DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

FILE COPY

APR - 8 2020

KIRK CALDWELL
MAYOR

KATHY K. SOKUGAWA
ACTING DIRECTOR

TIMOTHY F. T. HIU
DEPUTY DIRECTOR

EUGENE H. TAKAHASHI
DEPUTY DIRECTOR

March 31, 2020

2020/ED-4 (RY)
1834485

Mr. Keith Kawaoka, Acting Director
Office of Environmental Quality Control
Department of Health, State of Hawaii
235 South Beretania Street, Room 702
Honolulu, Hawaii 96813

Dear Mr. Kawaoka:

With this letter, the City & County of Honolulu, Department of Planning and Permitting, is transmitting the draft environmental assessment (DEA) for the West Oahu Solar Plus Storage (Project). The Project is located within a portion of Tax Map Key No.(TMK) 9-2-002: 007, Honouliuli, Ewa, Island of Oahu. The information and files required for publication, including an electronic copy of the DEA, have been provided via the OEQC online submission platform. We request publication of the DEA in the April 8, 2020 edition of the Environmental Notice.

Please contact Raymond Young via email at rcsyoung@honolulu.gov if you have any questions.

Sincerely,

Kathy K. Sokugawa
Acting Director

Encl: DEA form

cc: Nick Molinari/AES West Oahu
Lisa Kettley/Tetra Tech

20-229

From: webmaster@hawaii.gov
To: HI Office of Environmental Quality Control
Subject: New online submission for The Environmental Notice
Date: Wednesday, April 1, 2020 3:29:42 PM

Action Name

West Oahu Solar Plus Storage Project

Type of Document/Determination

Draft environmental assessment and anticipated finding of no significant impact (DEA-AFNSI)

HRS §343-5(a) Trigger(s)

- (1) Propose the use of state or county lands or the use of state or county funds

Judicial district

ʻEwa, Oʻahu

Tax Map Key(s) (TMK(s))

9-2-002:007

Action type

Applicant

Other required permits and approvals

Numerous

Discretionary consent required

State Special Use Permit

Approving agency

City & County of Honolulu Department of Planning and Permitting

Agency contact name

Raymond Young

Agency contact email (for info about the action)

rcsyoung@honolulu.gov

Agency contact phone

(808) 768-8049

Agency address

650 S. King Street
7th Floor
Honolulu, HI 96813
United States
Map It

Applicant

AES West Oʻahu Solar, LLC

Applicant contact name

Nick Molinari

Applicant contact email

nick.molinari@aes.com

Applicant contact phone

(303) 524-4368

Applicant address

282 Century Place, #2000
Louisville, CO 80027
United States
Map It

Was this submittal prepared by a consultant?

Yes

Consultant

Tetra Tech, Inc.

Consultant contact name

Lisa Kettley

Consultant contact email

lisa.kettley@tetratech.com

Consultant contact phone

(808) 441-6651

Consultant address

737 Bishop Street, Suite 2340
Honolulu, HI 96813
United States
Map It

Action summary

AES West Oahu Solar, LLC is proposing the West Oʻahu Solar Plus Storage Project on land owned by University of Hawaiʻi, approximately 3 miles northeast of Kapolei. The Project would provide up to 12.5 MW of solar energy and 50 MWh of battery storage, helping the State of Hawaiʻi achieve its energy goals of generating 100 percent of the state's energy from renewable sources. The Project would interconnect with Hawaiian Electric's island-wide grid via an existing 46-kV sub-transmission line that traverses the Project area. The power generated by the Project would be sold to Hawaiian Electric under a new 25 year power purchase agreement. At the end of the Project's operational life, the facilities would be decommissioned and the Project area would be returned to substantially the same condition as existed prior to Project development. The Project area occupied by the solar energy facility would be made available for compatible agricultural uses pursuant to HRS 205-4.5(a)(21).

Reasons supporting determination

Based upon the preliminary analysis and findings presented in the Draft EA, implementation of the Project is not expected to result in a significant adverse direct, indirect, or cumulative impact on the quality of the environment. As such, a Finding of No Significant Impact (FONSI) is anticipated in accordance with HRS Chapter 343. This assessment is based on an evaluation of the project impacts in

relation to the significance criteria specified in HAR §11-200.1-13, as detailed in Section 6.1 of the Draft EA.

Attached documents (signed agency letter & EA/EIS)

- AES_WestOahu_DraftEA_03.16.2020.pdf
- AES-West-Oahu-Solar-DEA_DPP-Transmittal-Letter.pdf

Action location map

- WestOahuSolarStorage_ProjectArea.zip

Authorized individual

Lisa Kettley

Authorization

- The above named authorized individual hereby certifies that he/she has the authority to make this submission.

