frontage and access from the Government Beach Road.

View along the driveway of the typical weedy vegetation covering over much of the Moore Property.

Figure 6. Site Photos

View at the end of the existing driveway of the native hala, clusters of which are found scattered throughout the property.

Figure 6. Site Photos

View of the previously cleared portion near the end of the existing drive that would be the area of the proposed house site.

View near the area of the proposed house site of the strand of ironwood in the coastal section, portions of which are proposed for thinning/removal.

Figure 6. Site Photos

View of native naupaka mixed with the weedy wedelia vegetation typically found in the shoreline area.

View of the broad pahoehoe "shelf" that extends to the cliff-face along the coast fronting the Moore property.

3. Hydrology

There are no natural water features such as streams, springs, or anchialine ponds found on or near the property. The hydrology of the Island as a whole is such that freshwater in the saturated part of the aquifer forms a lens-shaped body underlain by the denser saltwater from the ocean, and between the freshwater lens and the underlying saltwater is a brackish-water mixing zone. Generally, the freshwater lens is thicker in regions where recharge rates are high or aquifer permeability is low, and thinner where recharge rates are low or permeability is high. This freshwater lens thins out towards the shoreline, although on the windward portions of the Island it has generally been found to be sufficiently broad near the shore to be used as a source for potable water for coastal properties, including those in the general area of the subject property.

4. Flora and Fauna

Flora

A survey of the flora and fauna found on the property was conducted by Dr. Ron Terry in July and October of 2017. Other than the area of the driveway and a cleared area at the end of the existing driveway, the ground surface of the property is mostly undisturbed. Strand vegetation in the form of beach *naupaka* (*Scaevola taccada*), mauʻu ʻakiʻaki (*Fimbristylis cymosa*) and akulikuli (*Sesuvium portulacastrum*) is still present, although heavily invaded by wedelia (*Sphagneticola triloba*), ironwood and other weedy herbs, shrubs and trees. It is worth noting that there almost no trace of the original forest. No ʻōhiʻa trees are found on the property and the individual and clusters of *hala* (*Pandanus tectorius*) trees scattered throughout the property could all easily have grown in the last twenty years and do not necessarily represent a remnant of the original forest. The site is dominated by a dozen or so non-native trees (most of them invasive), including ironwood (*Casuarina equisetifolia*), strawberry guava (*Psidium cattleianum*), common guava (*Psidium guajava*), octopus tree (*Schefflera actinophylla*), cecropia (*Cecropia obtusifolia*), autograph tree (*Clusia rosea*), macaranga (*Macaranga mappa*), albizia (*Falcataria moluccana*), gunpowder tree (*Trema orientalis*), mango (*Mangifera indica*), rose apple (*Syzygium jambos*), and false kamani (*Terminalia catappa*) (see Figure 2). Non-native pilau maile (*Paederia foetida*), five-leaf yam (*Dioscorea pentaphylla*) and *lilikoi* (*Passiflora edulis*) vines heavily festoon the trees.

As mentioned above, the native *hala* tree is scattered throughout the property, with the largest concentration just *mauka* of the area planned for the residence. Several Polynesian introductions are also present, including scattered coconut trees (*Cocos nucifera*), noni (*Morinda citrifolia*), and ‘awapuhi (*Zingiber zerumbet*). These natives and Polynesian introductions represent a “head-start” on the planned agroforestry landscape for the property. All natives found on the property are very common in the region, on the Island, and throughout the Hawaiian Islands.

Fauna

During several visits to the property in 2017 several Japanese white-eyes (*Zosterops japonicus*) were observed, by far the most abundant bird on the property, as well as common mynas (*Acridotheres tristis*), northern cardinals (*Cardinalis cardinalis*), spotted doves (*Streptopelia chinensis*), striped doves (*Geopilia striata*), and house finches (*Carpodacus mexicanus*). No native birds were identified, and it is unlikely that many native forest birds would be expected to use the project site due to its low elevation, alien vegetation and lack of adequate forest resources. However, it is not inconceivable that Hawai’i ‘amakihi (*Hemignathus virens*) are at times present in the area, as some populations of this native honeycreeper appear to have adapted to the mosquito borne diseases of the Hawaiian lowlands. Common shorebirds such as Pacific golden-plover (*Pluvialis fulva*), ruddy turnstone (*Arenaria interpres*), and wandering tattler (*Heteroscelus incanus*) are often seen along the Puna coastline feeding on shoreline resources. Of these, only the Pacific golden-plover was observed during the site visits. The seabird, black noddy (*Anous minutus melanogenys*), was also observed flying near the cliffs and over the nearshore waters, as it frequently does near cliffed coasts throughout the main Hawaiian Islands. The black noddy often nests in crevices and caves of the lava (especially pahoehoe) sea cliffs, although no black noddy nests were observed on the cliffs fronting the Moore property.

As with all of East Hawai‘i, several endangered native terrestrial vertebrates may be present in the general area and may overfly, roost, nest, or utilize resources of the property. These include the endangered Hawaiian hawk (*Buteo solitarius*), the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), the endangered Hawaiian petrel (*Pterodroma sandwichensis*), the endangered band-

rumped storm petrel (*Oceanodroma castro*), and the threatened Newell's shearwater (*Puffinus auricularis newelli*).

Other mammals in the project area are all introduced species, including feral cats (*Felis catus*), feral pigs (*Sus scrofa*), small Indian mongooses (*Herpestes a. auropunctatus*) and various species of rats (*Rattus* spp.). Several species of non-native reptiles and amphibians may also be present. None are of conservation concern and all are deleterious to native flora and fauna.

5. Archaeological, Cultural, and Historical Resources

In August 2017, both an **Archaeological Inventory Survey (AIS) and a Cultural Impact Assessment (CIA)** were prepared for the property by ASM Affiliates LLC, copies of which are included for reference as **Appendices C and D** of the accompanying Conservation District Use Application (CDUA) for the proposed residence and agroforestry farm. The field work conducted as part of the AIS identified a single, previously unrecorded archaeological site (SIHP Site 50-10-45-30712), an agricultural complex, within the property. The site is described as comprising 64 features that include 22 mounds, 22 walls and three wall remnants, nine modified depressions, three cleared soil areas, three modified outcrops, one cluster of *pāhoehoe* excavations, rock alignment. Based on the relatively informal and opportunistic construction of the features, their association with soil deposits, and their widespread distribution, they have all been interpreted as agricultural clearing, planting, or boundary features. When considered in the context of previous archaeological studies in the area, the patterning of archaeological features corroborates ethnohistoric accounts of the area as a dispersed coastal settlement surrounded by opportunistic agricultural land use. A trail feature identified as Site 18418A on the property located just to the north of the project site was initially thought to cross the Moore property, as indicated by a line of rocks found in the vegetated coastal portion of the Moore property, however, subsurface testing in the area did not produce any confirming evidence, indicating that, if the trail did extend across the Moore property, it would likely have crossed *makai* of the shoreline, over the barren pahoehoe lava shelf fronting the property.

Site 30712, the agricultural complex, was evaluated by the archaeologists as significant solely for the information it has yielded. The site was fully documented during the course of the archaeological survey, and the archaeologists propose that the site documentation derived from the archaeological survey should serve to mitigate any potential impacts from the future development or use of the property. As the significance of the archaeological resource derives from information already collected from Site 30712, and the likelihood of encountering additional significant subsurface archaeological resources is remote, no further historic preservation work is recommended. As was noted above, the owner's plans are to preserve those archaeological features that area present and, where practical, utilize these features in much the same way they had been in the past, for retaining soil and protecting garden areas from wild pigs that are common to the area. In this way, those features that are present will be preserved and provide an educational value in demonstrating their traditional and historical use on the property. In the event that any unanticipated archaeological resources are unearthed within the project site during the proposed development activities, work in the immediate vicinity of those resources should be halted and SHPD should be contacted in compliance with Hawai'i Administrative Rules 13§13-280.

Additionally, the Cultural Impact Assessment of the proposed development on the property, performed by ASM Affiliates, LLC, did not reveal any cultural resources or practices occurring on or near the site that may be affected by the proposed construction. In summary, the investigation of the property and its history that was conducted as part of the Assessment did not reveal any cultural resources or practices aside from shoreline resources. None of the consulted individuals with ties to and history with the area had any specific information concerning the property.

Nevertheless, it is recognized that traditional gathering and fishing are known to still be practiced on the shoreline *makai* of the property. While some users are newcomers simply engaging in recreation and/or collecting food, others have deeper ties and are undertaking cultural practices as well. The Moore property does not contain any springs, *pu'u*, or caves that might be important cultural sites. No gathering of plant material is noted from the property, and aside from a shoreline strip that includes a native portion that will not be disturbed, most vegetation is either non-native or weeds. Although *hala* is present in clumps throughout the property, it can largely be avoided and will be

encouraged to grow as part of the implementation of agroforestry practices, in which *hala* plays a valuable role for soil building and for providing windbreaks, mulch, and shade.