DRAFT ENVIRONMENTAL ASSESSMENT

West O‘ahu Solar Plus Storage Project

University of Hawai‘i West O‘ahu Mauka Lands Property

‘Ewa District, O‘ahu, Hawai‘i

Prepared for

AES West O‘ahu Solar, LLC

MARCH 2020

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Project Summary

Project Name	West O‘ahu Solar Plus Storage Project
Applicant	AES West O‘ahu Solar, LLC
Project Overview	Construction and operation of 12.5-megawatt (MW) solar photovoltaic and 50 MW-hour (MWh) battery energy storage system
Location	Approximately 3 miles northeast of Kapolei ‘Ewa District, O‘ahu
Tax Map Key	9-2-002:007
Landowner	State of Hawai‘i (University of Hawai‘i [UH] West O‘ahu)
Project Area	Approximately 97 acres[1]
State Land Use District	Agriculture
County Zoning	Restricted Agriculture (AG-1)
Development Plan (Land Use Classification)	‘Ewa Development Plan (Agricultural and Preservation Areas with Natural Drainageways; outside Urban Growth Boundary)
Required Permits and Approvals	• State Special Use Permit (SUP)[2] • County Conditional Use Permit (CUP) Minor • Hawai‘i Revised Statutes (HRS) Chapter 6E Compliance (Historic Preservation Review) • National Pollutant Discharge Elimination System (NPDES) Permit • Community Noise Permit • Building Permit • Grading and Grubbing Permit • Federal Aviation Administration (FAA) Notice of Proposed Construction or Alteration
HRS Chapter 343 Trigger	Use of State Lands
Approving Agency	City and County of Honolulu, Department of Planning and Permitting
Anticipated Determination	Anticipated Finding of No Significant Impact (FONSI)

Contact Information	**Applicant:** AES West O‘ahu Solar, LLC 282 Century Place, #2000 Louisville, CO 80027 Attn: Nick Molinari nick.molinari@aes.com **Approving Agency:** City & County of Honolulu Dept. of Planning and Permitting 650 South King Street, 7th Floor Honolulu, HI 96813 Attn: Raymond Young rcsyoung@honolulu.gov **Agent:** Tetra Tech 737 Bishop Street, Suite 2340 Honolulu, Hawai‘i 96813 Attn: Lisa Kettley lisa.kettley@tetratech.com

NOTES:

[1] Based on the current layout, the Project does not occupy the entire 97 acres of the Project area (see Figure 2-1). As the Project design is refined based on the results of technical studies and community input, it is possible that the area secured for the Project through an agreement with UH West O‘ahu could be less than 97 acres.

[2] The SUP is a discretionary approval which in combination with the use of state lands as a trigger necessitates HRS Chapter 343 environmental review.

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Abbreviations and Acronyms

AES	AES West O‘ahu Solar, LLC
AC	alternating current
BMP	Best Management Practice
CO_2	carbon dioxide
CUP	Conditional Use Permit
CWRM	Commission on Water Resource Management
DC	direct current
DLNR	Department of Land and Natural Resources
DOFAW	Hawai‘i Division of Forestry and Wildlife
DOH	Hawai‘i Department of Health
DOT	Hawai‘i Department of Transportation
DPP	Department of Planning and Permitting
EA	Environmental Assessment
EISPN	Environmental Impact Statement Preparation Notice
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESCP	Erosion and Sediment Control Plan
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
HAR	Hawai‘i Administrative Rules
Hawaiian Electric	Hawaiian Electric Company
HCEI	Hawai‘i Clean Energy Initiative
HRS	Hawai‘i Revised Statutes
IAL	Important Agricultural Land
kV	kilovolt
MW	megawatt
MWh	megawatt-hour
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NWI	National Wetland Inventory

NWP	Nationwide Permit
OEQC	Office of Environmental Quality Control
PPA	Power Purchase Agreement
Project	West Oʻahu Solar Plus Storage Project
PSIP	Power Supply Improvement Plan
PUC	Public Utilities Commission
RFP	Request for Proposal
RPS	renewable portfolio standard
SCADA	supervisory control and data acquisition
SPCC	Spill Prevention Control and Countermeasure
SUP	State Use Permit
SWPPP	Stormwater Pollution Prevention Plan
TMK	tax map key
UH	University of Hawaiʻi
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

1 Project Overview

AES Distributed Energy, Inc. is proposing the West Oʻahu Solar Plus Storage Project (Project) on the island of Oʻahu, Hawaiʻi. The Project involves construction and operation of a solar photovoltaic and battery energy storage system on land owned by University of Hawaiʻi (UH), approximately 3 miles northeast of Kapolei on the southwest side of Oʻahu. The Project area encompasses approximately 97 acres[1] within an approximately 861-acre parcel (identified as tax map key [TMK] 9-2-002:007), which is part of a larger area commonly referred to as the UH West Oʻahu Mauka Lands property.[2] The Project location, TMK boundaries, land ownership and general setting are shown in Figures 1-1 through 1-5, respectively.

The Project is envisioned to help the State of Hawaiʻi achieve its Renewable Portfolio Standard (RPS) energy goals of generating 100 percent of the state's energy from renewable sources. It would include an approximately 12.5-megawatt (MW) ground-mounted solar photovoltaic system plus 50 MW-hour (MWh) battery energy storage system, as well as ancillary support facilities. It would interconnect with the Hawaiian Electric Company (Hawaiian Electric) island-wide grid via an existing 46-kilovolt (kV) sub-transmission line that traverses the Project area. The Project area would be secured for use through an agreement with UH.[3] The power generated by the Project would be sold to Hawaiian Electric under a new 25-year power purchase agreement (PPA). In addition to generating and storing solar energy, the Project area would also be made available for compatible agricultural activities.

The Project would be owned and operated by AES West Oʻahu Solar, LLC (AES), a Delaware limited liability company and affiliate of AES Distributed Energy, Inc., which is a subsidiary of the AES Corporation. AES Distributed Energy, Inc. has a long history in the development and operation of solar energy facilities throughout the United States, including several solar energy facilities in Hawaiʻi.

1.1 Background Information

Hawaiʻi is widely recognized as the most fossil fuel dependent state in the nation and is exceedingly vulnerable to fluctuations in resource availability. In an effort to reduce Hawaiʻi's dependence on imported fossil fuels and increase the amount of locally produced renewable energy, the Hawaiʻi Clean

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[1] Based on the current layout, the Project does not occupy the entire 97 acres within the Project area (see Figure 2-1). As the Project design is refined based on the results of technical studies and community input, it is possible that the area secured for the Project through an agreement with UH West Oʻahu could be less than 97 acres.

[2] In total, the UH West Oʻahu Mauka Lands property encompasses approximately 991 acres. In addition to the parcel in which the Project would be located, it also includes the following parcels: 9-2-002:001 (80 acres), 9-2-002:005 (12 acres), and 9-2-002:003 (38 acres).

[3] Under an August 2019 option agreement with UH, AES will enter into a Grant of System Easement under which AES will have the right to develop, construct, install, operate, maintain, repair, and replace the Project upon and/or remove the Project on a portion of the UH West Oʻahu Mauka Lands property. AES is required to take actions as necessary to designate the area as an easement. The easement area will include an exclusive area for the Project facilities, a non-exclusive access easement and a non-exclusive utility easement for Hawaiian Electric.

Energy Initiative (HCEI) was launched in 2008 through an agreement between the State of Hawaiʻi and the Department of Energy. The HCEI provides a regulatory framework to address the various systems that govern energy planning and delivery within the state (DBEDT, 2019a). As part of the HCEI, the State established an RPS, as codified in Hawaiʻi Revised Statutes (HRS) Chapter 269-92. The RPS specifies that the electric utility companies that sell electricity for consumption in Hawaiʻi are required to use renewable energy for the equivalent of 30 percent of net electricity sales by 2020, 40 percent by 2030, seventy percent by 2040, and 100 percent by 2045.

In 2016, Hawaiian Electric issued an update to their Power Supply Improvement Plan (PSIP) presenting specific actions that would be implemented over a five-year planning period to accelerate achievement of Hawaiʻi's renewable energy goals. In particular, the PSIP commits Hawaiian Electric to aggressively seek grid-scale renewable resources and to achieve a consolidated RPS of 52 percent by 2021. The resource needs identified for the island of Oʻahu include approximately 352 MW of grid-scale solar energy and 64 MW of grid-scale wind energy (Hawaiian Electric, 2016). To meet these resource requirements, Hawaiian Electric established a process for solicitation and procurement of qualified renewable dispatchable generation.

Through this process, Hawaiian Electric issued its *Request for Proposals for Variable Renewable Dispatchable Generation for the Island of Oʻahu* (RFP; Docket No. 2017-0352) in February 2018.[4] The RFP established a competitive bidding process for projects to provide grid-scale renewable generation to the Hawaiian Electric system, thus contributing to the State's RPS. Based on responses to the RFP, Hawaiian Electric selected a total of eight solar plus storage projects, each of which required subsequent approval of a PPA by the Public Utilities Commission (PUC).[5] The West Oʻahu Solar Project was one of the projects selected by Hawaiian Electric; the PPA for the Project was approved by the PUC in August 2019 (PUC, 2019).

The area proposed for the West Oʻahu Solar Project is part of the overall 991-acre UH West Oʻahu Mauka Lands property. In September 2014, the UH Board of Regents approved the UH – West Oʻahu Land Use Plan, in which approximately 273 acres of the Mauka Lands property was identified for an energy farm (UH, 2015). Based on the opportunity presented by the Hawaiian Electric RFP process, UH sought potential developers for a renewable energy facility in this location and ultimately awarded AES site control with development rights for the Project area. Consistent with UH's land development strategy, the Project would be enabled through an agreement in which the university would retain ownership of the land while securing a revenue stream.

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[4] As detailed in the RFP, Hawaiian Electric indicated that renewable dispatchable generation would be sought in stages, such that a second phase of the RFP may be issued if the generation needed to meet the PSIP requirements was not fully met in the first phase of the procurement process. Phase 2 of the Hawaiian Electric RFP was issued on August 22, 2019.

[5] A total of six projects (with a total capacity of approximately 247 MW and one gigawatt hour of storage) were initially approved by the PUC, including three projects on Oʻahu, one on Maui and two on Hawaiʻi Island. Two additional projects, including the West Oʻahu Solar Project and a 15 MW project on Maui were also selected by Hawaiian Electric and were subsequently added to this portfolio.