6. Coastal Conditions and Resources

Typical of much of the southeastern Puna coastline, the coastal stretch fronting the property is characterized by steep rocky cliffs bounded by steep submarine slopes, and with no beaches or shallow offshore areas present. The coastal waters fronting the property are pristine and classified as Class AA waters by the Hawaii Department of Health (DOH). The coastal and marine fauna and flora are typical of the high-energy coasts of Puna, which are young ecosystems with limited coral growth but a variety of algae, fish and invertebrates. Marine life along the shoreline, principally crabs, mollusks (*opihi*) and seaweed, cling to the boulders and cliffs along the shore. Marine mammals and reptiles, some of them endangered, also visit the Puna coastal waters. As noted above, given the considerable distance and geographical separation between the ocean and planned farm area, there would be little or no potential threats to the ocean environment from the agroforestry activities planned on the property.

7. Recreational Resources

The shoreline constitutes the most significant public recreational asset in the Project area. There is relatively little use of the rough and irregular shoreline in this area. According to the County of Hawai‘i (http://www.hawaiicounty.gov/pl-shoreline-access-big-island), there are no official *mauka-makai* shoreline public access routes in the area extending from the Government Road, however, there are some driveways that are informally used or by permission of the landowner. Lateral access along the rocky coastline, especially over the pahoehoe lava shelf in the area, is practiced by few fishers and gatherers that are occasionally seen in the area fishing or gathering *opihi*. The planned agroforestry activities planned for the Moore property would occur significantly *mauka* of the shoreline area and would, therefore, have no impact over the access to or use of the coastal resources.

8. Scenic Resources

The primary scenic and open space resource in the project area is the coastal area and, to some extent, some of the open areas found along the Government Beach Road that provide open vistas to the mountains or ocean, especially in the area northwest of the property towards the Maku‘u Village area. The areas along the Government Beach Road directly fronting and adjacent to the property, however, are largely overgrown, limiting any opportunity for scenic views along the portion of this road fronting or near the property. Most scenic opportunities are provided by walking out over the intervening properties to the shoreline beyond the vegetation where views along the rocky shoreline are dramatic throughout the day.

In that the agroforestry planned for the Moore property would replace much of the existing weedy and invasive vegetation with more traditional Hawaiian and Polynesian trees and plants, and much of the tall vegetation in the shoreline area would remain, there is not expected to much change to the scenic or open space resources in the area, although the visual character of the site itself would eventually be changed from that of a virtual jungle, dominated by invasive and weedy trees and plants, to one of more of a managed agroforest comprised primarily of indigenous and traditional trees and plants commonly found in Hawaiian farms.

B. Assessment of Potential Environmental Threats

As part of a Draft Environmental Assessment (EA) that was prepared in support of the Conservation District Use Application for the proposed single-family residence and farm uses on the property, surveys were conducted of the flora, fauna, historical and cultural resources that may be found on the property.

The flora and fauna surveys found that there are no rare, threatened or endangered plant species present on the property. The project site is dominated by alien vegetation, with the only semi-sensitive ecosystem on the property being the shoreline vegetation, where a few common native plants are present mixed with non-natives such as ironwood. According to the

Environmental Assessment prepared for the Project, because of the location and nature of the agroforestry related activities relative to sensitive vegetation and species, implementation and the ongoing operation of the farm is not likely to result in any adverse biological impacts.

As noted above, several endangered native terrestrial vertebrates may be present in the general area and may overfly, roost, nest, or utilize the property resources, including the *mauka* portion, in the area proposed for the argoforestry. These include the endangered Hawaiian hawk (*Buteo solitarius*) and the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*). The area of the shoreline where some endangered native birds may be found, would be unaffected by the farm activities and, therefore, would not require mitigating or protective measures.

In order to avoid impacts to the endangered but regionally widespread terrestrial vertebrates listed above, the Applicant will commit to conditions that are proposed for the Conservation District Use Permit, for which this Agricultural Management Plan has been prepared. Specifically, the Applicant will refrain from activities that disturb or remove shrubs or trees taller than 15 feet between June 1 and September 15, when Hawaiian hoary bats may be sensitive to disturbance. Should land-clearing occur between the months of March and September, inclusive, a pre-disturbance hawk nest search by a qualified ornithologist using standard methods will be conducted and, should Hawaiian hawk nests be found to be present, no land clearing would take place until October when any hawk nestlings that may have been present will have fledged.

Additionally, an archaeological inventory survey of the property documented a single archaeological site present on the property, a broad collection of agriculturally related features consisting of primarily mound and wall remnants related to the prior agricultural use of the property. The agricultural complex was evaluated by the archaeologists as significant solely for the information it has yielded. As previously noted, the site was fully documented during the course of the archaeological survey, and the archaeologists propose that the site documentation should serve to mitigate any potential impacts from the future development or use of the property. As the significance of the archaeological resource derives from information already collected from this site, and the likelihood of encountering additional significant subsurface archaeological resources is remote, no further historic preservation work is recommended. The survey has been under review from the State Historic Preservation Division (SHPD) since November 12, 2017. In the event that any unanticipated archaeological resources are unearthed

within the project site during the proposed farm related activities, work in the immediate vicinity of those resources would be halted and SHPD would be contacted in compliance with Hawai‘i Administrative Rules (HAR13§13-280).

III. ASSESSMENT OF NATURAL HAZARDS

A. Flood and Wave Hazards

Floodplain status for many areas of the Island of Hawai‘i has been determined by the Federal Emergency Management Agency (FEMA), which produces the National Flood Insurance Program's Flood Insurance Rate Maps (FIRM). The flood zones for this region were recently mapped, and digital maps are available at from the Department of Land and Natural Resources at http://gis.hawaiinfip.org/fhat/, shown on the **Flood Zone Map in Figure 7.** A further detailed depiction of the flood zones over the property, which is also indicated on the **Site Plan in Figure 3**, was prepared by the project surveyor, using registered digital files provided by the State's Department of Land and Natural Resources (DLNR). This mapping placed the boundary of VE flood zone (that is; coastal areas with greater chance of impact from storm waves with the base flood elevations indicated) to be in the area of the coastal vegetation near the 14 to 16-foot elevation. The remainder of the property, including the *mauka* area planned for the agroforestry activity, which is a minimum of 100-feet inland of the VE flood zone, is classified in Flood Zone X, which are areas outside the mapped 500-year floodplain with minimal risk of tsunami inundation. There are no water features on the property, such as streams or ponds. Given that all farm related activity will be in the *mauka* area and well away from areas potentially impacted by storm waves, the potential for impacts from flood or wave related hazards is minimal.

B. Lava Hazard and Seismic Risk

Regarding the potential for lava hazards, similar to much of the lower Puna area, the property is situated in a Lava Flow Hazard Zone 3, indicating areas of relatively higher hazard risk due to the property's location down slope from Kilauea, which is an active volcano. In Zone 3, approximately 1-5 percent of the land area has been covered by lava flows since 1800, but more than 75 percent has been covered in the last 750 years. As such, there is a moderate risk of lava inundation of the property over short time scales.

As noted above, the younger lava flow on the property was estimated by geologists to have occurred in the early 18th Century. The next lava flow to reach the coastline in this area (2.5 miles to the southeast) was in June, 1840. For 150 years no lava flows have threatened this area, until 2014, when lava flows from Kilauea's ERZ entered Pahoa and almost crossed the Kea'au-Pahoa Highway. These flows stopped eight miles upslope from the property, but the