1.2 Purpose and Need

Collectively, the HCEI and the State of Hawai‘i’s RPS establish the need to reduce Hawai‘i’s dependence on imported fossil fuels and increase the amount of locally produced renewable energy. The need for development and implementation of renewable energy projects is further demonstrated by the commitments detailed in Hawaiian Electric’s PSIP and the associated RFP process (Hawaiian Electric, 2016; Hawaiian Electric, 2018).

The purpose of the Project is to construct and operate facilities on the UH West O‘ahu Mauka Lands property that would generate and store electricity derived from solar resources, thereby providing clean, renewable energy for the island of O‘ahu. The Project would help to meet the state’s need for renewable energy by providing up to 12.5 MW of solar energy and 50 MWh of battery storage, which is enough to provide electricity for approximately 4,600 homes (based on average energy use). In doing so, it would directly contribute to the state’s renewable energy goals, fulfilling approximately 0.5 percent of Hawaiian Electric’s RPS (Hawaiian Electric, 2019a). The solar energy from the Project would replace a portion of electricity that is currently generated by burning fossil fuels, thus reducing greenhouse gas emissions and other forms of pollution that are detrimental to the environment and human health. In total, the Project is expected to offset the use of approximately 545,794 barrels of fuel and 64 tons of coal, and would decrease greenhouse gas emissions by approximately 244,394 tons over its lifetime (Hawaiian Electric, 2019a). Furthermore, based on the 25-year fixed-price PPA, the energy produced by the Project would be sold at a price that is less than the current cost of fossil fuel power and would help to hedge against long-term price volatility. The Project would also help to improve electric grid stability by enabling Hawaiian Electric to utilize stored solar energy to meet peak demand. As an additional benefit, the Project’s agreement with UH would provide a valuable revenue stream for the university over the next 25 years or more.

1.3 Project Area

The Project area is located within the ahupua‘a of Honouliuli in the ‘Ewa District on the island of O‘ahu. It is approximately 97 acres in size and sits within the southwestern portion of the 991-acre UH West O‘ahu Mauka Lands property. The UH West O‘ahu Mauka Lands property is bordered on its southeastern edge by the H-1 Freeway, beyond which is the UH West O‘ahu campus and the city of Kapolei. The southern and western portions of the property are bordered by vacant land, with Makakilo Quarry and the residential community of Makakilo located just beyond. The area north of the Project area generally comprises open space associated with the Wai‘anae Mountains. The former Honouliuli Internment Camp site, which the National Park Service (NPS) is currently working to incorporate as a National Monument, is located to the northeast. The eastern portion of the property is bordered by Honouliuli Gulch and a variety of agricultural operations; further east is Kunia Road and the Village Park community.

This property was previously cultivated as part of an extensive sugar cane and pineapple plantation that historically extended across O‘ahu’s ‘Ewa Plain. Since closure of the plantation in the 1990s, the land has

been fallow and intermittently used for cattle grazing. Remnants of infrastructure associated with the former plantation remains onsite, including a pump station, an associated steel frame structure and components of the irrigation system. The only other structure within the property is a Board of Water Supply water tank, which supplies water for the UH West Oʻahu campus. A tributary to Kaloʻi Gulch as well as a remnant portion of the Waiahole Ditch run through the Project area.

Access to the Project area is via an existing gated entry and network of former plantation roads with ingress/egress from Pālehua Road, which runs north then west from the intersection of Kualakaʻi Parkway and H-1 Freeway. Pālehua Road is also used for access to the Makakilo Quarry, which is owned and operated by Grace Pacific; 24-hour security controls entry to the UH West Oʻahu Mauka Lands property and Makakilo Quarry. The former plantation roads within the UH West Oʻahu Mauka Lands property, which were originally constructed and used for sugar cane haul trucks, have been maintained and provide access for users of the UH West Oʻahu Mauka Lands property, including the cattle ranchers and Board of Water Supply.

1.4 HRS Chapter 343 Compliance

HRS Chapter 343 environmental review is required for any action that (1) requires one or more approvals[6] prior to implementation and (2) includes one or more triggers identified in HRS Chapter 343-5(a); these requirements are detailed in the Hawaiʻi Administrative Rules (HAR) §11-200.1, which are the implementing rules for compliance with HRS Chapter 343.

The Project will entail execution of an agreement with UH for the use of state land. As described above, under an August 2019 option agreement with UH, AES will enter into a Grant of System Easement (including an exclusive area for the Project facilities, a non-exclusive access easement and a non-exclusive utility easement); HRS Chapter 11-200.1-9 states that use (title, lease, permit, easement, license, etc.) or entitlement to state-owned lands is considered use of state lands, which is one of the identified triggers identified in HRS Chapter 343-5(a). As further discussed in Section 5.1.1, the Project will also require a Special Use Permit (SUP) which is a discretionary permit requiring approval by the City & County of Honolulu Department of Planning and Permitting (DPP), Planning Commission, and the State of Hawaiʻi Land Use Commission. As the Project will require discretionary consent for the SUP and will involve the use of state lands, compliance with HRS Chapter 343 is required.

In accordance with HAR §11-200.1-7, DPP was determined to be the approving agency for the purposes of HRS Chapter 343 compliance because they will be the agency initially responsible for receiving and processing the request for an SUP. Based on the scope and scale of the Project and consistent with HAR §11-200.1-14, DPP determined an environmental assessment (EA) to be the appropriate level of environmental review. As such, this Draft EA has been prepared in compliance with HRS Chapter 343 and HAR §11-200.1 and submitted to the Office of Environmental Quality Control (OEQC) for publication in the *Environmental Notice*. Comments received during the required 30-day public review period will be

[6] Approval is defined as a discretionary consent required from an agency prior to implementation of an action (HAR §11-200.1-2).

incorporated into a Final EA, which will be provided to DPP and published in the *Environmental Notice*. Based on their review of the Final EA and application of the significance criteria in HAR §11-200.1-13, DPP will issue a determination notice of either a "Finding of No Significant Impact" (FONSI) or an "Environmental Impact Statement Preparation Notice" (EISPN). Based on preliminary information, it is currently anticipated that a FONSI will be issued for the Project.

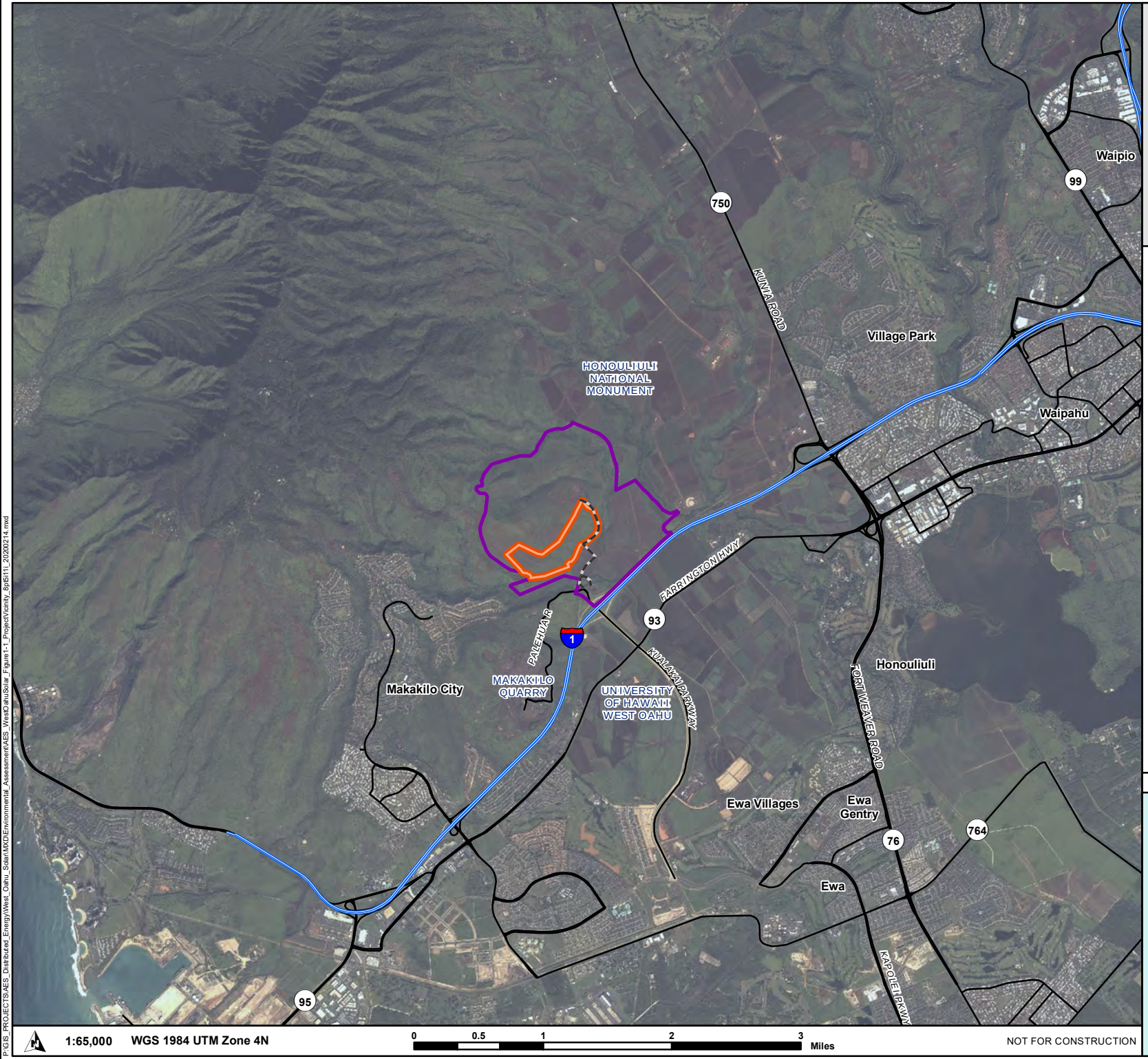

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Figure 1-1

West Oahu Solar Plus Storage Project

AES Distributed Energy

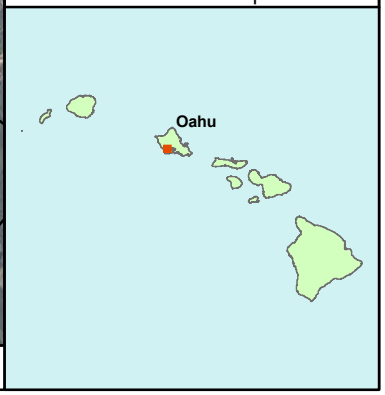
Project Vicinity

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- Interstate Highway
- Roadway

TETRA TECH

Reference Map



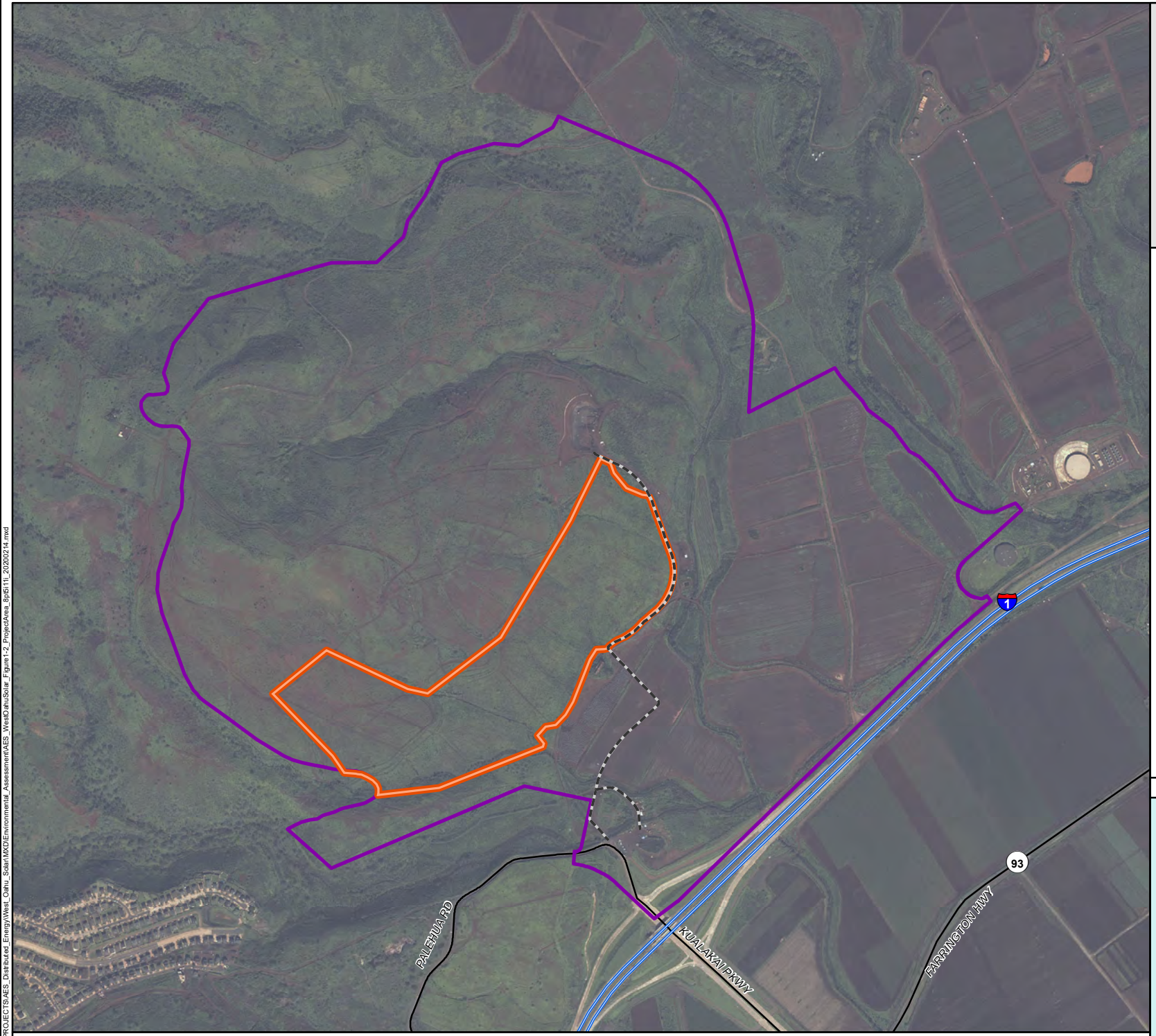


Figure 1-2

West Oahu Solar Plus Storage Project

AES Distributed Energy

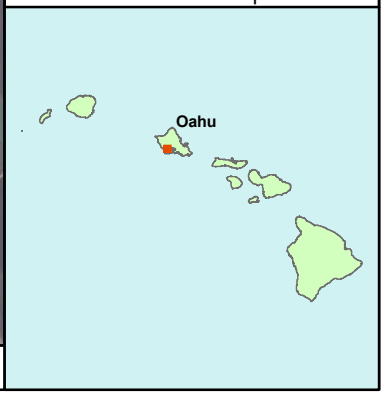
Project Area

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- Interstate Highway
- Roadway