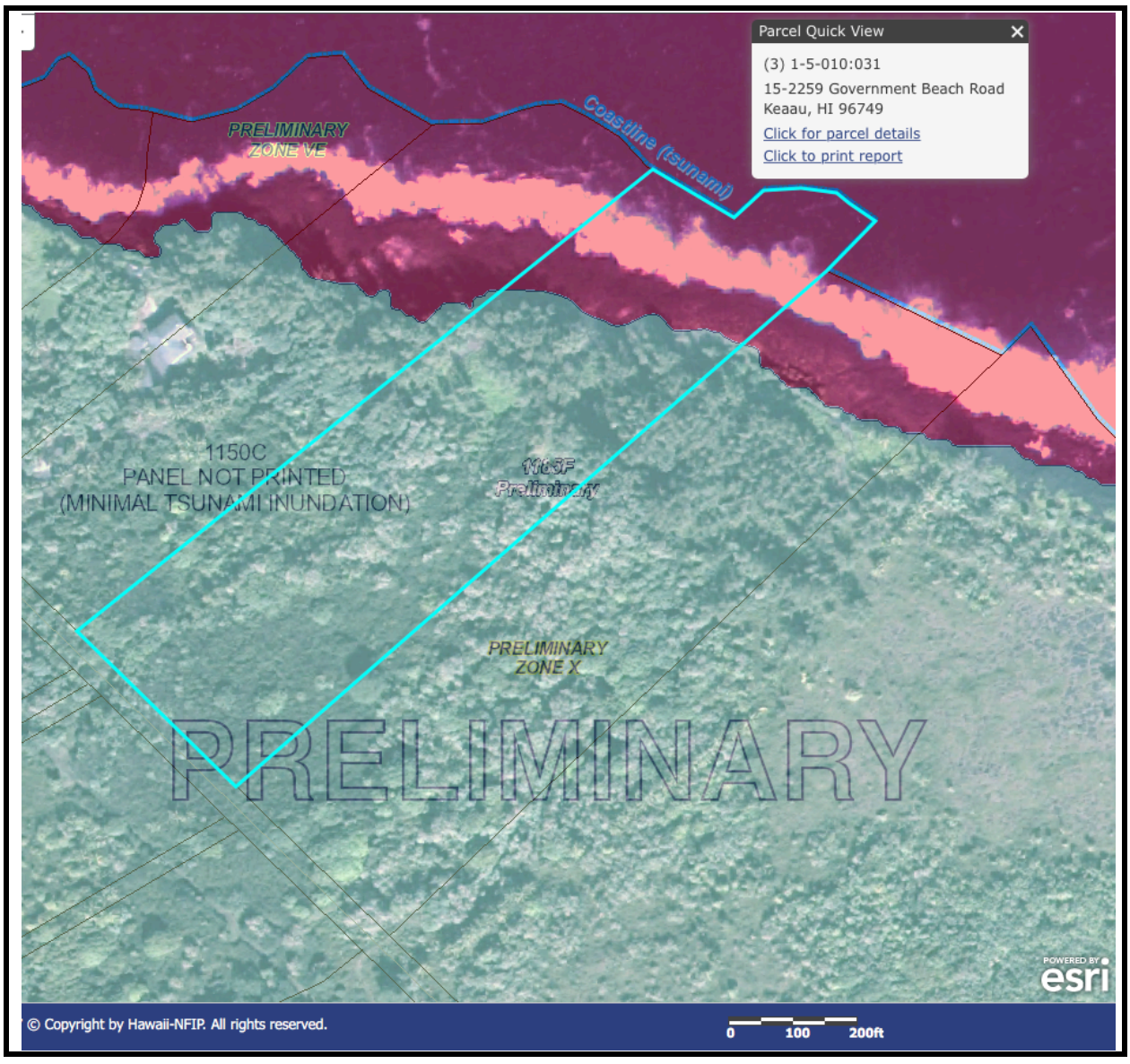

Figure 7. Flood Zone Map

coastal area between Hawaiian Paradise Park and Hawaiian Acres could have been impacted had the eruption continued. A map of historic lava flows in the area (Moore and Trusdell) depicts eleven lava flows that have traveled northeast from the ERZ over the past 1,500 years; seven of these have reached the ocean. Radiometric dating and detailed mapping of such flows suggest that, "on average", lava flows travel northeast from that rift zone once every 140 years or so; flows have reached the coastline about every 200 years. Lava flows that have reached the coast are, however, relatively narrow, so that the odds that the Moore property will be overrun by lava within the next few centuries are relatively low over the expected functional lifetime of the structure.

While a lava flow impacting the area could overrun the farm area and curtail further agricultural use on the property, due to the slow speed of the flows, there would be ample time for warning and evacuation of the area and thus a very low risk to human life from lava activity.

The Island of Hawai‘i experiences high seismic activity and is at risk from major earthquake damage (USGS 2000), especially to structures that are poorly designed or built, as the 6.7-magnitude quake of October 15, 2006 demonstrated. The portion of the property site proposed for improvement is flat to low-sloping. There are appropriate setbacks to surrounding steeper slopes, with a minimum of 300 feet to the 15-foot-plus high sea cliff. There does not appear to be a substantial risk at the site from subsidence, landslides or other forms of mass wasting.

IV. DESCRIPTION OF AGRICULTURAL BEST MANAGEMENT PRACTICES (BMP'S)

The following description of BMP recommendations for the farm implementation and operation is taken from the University of Hawaii-Manoa, College of Tropical Agriculture and Human Resource (CTAHR), *"Best Management Practices to Manage Non-Point Pollution in Agriculture",* F. Abbas and A. Fares, June 2009, and from University of Hawaii-Manoa, College of Tropical Agriculture and Human Resource (CTAHR), *"Integrated Pest Management for the Home Gardens: Insect Identification and Control",* R. Ebesu, July 2003.

A. Short-term BMPs (During Implementation)

During the implementation of the farm related improvements, comprising the clearing of invasive species, construction of the farm well, water storage and farm shed, and tree plantings; the primary threats to the environment during these activities would be from the potential for generating particulate dust, erosion and sedimentation as a result of the planned grading activities, which would be concentrated in the areas of the well site, water storage and farm shed. As noted, no grading would be associated with the clearing of the invasive species or crop cultivation and trees would be planted in individual holes and protected with mulch. Furthermore, there would be no disturbance to the native ground cover during the process of removing the concentration of invasive species on the property. Consequently, the BMPs to be implemented during this period would be similar to those followed for most construction related activities, which would include:

- Minimizing the total amount of land disturbance required which will be delineated to construction contractor prior to the commencement of any onsite work.
- Construction activities with the potential to produce potential stormwater run-off will not be allowed during periods of unusually heavy rains or storm conditions.
- Prior to the start of construction, contractors will implement erosion and dust control measures to prevent any sediment from leaving the construction areas, especially towards the ocean.
- Graded areas will be replanted or otherwise stabilized, as soon as possible following grading activity.

As noted, the ground conditions on the property are such that there is very little soil present and given the geologic conditions, the potential for soil erosion is extremely slight. A key component of the Agricultural Management Plan for the property will be to build the soil environment, especially in areas planned for crop plantings, and to retain those soils that are present. This is the same challenge that the farmers of the past faced and was addressed through the creation of the stone enclosures, not only to protect crops from feral cattle or pigs, but to also contain that soil that had been created through a gathering of the leaf litter and burnt scrub that was present nearby. By concentrating the newly created garden areas in the same enclosed areas, these rockwall enclosures will again serve the same purpose

of containing and protecting those soils that are developed from the possible erosion and protecting the crops from the farm animals in the area.

B. Long-term BMP's (Following Implementation/Ongoing)

The BMPs listed below that would be implemented as part of the ongoing farm operations are designed to minimize the potential environmental and health impacts by curtailing the potential movement of sediments, nutrients, pesticides, or other potential pollutants, while maximizing the efficient use of resources and optimizing crop production. These Long-term BMPs pertaining to soil, water, nutrient, and pest management also require ongoing data collection, record keeping and monitoring to insure their effective implementation.

Soil Management. Effective Soil Management BMPs are aimed at minimizing the potential for soil erosion, surface water run-off, soil compaction or soil loss. The emphasis is placed on cultivation practices that minimize tillage, adds organic material to the soils and establishes ground covers. As proposed for the Farm site, these objectives would be achieved by creating holes for the tree plantings rather than grading or tilling the area for cultivation; maintaining the existing ground cover, to the extent practicable; and adding mulch from onsite composting and green-waste. The existing ground conditions in the farm area where new trees are to be planted are typically rocky with only thin layers of organic soils. The fractured lava rock substrate makes for well-draining soil conditions with low potential for ponding or soil erosion. What soils that are present or added at the tree plantings can be retained in place by berming soils around individual plantings and adding mulch material to the disturbed area.

Water Management. The BMPs for water management are focused on effective irrigation management, also referred to as "right time-right amount" irrigation to ensure that the specific crop water requirements are met, while avoiding overwatering and the potential for soil, nutrient, or chemical movement. Pressurized irrigation systems, such as the temporary drip systems proposed for the site, have substantially higher irrigation efficiencies to traditional surface irrigation methods. Irrigation needs are minimized through the ongoing monitoring of each crop and their associated soil conditions. Irrigation scheduling should also be optimized based on regular review of the soil conditions and water content, rainfall data, and crop parameters.

Nutrient Management. BMPs for nutrient management seek to monitor and regulate the application of nutrients to the soil according to the specific crop nutrient requirements. Nutrient management also includes the selection and use of appropriate organic manure amendments, which can help build and stabilize soils while reducing the need for chemical nutrients. Additionally, effective nutrient management involves the following practices:

- Understand the principles for nutrient management
- Understand the existing soil characteristics, fertility reserves, and nutrient requirements.
- Calibrate the application equipment in order to know and monitor the rate of nutrient application.
- Implement BMPs for nutrient application (i.e, precautionary measures) to avoid the potential for nutrient leaching.
- Implement BMPs for soil and water conservation to minimize the potential for soil or nutrient movement.

Also, when using livestock manure as a nutrient source, the following should be
considered:

- Local, state and federal laws and regulations must be followed during manure application.
- Take all precautionary measures to control against accidental leakage, spillage, or runoff from the manuer storage site, especially if sited near a water body or source.
- Certain manures, such as chicken manure, can be volatile and contribute a noxious odor to the environment through ammonia emission and efforts should be taken to reduce emissions during manure storage and application.

Pest Management (Pesticide Storage, Handling and Application). The safe and effective handling of pesticides is as important to personal health and safety as is to environmental protection. The BMPs related to the safe storage, handling and application of pesticides that should be integrated as part of the farm operations, include the following:

- Buy pesticides in small quantities.
- Store then in a secured area.

- Dispose of them in accordance with federal, state, and local regulations.
- Maintain application equipment in working condition and calibrate to ensure recommended rates are applied
- Ensure that the pesticide applicator knows the exact location in the field to be treated.
- Avoid unnecessary application of pesticides.
- Avoid overspray and drift, especial when in close proximity to surface waters.
- Avoid pesticide application when soil moisture status is high, to prevent possible runoff or deep percolation.
- Avoid irrigation right after a pesticide application.
- Establish buffer zones to maintain a safe-distance from wells and surface water (50-100 feet recommended); and do not apply pesticides in buffer zones.
- Avoid repetitive use of the same pesticide, which may lead to pesticide resistance in the pest.
- Read and follow safety directions and maintain appropriate Material Safety Data Sheets.
- Use appropriate protective equipment specified on the pesticide label to minimize unnecessary exposure.
- Formulate a safety plan to provide emergency hand and eye wash facilities for personnel who might be accidentally exposed to pesticides.
- Have a pesticide first-aid kit available when handling pesticides.

Integrated Pest Management (IMP). IMP is a holistic approach to pest management that can reduce the use of pesticides that may potentially impact the environment or the health and safety of those handling them. A successful IPM program involves the application of a mix of cultural, biological and chemical control methods, including pest monitoring, identification and control; the result of which can provide a program for effective pest management with fewer pesticide applications. Essential elements of an effective IPM program include the following:

- Selection of pest-resistant crops.
- Maintaining strict sanitary conditions.
- Including biological control with mulching.
- Effective insect identification and control.*
- Removal, and eradication of affected plants.
- Effective control and timing of pesticide applications.

*[For Reference on IPM Insect Identification and Control, See: *IPM for Home Gardens: Insect Identification and Control,* College of Tropical Agriculture and Human Resources (CTAHR), University of Hawaii-Manoa, Honolulu, Ebesu, R., July 2003.]

V. DESCRIPTION OF RESOURCE CONSERVATION MEASURES

Native Vegetation and Natural Habitats

While there are few native plant species found on the property, most notably the *hala*, all are very common to the region, on the Island, and throughout the Hawaiian Islands.
and there are no ecologically sensitive habitats in the project area. Those clusters of *hala* currently found on the property will be preserved and protected as part of the overall agricultural management plan for the property.

Soil and Water Conservation

In that no grading or ground disturbance is planned as part of the systematic removal of the invasive and weedy species that currently dominate the landscape and all new tree plantings will be placed in individual holes and covered with mulch in the planting area as a means of retaining moisture and soil, there is very little potential for erosion of soil from the site. Garden plantings will generally occur in the previously rock-wall defined garden areas and a program of regular mulching in these garden areas, together with the existing wall enclosures will ensure that the soils that are present remain place. In fact, give the scarcity of existing soils on the site, an important component to this Plan will be in building the soil regime, especially in the defined garden areas. It should be noted that the existing vegetation in the coastal area, together with the broad lava shelf that extends between the shoreline vegetation and coast, will also serve as an effective vegetative buffer *makai* of the agroforestry activity, thereby minimize any potential for soil erosion towards the sea.

As noted, the area is generally subject to high levels of rainfall throughout the year such that there should be little need for irrigation throughout the farm. What water that would be used, which could be from either an onsite well, roof-top water catchment sytem or both, can be minimized through a use of regular mulching in the garden areas, which would have the additional benefit of building the soil regimen and weed control in these areas. Some temporary drip irrigation may be needed in

association with the new tree plantings, however, if these are restricted to drip irrigation lines at the individual trees, and combined with mulching at each planting, supplemental irrigation demand can be kept to a minimum. In this way, an effective conservation of soil and water resources can be achieved throughout the farm area.

VI. SCHEDULE AND SEQUENCE OF ACTIVITIES

As noted, a focal component to the overall agricultural management plan for the Moore property involves the sequential and phased removal of the existing exotic landscape that is dominated by invasive and weedy trees and plants that are common to the area replacing these with the native and Polynesian trees and plants that are traditionally found in an Hawaiian farm and are compatible and supportive of a farm environment.

In conjunction with this effort, all trees from the cleared areas will be cut, chipped, and composted on site to be used as mulch material at new tree plantings and in the defined garden areas, utilizing the existing rock walls enclosures that are remnant from prior agricultural activities on the property. Sequentially, the phased removal of the invasive trees and replacement with the farm trees, that would occur over a projected eight (8) year period, as shown diagrammatically in the **Agroforestry Action Timetable, Table 1,** would take place following the implementation of the necessary access and utility improvements and construction of the planned residence, farm shed, and water storage facilities, which would take place in the first year, following receipt of the necessary permits and approvals.

VII. ONGOING MONITORING AND MAINTENANCE ACTIVITIES

As noted, the areas that are cleared of the invasive vegetation will be managed and maintained through the use of grazing animals, principally goats or sheep. These areas and the temporary containment fencing; using moveable, solar powered, electrical fencing, will require regular monitoring to check for the integrity of the containment fencing and the effectiveness of the goats or sheep to protect against the possible regeneration or introduction of new invasive plants in the area. Once the area has been fully controlled, new farm trees can be introduced but will need to be individually protected from grazing with protective fencing. The initial area for clearing would include those areas proposed for gardening, primarily in the central portion of the property, in the area *mauka* of the proposed residence and farm shed. While the goats or sheep will be used in these areas initially to help clear the area of weedy vines and the possible regeneration of invasive plants; once the animals are

TABLE 1. MOORE Agroforestry Farm - GENERAL TIMETABLE / SEQUENCE OF ACTIONS										
ACTION	MONTHS/ (YEARS)									
	1	2	3	4	5	6	7	8	9	10
Clearing/Grading of Defined Access and Construction Areas										
Well Construction										
Construction of Residence / Farm Shed/Water Storage										
Phased Removal of Invasive/WeedyTrees/Plants		(Ongoing/Phased - YEARS 2-9)								
Planting of Natives and Trad. Hawaiian Farm Trees		(Ongoing Reforestation in Conjunction with Phased Removal of Invasives - Yrs 2-9)								
Onsite Composting of Cleared Vegetation		(Ongoing /Concurrent with Removal of Invasive Vegetation)								
Rock-wall Restoration in Defined Garden Areas		(Ongoing - Years 2-4)								

removed as a management tool, each area will need to be monitored closely to identify and remove (or treat with selective herbicide) any invasive trees or weedy plants tending to reestablish in the previously cleared areas. The enclose garden areas can also be protected from either farm animals or any wild pig that are common to the area by reestablishing the existing loose-stacked rock walls that would help define and protect the garden areas.

Additionally, regular and ongoing monitoring of the farm soils, water and plant conditions is an important component to identifying potential environmental or biological threats early on; to insuring the effective use of available resources; and to maintaining optimum growing conditions for the selected garden trees and plants. Close monitoring of the site conditions is also an essential component of and effective IPM program in order to identify the early signs of invasive pests to be managed and beneficial organisms to be encouraged. Ongoing monitoring of those areas cleared of invasive species is also required to insure the effectiveness of the control methods being applied.

Those areas to be monitored on a regular basis as part of the ongoing farm operations, include the following:

- Tree plantings for signs of nutrient deficiencies and invasive pests;
- Ground conditions for signs of erosion, especially in and around irrigated areas;
- Irrigation water supply for signs of excessive pumping or leakage;
- Soil conditions, especially around tree plantings, for signs of overwatering, chemical build-up or nutrient deficiencies; and
- Areas cleared of invasive species for signs of regeneration or introduction of other weed species that are finding opportunity in newly cleared areas.

Similarly, regular monitoring and maintenance of the farm facilities and equipment are important to maintaining safe environmental conditions, especially in the storage of potentially harmful chemicals or volatile compounds; for the safe and effective application of chemicals in the cultivated areas; and the efficient use of available resources. Those areas that require special attention in terms of regular inspection and maintenance include:

- Buildings and the storage areas used for storing fertilizers and chemicals to ensure that they remain dry, safe and secure;
- Application equipment to insure they remain in working conditions and are properly calibrated so that recommended rates are applied; and
- Irrigation storage facilities and equipment to identify any signs of leakage.

It is worth noting that the Mr. Moore has had discussions with other property owners in the area and those with historic ties to the area regarding their experience with growing fruit trees and garden crops in this area. The owner is encouraged to broaden this knowledge base by reaching out to those who lived or are living in the immediate area and who may have empirical knowledge of growing food crops in the area, practical techniques for maintaining ideal growing conditions, and methods for safe and effective pest control. This empirical understanding of the local growing conditions and crops is invaluable; and, combined with implementation of the guidelines and management actions set forth in this Plan, will help insure that the Agricultural Best Management Practices described above are applied in a manner that is appropriate to the area and crops being grown, and are effectively applied towards the long-term goals of the protection and care for the land and natural resources of the area while optimizing the growing conditions for the selected crops.