TETRA TECH

Reference Map



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NOT FOR CONSTRUCTION

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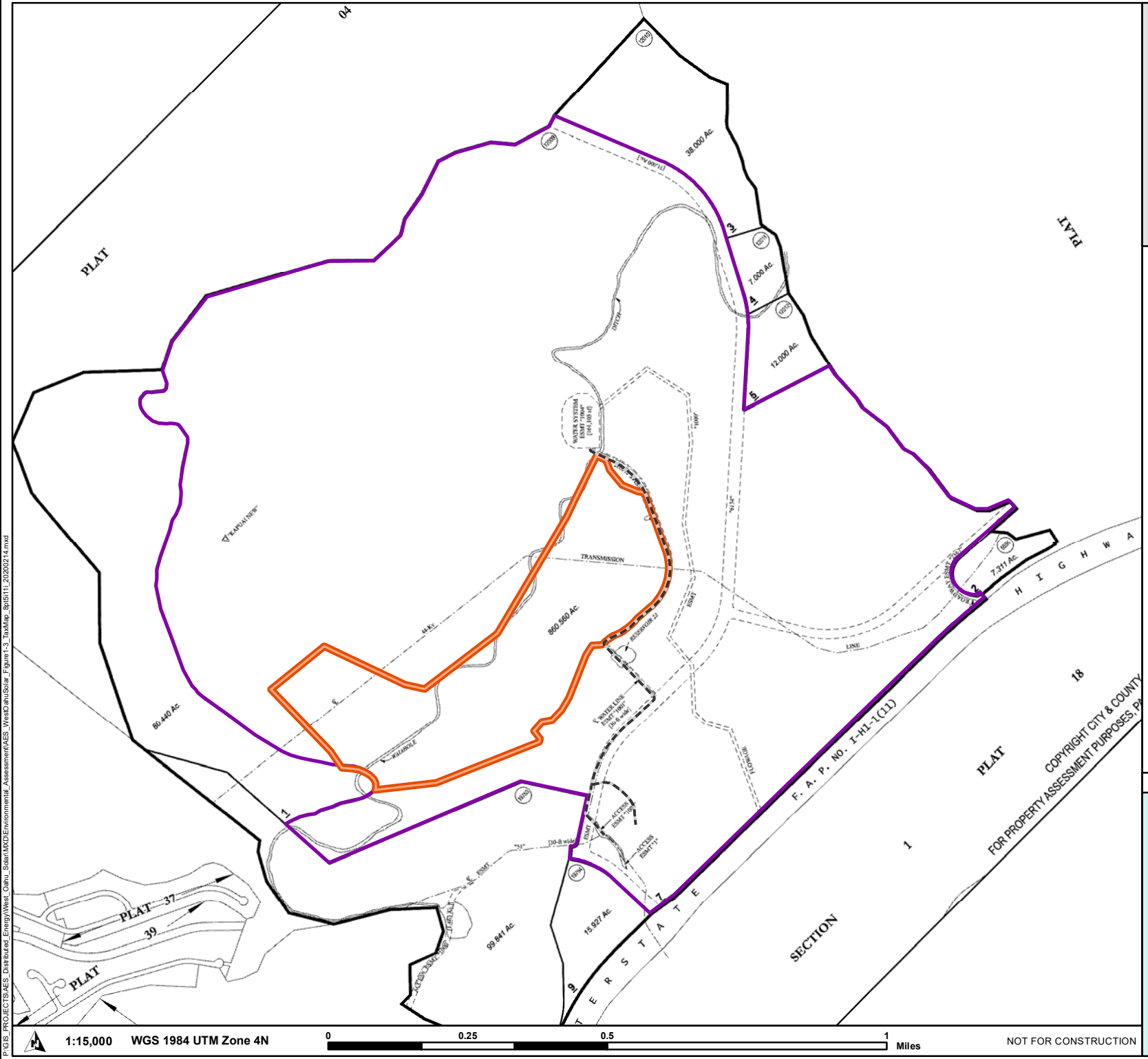


Figure 1-3

West Oahu Solar Plus Storage Project

AES Distributed Energy

Tax Map

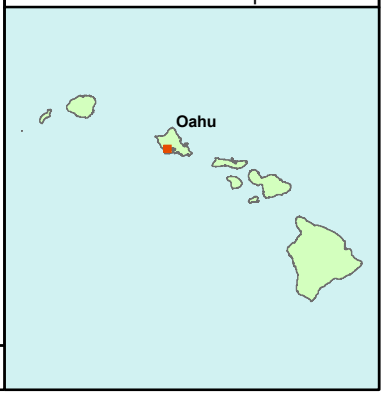
HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road