Environmental Assessment

Moore Single-Family Residence and Agroforestry in the Conservation District at Pōpōkī

APPENDIX 5
Coastal Erosion Study

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GEOHAZARDS CONSULTANTS INTERNATIONAL, INC.

Appraisal of hazards – reduction of risk

Coastal Erosion Study for the Moore Property

SE of Hawaiian Paradise Park

Puna, Hawaii

TMK: (3) 1-5-10:31

A project for ***Geometrician Associates***

Hilo, Hawaii

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EXECUTIVE SUMMARY

1 A comparison of aerial photographs taken in 1954 with later aerial photographs and images obtained in 2017 show no measurable erosion of the coastal cliff fronting the Moore Property. The poor resolution of aerial photographs suggests changes of 10 feet or so could have occurred over this 63 year period (about 2"/yr), but we feel any actual erosion has been much less.

2 The Property is protected from erosion by a rugged, 15-18' high vertical sea cliff composed of massive lava that blocks all but the highest storm waves.

3 The Property is bordered by a flat-lying, 70'-100-wide shelf of barren, dense pahoehoe lava behind the sea cliff. Inland from this pahoehoe shelf is a 80' – 100'-wide depressed area covered by thin, discontinuous deposits of unconsolidated sand. These sands can be both deposited and eroded by infrequent major storm surges, and would not be suitable for construction.

4 Ballistically-emplaced storm boulders (Here termed “pōhaku leleʻ”) weighing up to three tons form an unusual hazard – they can be ejected from large storm waves and deposited up to 200’ mauka of the coastal cliff.

5 Proposed construction sites on higher ground more than 200’ mauka of the coastline will not be impacted by erosion for several centuries

6 Other geologic hazards that could impact the Property in the future (Volcanic, Seismic, and Flooding) are evaluated and found to pose no great risk to the Property.

INTRODUCTION

Study requirement

The Hawaii Administrative Rules concerning Conservation Districts (Title 13, Subtitle 1, Chapter 5, adopted August 12, 2011) state that applicants for Single Family Residential construction in coastal Conservation Districts must consider rates of coastal erosion affecting their properties in order to determine minimum shoreline setbacks for permitting. DLNR established a requirement that Annual Coastal Erosion Rates must be determined, based on formal "Coastal Erosion Studies". This report documents the nature of erosion and shoreline migration and other potential coastal hazards at the Moore property (hereafter referred to as "the Property"), based on measurements and observations obtained through field inspection, aerial photography, satellite imagery, and review of the geologic literature. At this time the position of the shoreline has not surveyed, and all distance references in this report are referenced to the coastal sea cliff.

Location

The 8.75 acre Property (TMK (3) 1-5-10:31) is located along the Puna coast 13 miles southeast of Hilo, between the Paradise Park and Hawaiian Beaches subdivisions, north of the "Government Beach Road" in the USGS Pahoa North Quadrangle (Figure 1).

The entire frontage area of the Property is bounded by a broad, flat pahoehoe lava shelf extending from the rugged coastline inland 80-100 feet (Figure 2). This coastal shelf is obviously exposed to strong storm swells that overtop the coastal sea cliff and scour the shelf clear of vegetation, except for ephemeral grasses. The shelf surface consists of horizontal pahoehoe lavas with less than 1-2' of relief, cut in places by narrow cracks near the sea cliff (Figure 3), that apparently have formed due to tensional stresses associated with cliff erosion. The sea cliff is near vertical (Figure 4), consisting of the massive interior of a single very thick pahoehoe flow. The base of the cliff is marked by large subangular boulders length that have fallen from the cliffs above (Figures 4, 7). These blocks are too large (to six feet in maximum

size) to be mobilized by the incoming waves and form energy dispersing barriers to incoming surf.

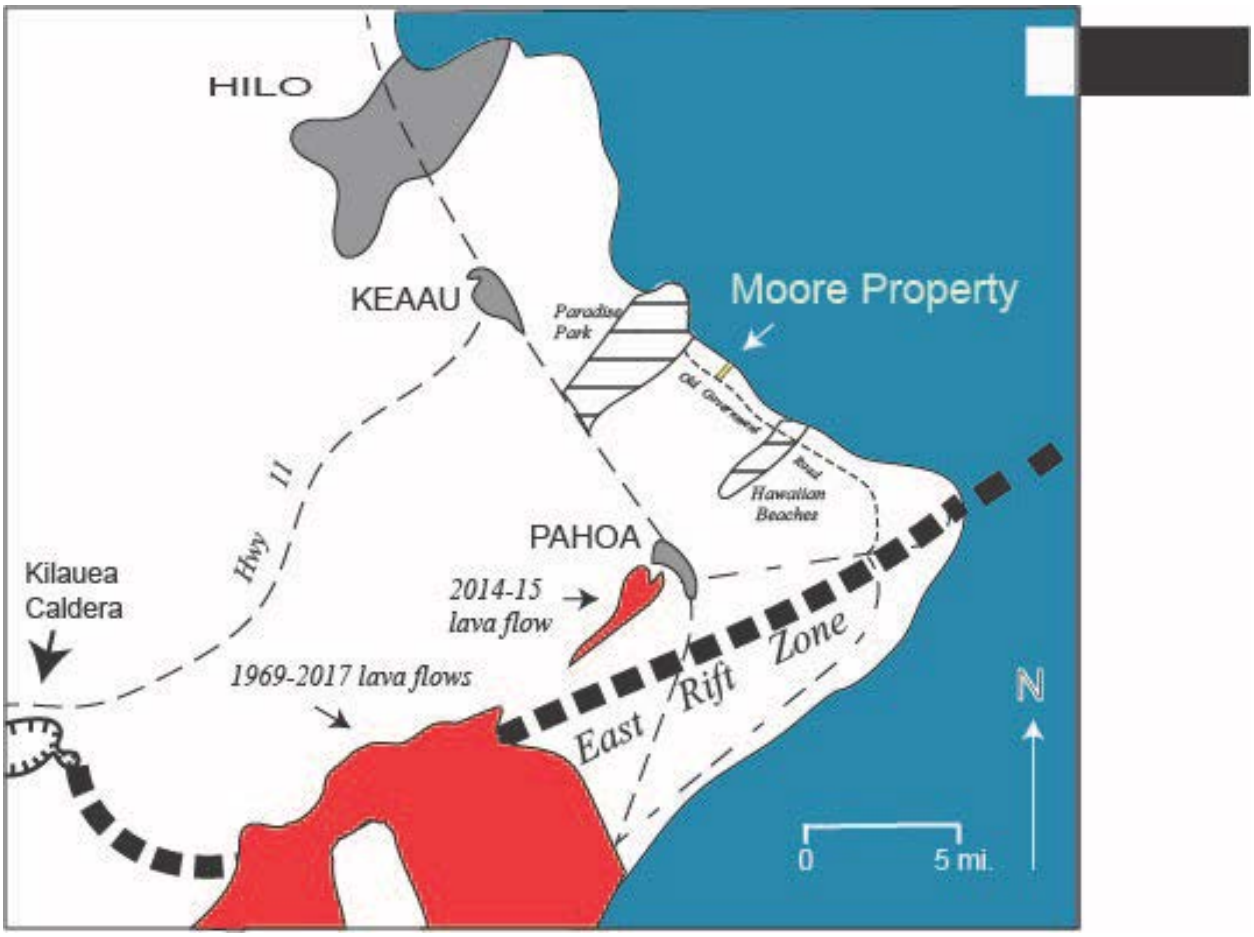

Figure 1. Location of Moore Property, showing cultural features and recent lava flows.

Field Inspections

John Lockwood and Tim Scheffler visited the Property (hereafter referred to as "the Property") on 10 August, 2017, followed by field visits by Lockwood on 25 August and 7 September. A total of ten hours were spent making field observations, surveying with Brunton pocket transit and measuring tape, and obtaining site photography.

Field observations of the coastline were taken at various tide levels on the three inspection days from +0.75 to -.0.1 feet above the tidal datum (tidal datum for Hilo, Hilo Bay, and Kuhio Bay, HI -*http://tidesand currents.noaa.gov).* The ocean was characterized by

moderate swells (3-4 feet) in August, with higher swells (to 6-7 feet) on 7 September, which generated light surf that prevented detailed observation of coastal lavas along the sea cliff.. At no time during our visits did incoming waves overtop the sea cliff.

The shoreline is legally defined in Hawaii as "*the upper reaches of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves, ...*" (HAR §13-5-2). At the time of this writing, an official shoreline position has not been surveyed, but likely will coincide with the makai edge of ironwood tree growth (Figure 8). Grasses extend makai of the ironwood trees, but are not established woody vegetation.

Figure 2. Pahoehoe shelf along Property coast.

Figure 3. Tensional crack on pahoehoe shelf

Figure 4. Coastline fronting Property. The massive pahoehoe here consists of a single thick lava flow that have ponded behind a coastal berm during flow emplacement. This dense rock is very resistant to erosion, although large blocks have spalled away, forming a buffer that dissipates wave energy.

GEOLOGIC FINDINGS

There are two pahoehoe lava flows underlying the Property with estimated ages of 200-750 years before present, according to the published geologic mapping of Moore and Trusdell (1991) and Wolfe and Morris (1996). In their generalized geologic map of Kilauea's lower East Rift Zone. Moore and Trusdell recognize that two lava flow units of different ages are present on the Property, but do not show distribution detail. They consider the younger flow (their unit "f8d4") to be derived from the Ai-laau shield near the summit of Kilauea. Although this is true for the source much of this widely-distributed unit west of the Property, it is not true here. Photo inspection of lava flow distribution upslope of the Property show were derived from Kilauea's East Rift Zone, 16-17 miles upslope, far from Kilauea's summit. Moore and Trusdell assign an average age of 335 years bp ("Before Present")[1].to this younger "f8d4" unit, recognizing that several different lava flows are incorporated as mapped. They recognize the older lava flow forming the coastline fronting the Property (their unit "f7c11), and assign it an age of 400-700 years bp.

Wolfe and Morris (1996) show more detail for this area, but again do not agree with our reconnaissance mapping of the Property. Like Moore and Trusdell, they also recognize a younger lava flow on the Property, and assign that to unit "f8p4", with an age of 200-400 yrs. bp. They assign the underlying older flow to unit "p4o" (age 400-750 yrs. bp), but do not correctly show its distribution along the coastline fronting the Property – difficult at their 1:100,000 scale.

Based on its very young appearance (fresh surface glass and lack of overlying soil), we feel that the younger flow (which we refer to in Figure 5 as the "Younger Flow") is little more than 300 years,old (< 250 yrs. bp), sometime in the early 18th Century, before Westerners arrived in Hawaii. The lava flow that forms the coastal shelf (our "Older Flow"– Figure 5) is at the significantly older end of the 400-750 yr. bp. range given by Wolfe and Morris. Our evidence for the older age is based on the flow's greater surface weathering (little surface glass remains) and

[1] "Years b.p" refers to radiocarbon years before 1950, the year that contamination from atmospheric nuclear bomb testing made radiocarbon dating of younger biogenic carbon impossible.

the fact that this flow underlies pockets of sandy soil (Figure 6) that we feel may be related to a littoral cone exposed along the coastline 6-700 yards to the northwest. This cone is assigned to unit “pld3” by Wolfe and Morris (1996), with a suggested age of 750-1500 yrs. bp. The age of that cone has not been determined by radiometric dating, however, and is possibly related to an earlier ocean-entry phase of the “Older Flow” eruption. We tentatively assign an age of 750 years to this flow, although it could be somewhat older.

Our geologic reconnaissance map of the Property (Figure 5) shows the approximate distribution of these two lava flows, but was only mapped in detail where lava flows are well-exposed adjoining the inshore coastal sand deposit. The Property mauka of the coastal area is densely forested with mostly alien species, surface outcrops are few, and the contact between the “Younger” and “Older” lava flows is poorly constrained. Of interest to note is that the distribution shown for the “Older” flow roughly coincides roughly with the areas of extensive Hawaiian agricultural sites shown by the Archeology Report for this Property. Apparently the “Younger” flow buried pre-existing agricultural sides and had too little soil to be suitable for farming.

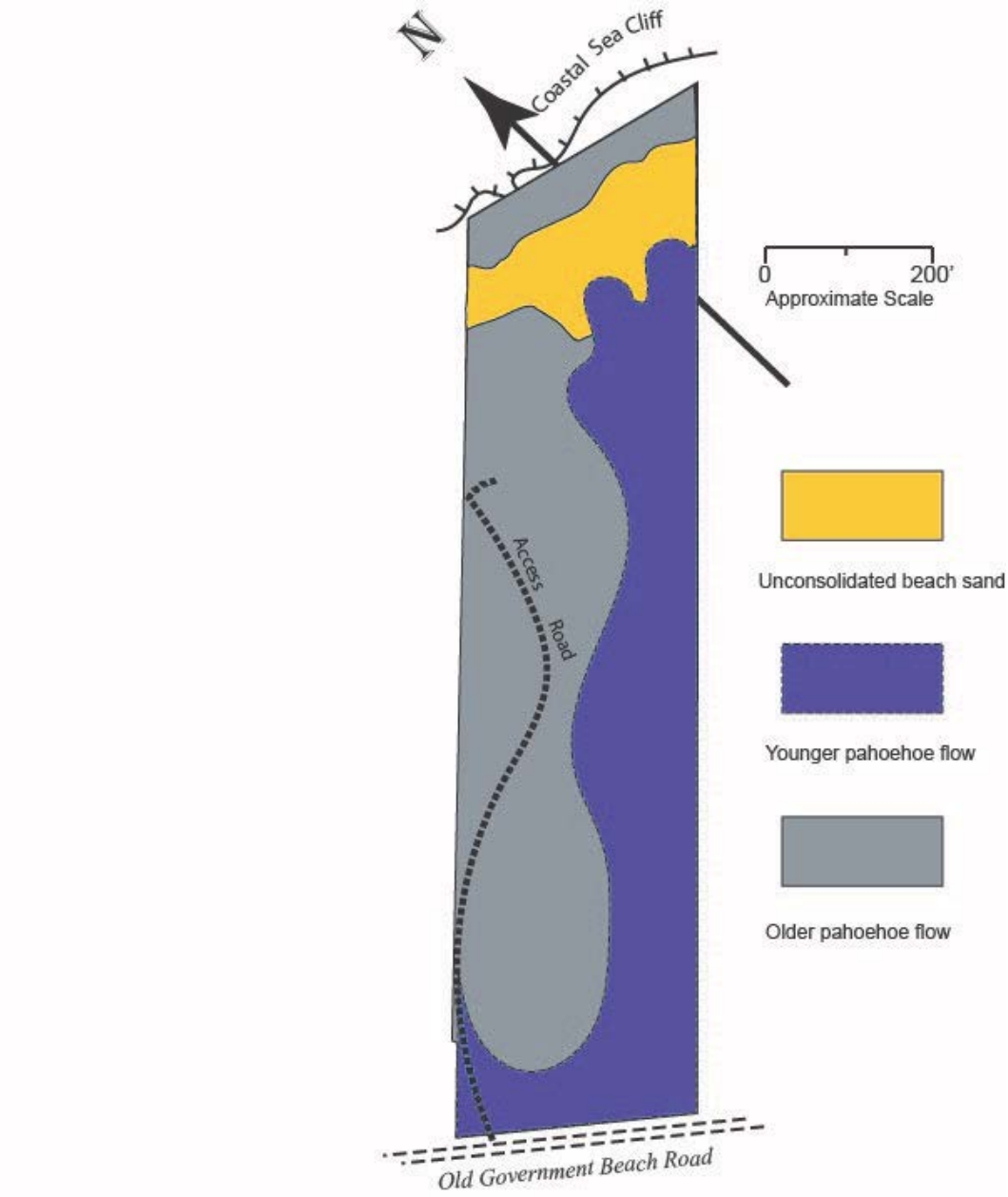

Figure 5. Geologic reconnaissance map of the Moore Property, showing principal geologic features and location of Figure 10 profile (Base sketch for later drafting).

Figure 6. Young pahoehoe lava flow overlying the older pahoehoe that forms coastal shelf fronting Property. The two flows are separated by a narrow lense of sandy debris that may have been derived from littoral cinder cone 1,000' to the west.. This particular exposure is located about 50' east of the Property, 95' inshore from the coastline.

Flow Characteristics

The Younger Flow is characterized by a dense, medium-dark grey matrix with no conspicuous olivine (in contrast to the underlying Older Flow). Abundant very fine, white, subhedral plagioclase crystal typically less than 0.3 mm in length are ubiquitous in the groundmass. Sub-rounded, hematite-lined vesicles are irregularly distributed , with diameters reaching 4 mm. The surface of this flow is everywhere covered by fresh, shiny black glass, suggesting its age is quite young – certainly less than 250 years.

The "Older Flow" is a dense pahoehoe with about 1% of conspicuous, yellow-green olivine anhedra, and fine internal "sparkle from micro phenocrysts of plagioclase and pyroxene. Vesicles are typically subrounded and uniformly distributed – typically 1-2 mm in diameter.

Origin of the Coastal Pahoehoe Shelf

In places the coastal pahoehoe surface is marked by anomalous areas of frothy, vesicle rich, glassy material (Figures 6A, 6B) that indicates interaction with voluminous seawater. This suggests that when the flow was originally emplaced and still molten it was deluged with crashing surf in places, indicating that the presently exposed flow was located close to the original coastline. The proximity of this thick pahoehoe flow to the original coastline is also suggested by the presence of a large included block of glassy, partly oxidized "littoral breccia" that was apparently thrown inland by waves and incorporated in the massive pahoehoe lava pond (Figure 7). We hypothesize that when the massive pahoehoe flow reached the ocean some 750 years ago, littoral explosions built up a coastal berm of spatter that formed a barrier behind which especially thick molten pahoehoe ponded. The impact of waves on this littoral berm tore loose fragments that were thrown back into the dammed molten pahoehoe pond. This situation is analogous to the ponding of thick pahoehoe that has been observed to form inland from littoral cones and spatter deposits along the Kalapana coastline during the presently on-going eruption of Kilauea. The fragmental deposits that we suggest formed the original coastline during emplacement of this flow were quickly eroded away hundreds of years ago, but active erosion ceased once the fragmental material was eroded away and the solid, massive pahoehoe formed inland from the berm was exposed.

Other evidence supports the existence of a large pond of molten lava inland of the now eroded-away coastal berm. The flat-lying coastal pahoehoe shelf is bordered on its mauka edge, 80-100' inland from the coastline, by an anomalous downward tilting of the originally horizontal surface (Figure 8). This tilting was evidently caused by the lateral draining of a large volume of molten lava from beneath the crust in this area to lower areas (perhaps though gaps in the coastal berm). This caused the crust to subside, forming an elongate 3-5 feet deep depression inboard of the pahoehoe shelf. This depression extends across the entire Property (Figure 5), and has now largely been infilled by the littoral sand deposits that shown on Figure 8. Large cracks formed on the pahoehoe shelf surface along the zone where tilting of the surface crust occurred as molten lava drained away from beneath the crust (Figure 9). A geologic cross-section of this area (Figure 10) shows the accumulation of sand deposits in this down-dropped area.

Figure 6A. Frothy texture caused by interaction of seawater and molten rock

Figure 6B. Frothy texture caused by interaction of seawater and molten rock.

Figure 7. Coastline fronting Property, showing large fragment of littoral breccia (arrow) included in the "backshore" pahoehoe pond.

Figure 8. Sand-filled Inshore subsidence area. Note tilting of pahoehoe shelf at margin of flat shelf. View to northwest.

Figure 9. Tensional crack at margin of subsided pahoehoe shelf.

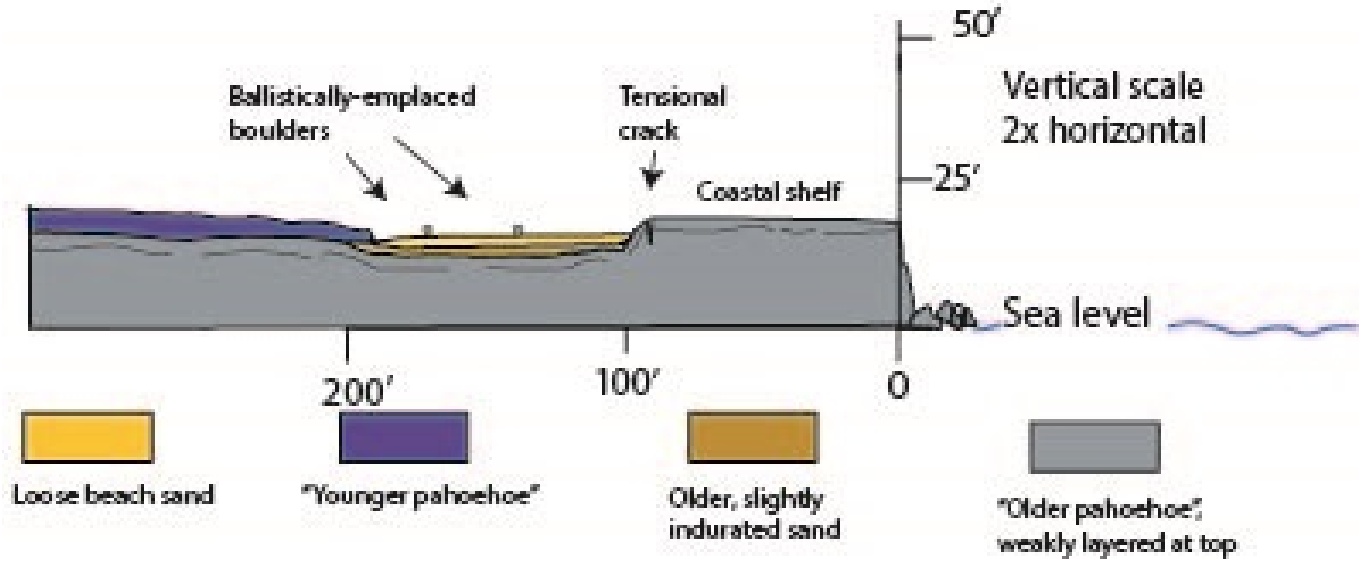

Figure 10. Geologic Profile across coastal portion of Moore Property, along line N-S in Figure 5.

EROSION RATE

Inspection of available aerial photographs (Table 1) show no measurable change in position of the overall coastal sea-cliff or of the vegetation line since the earliest 1954 photos. The large scale (limited resolution) of the aerial photographs inspected study makes quantitative analyses of fine-scale morphological changes of the sea cliff or vegetation positions impossible, and it is doubtful that horizontal changes of less than 10 feet could be detected. Since an approximation of the erosion rate at this property is not statistically feasible using the methods outlined by Hwang (2005), any shoreline determinations must rely upon alternative indicators – primarily observation of active erosion such as freshly cut cliff faces or presence of angular erosional debris.

Date	Agency	Flight Line	Frames
1954	USN-USGS	017	1755, 1756
1965	USDA	EKL-12CC	007, 008
1977	USGS	GS-VEEC 6	152, 153
2014	Google Earth		

Table 1 Available aerial photography. The 1954 "frame numbers". shown refer to the UH Manoa file system, and not to original USN frame numbers.

Since there is no visible indication that the coastline has changed over the 58 year period since the first aerial photographic record began, it thus appears that the maximum amount of coastal erosion fronting the Property over this period is less than 10 feet – for a maximum rate of 0.17ft (2 in.)/yr. since 1954. There is no sign of recent erosion of the cliff line (as evidenced by the presence of well-established algae on cliff faces and absence of any indication of fresh rockfall scars). For this reason, and because of the solid, erosion-resistant nature of the pahoehoe interior rock that forms the cliff face, we feel strongly that any mechanical erosion that is taking place must be much less than the 2"/yr maximum that could have occurred.

EFFECTS OF SEA LEVEL RISE AND SUBSIDENCE ON COASLINE MIGRATION

An overall global rise in sea level of 3.3 feet by the end of the 21st century has been proposed by Fletcher (2010) and others. Hwang et al (2007) use a figure of .16 in/yr in their assessments. Relative sea-level rise, of course, is a result of the combined water rise and land subsidence.

The 1975 Kalapana earthquake on Kilauea's rift caused land in Kapoho to drop .8ft. (based on Hawaii Volcano Observatory (USGS) data in Hwang *et al.* 2007:6). This *episodic* seismic induced subsistence is difficult to anticipate or measure over long periods of time. On the basis of InSAR (Synthetic Aperture Radar Interferometry) remote sensing data, Hwang et

al.(*ibid.*) state that the coastline at Kapoho may be subsiding at a *continuous* rate of between .31 – .67 in/yr. Rates of subsidence at the Property, however, are necessarily much lower as a result of their distance from Kilauea's tectonically active rift zone.

The combined effects of land subsidence and rising sea levels may cause an overall (relative) drop in the coastline elevation of between .1 - .3 in/yr. The durability and height of the coastal sea cliff (greater than 15 feet at even the highest tides) ensures that combined sea level change and land subsidence will not cause any coastline transgression in this area.

GEOLOGIC HAZARDS

General Coastal Zone Hazards

Hwang (2005) recommends that all hazards facing coastal areas should be considered when planning for land-use zoning in Hawaii, and not just erosion. Fletcher *et al.* (2002) portray generalized hazards assessments for long areas of Hawaii's coastlines; they rate the specific hazards for the area of Puna fronting the Property in Table 2. They consider overall hazards along this stretch of coastline as "high", but we disagree with some of their values and rate overall hazards as "low to medium". (Column 4 in Table 2). Specific geologic hazards that could impact the Property are discussed after this Table.

Hazard Type	**Relative Threat**	**Scale (1-4)**	**Our Values**
Tsunami	Medium-high	3	3
Stream Flooding	Medium-high	3	1
High Waves	Medium-high	3	3
Storms	Medium-high	3	4
Erosion	Low	2	1
Sea Level Change	Medium-high	3	1
Volcanic/Seismic	High	4	4
Overall Hazard Assessment	High	6 (on scale of 1-7)	2-3

Table 2 Natural hazards impacting the coastline fronting the Moore Property (from Fletcher et al., 2002, p.150). Our values in Column 4.

Erosion

There is no evidence for any measurable erosion taking place at the coastal cliff face, although extreme storm waves have apparently broken loose large fragments from the upper cliff face (less resistant lavas) and propelled them inland (see section on “pohaku lele” below). Erosion has impacted the thin Casuarina-covered sand deposits that are located inland of the coastal pahoehoe shelf (Figure 8). These thin sand deposits are loose and friable, subject to deposition and erosion by major storm waves that overtop the sea cliff or travel laterally from low areas to the east.. Bare roots of Casuarina trees have been excavated by such sand erosion (Figure 11). Any future permanent structures should be sited mauka of this unstable sand deposit.

These sands have been actively eroded to a depth of 5-6 feet just east of the Property by storm waves that are apparently channeled inland from a small coastal embayment 300’ further east that is not protected by a sea cliff. This erosion, which does not affect the Property, is related to storm waves that surge over into this embayment and travel westward along the “inshore subsided area”.

Figure 11. Exposed Casuarina root caused by erosion of sand layer inland from coastal pahoehoe shelf.

Ballistically Emplaced Storm Boulders ("pōhaku lele")

Perhaps the greatest geologic hazard that will impact the coastal area of the Property in the future is related to exceptionally high storm waves that can tear off large blocks from the upper parts of the sea cliff and propel them large distances inland. Such blocks are initially transported by high waves over the sea cliff, but because of their greater density than seawater and thus great inertia, they may leave the waves behind and be propelled through the air as ballistically-emplaced storm boulders. This is an uncommon phenomenon, and for this report we are proposing the term "pōhaku lele" (flying rocks) to describe them. Over 100 of these blocks were observed on the Property, with more than a dozen of them in excess of two feet in diameter, some weighing up to three tons (Figures 12 A, B). Most landed in the sandy area filling the "inshore subsided area" (Figure 5), but one was noted 205' from the coastline, about 60' mauka of the sandy infilled area (Figure 12C). Almost all of the pōhaku lele have freshly broken surfaces, with no development of lichen. We regard this hazard as extremely rare, and suspect most of them were emplaced during the August, 2014 impact of the near-hurricane strength storm ISELLE, which was the strongest tropical cyclone to make landfall on the Island of Hawaii

in recorded history (https://en.wikipedia.org/wiki/Hurricane_Iselle), and was focused on the Puna coastline fronting the Property. One of the storm boulders (Figure 12B) appears to have been emplaced much earlier – indicating that "pōhaku lele" emplacement has occurred in the past and likely will occur in the future during major storms or tsunami.

Figure 12A. Storm wave-emplaced angular storm boulder ("pohaku lele") 115' inland from coastline. Note slight rounding of angular corners, indication some tumbling in waves. Rod is 4.5 feet long. Most of these blocks appear freshly broken, with no encrusting vegetation and were possibly emplaced by massive waves associated with the August, 2014 Iselle tropical storm.

Figure 12B. Storm-wave-emplaced boulder125' inland from coastline. Note irregular, uneroded surface of the boulder, indicating it was emplaced ballistically through the air, and not rolled along by waves. Ferns and lichen cover its surface, suggesting that it was emplaced by a storm or tsunami much earlier than Iselle.

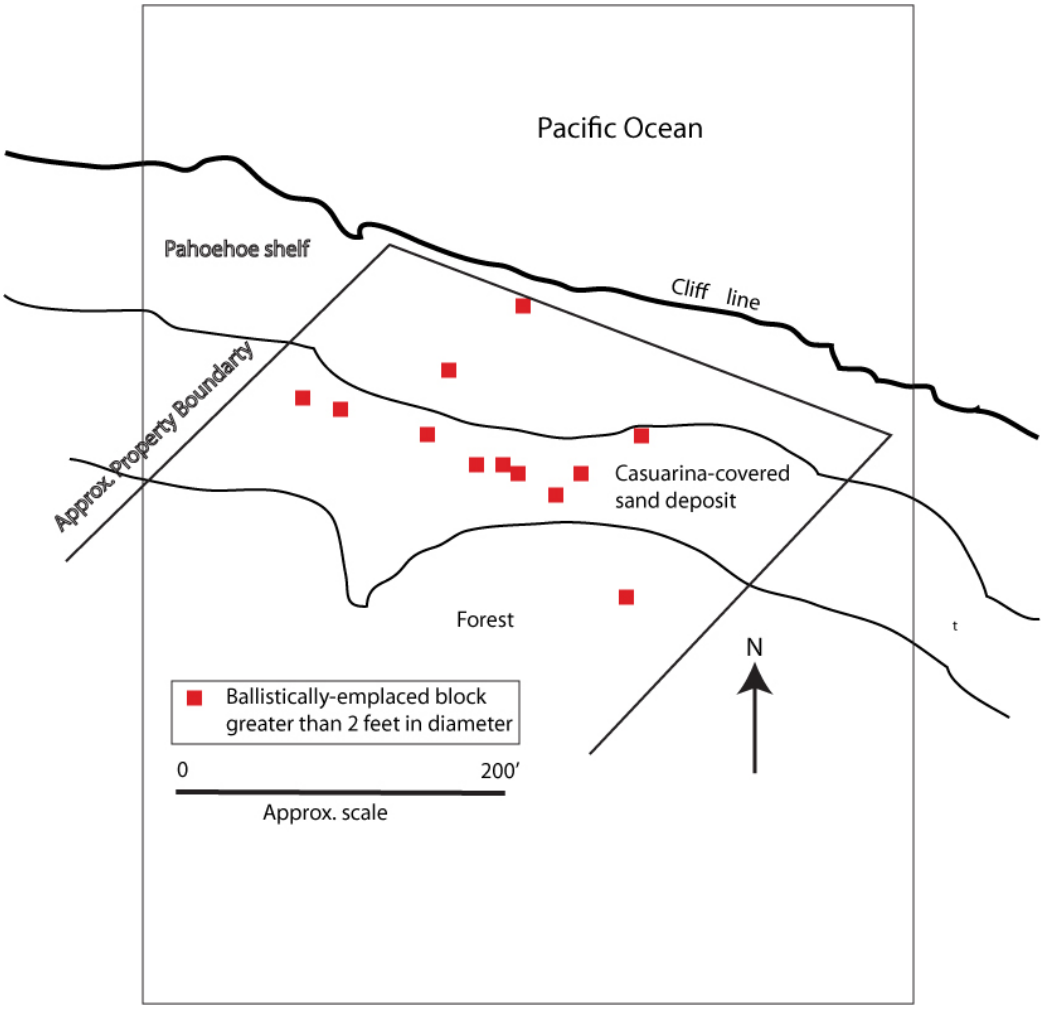

Figure 12C. Locations of pohaku lele greater than two feet in diameter in the coastal area fronting the Property.

Seismic Hazards

The Island of Hawaii is one of the most seismically active areas on Earth, with more destructive earthquakes occurring here than in any other comparably sized area in the United States (Wyss and Koyanagi, 1992). Although the most severe historical earthquakes have occurred on the southern flank of Hawaii, Wyss and Koyanagi indicate that all of the Puna area in an area subject to earthquakes of up to intensity VIII on the Modified Mercalli Scale. Such intensities can cause moderate to severe damage to unreinforced structures or to buildings with inadequate foundations. The pahoehoe lava flows underlying the Property are everywhere solid

and well-suited to support properly designed construction at any scale. Properly designed structures constructed on this Property in accordance with County of Hawaii revised Building Codes will be safe during any foreseeable earthquakes. Like all of Hawaii Island though, severe ground shaking will occur during future earthquakes, and care should be taken for the protection of fragile items within homes.

Volcanic Hazards

This Property lies entirely within USGS Lava Flow Hazard Zone 3 (Wright and others, 1992) - the same as Hilo) - but in reality, is at the high-risk margin of Zone 3, only about two miles from the loosely-defined boundary of Zone 2. We have estimated the "Younger Flow" was emplaced in the early 18th Century. The next lava flow to reach the coastline in this area (2.5 miles to the southeast) in June, 1840. No lava flows have threatened this area since, prior to 2014, when lava flows from Kilauea's East Rift Zone (ERZ) entered Pahoa and almost crossed the Keaau-Pahoa Highway (Figure 1). These flows stopped six miles upslope from the Property, but the coastal area between Hawaiian Paradise Park and Hawaiian Acres could have been impacted had the eruption continued.

Moore and Trusdell show eleven lava flows that have traveled northeast from the ERZ over the past 1,500 years; seven of these have reached the ocean. Radiometric dating and detailed mapping is inadequate to define quantitative recurrence intervals for eruptive activity on the ERZ, but that limited data does suggest that "on average" lava flows travel northeast from that rift zone once every 140 years or so; flows have reached the coastline about every 200 years. Lava flows that have reached the coast are, however, relatively narrow, so that the odds that the Moore Property will be overrun by lava within the next few centuries are relatively low. Nothing to worry about, but Kilauea is one of the world's most active volcanoes, and anyone living on her surface must accept the fact that Pele has created the lavas we live on, and that she can bury her older creations with fresh new lava any time she chooses!

Flooding

No indications of any past flooding events were observed in the Property, other than the inundation of the "inshore subsidence area" (Figure 8) by presumably infrequent major storm wave surges. Like most of windward Hawaii, extremely heavy rainfall can impact this area

during future storms, water may fill depressions temporarily, but because the volcanic rocks underlying the Property have great permeability, ponds will drain rapidly when rains cease. Organic matter overlying the pahoehoe substrates increase water storage and permeability, so that preservation of forest cover on the Property wherever possible is important.

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