Source:
City and County of Honolulu
All Rights Reserved 2016
Zone 9, Section 2, Plat 002

TETRA TECH

Reference Map



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NOT FOR CONSTRUCTION

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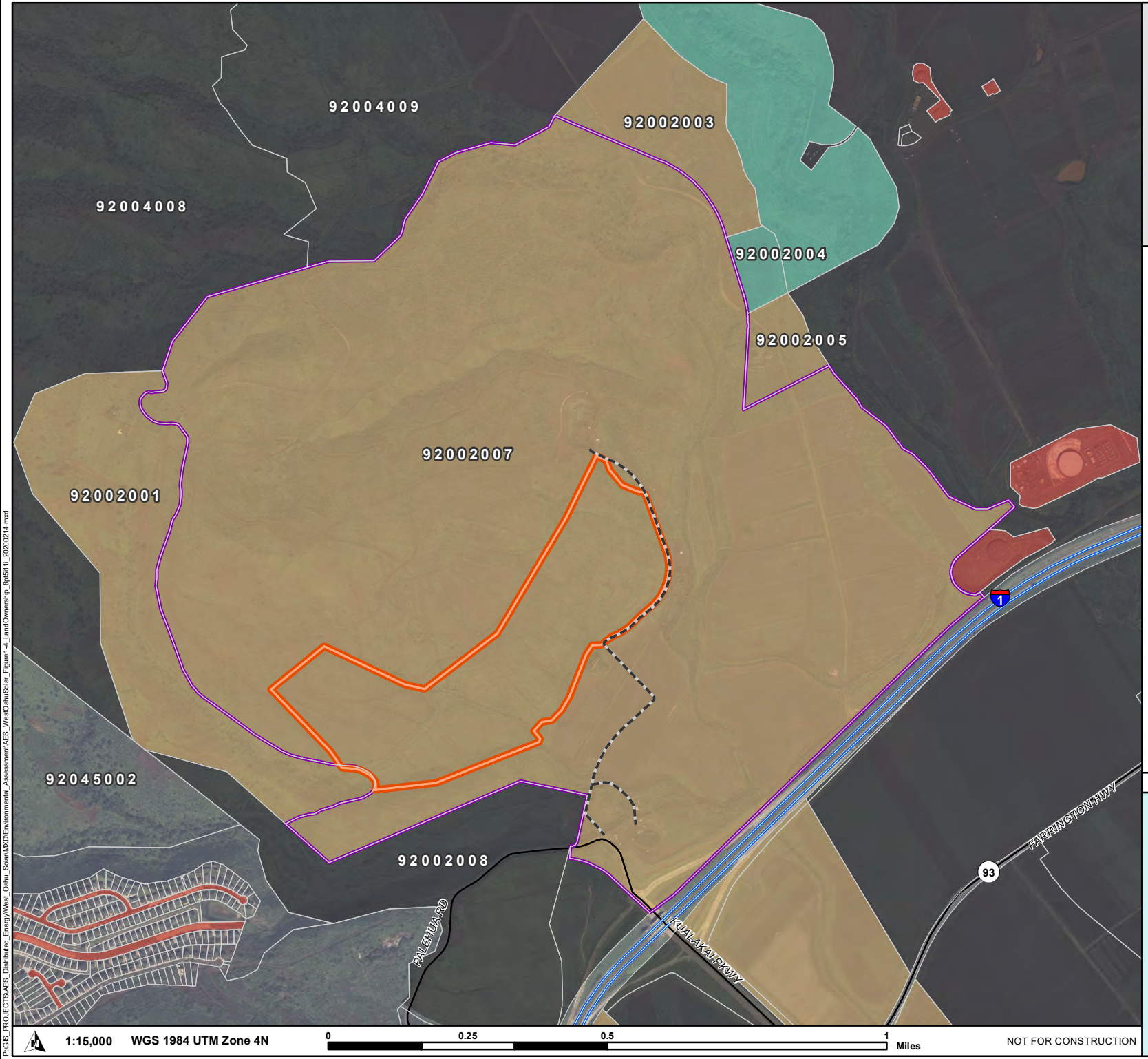


Figure 1-4

West Oahu Solar Plus Storage Project

AES Distributed Energy

Land Ownership

HONOLULU COUNTY, HI

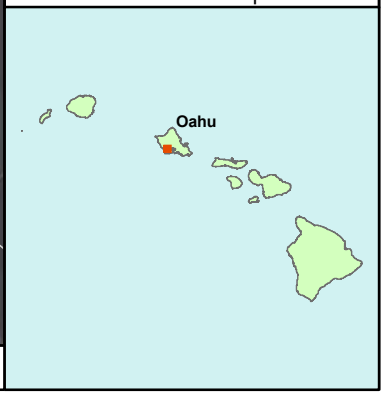
- Project Area
- Property Boundary
- Existing Access Road
- TMK Boundary
- Interstate Highway
- Roadway

Land Ownership

- County
- Federal
- State
- Private (Large Land Owner)
- Private (Other)

TETRA TECH

Reference Map



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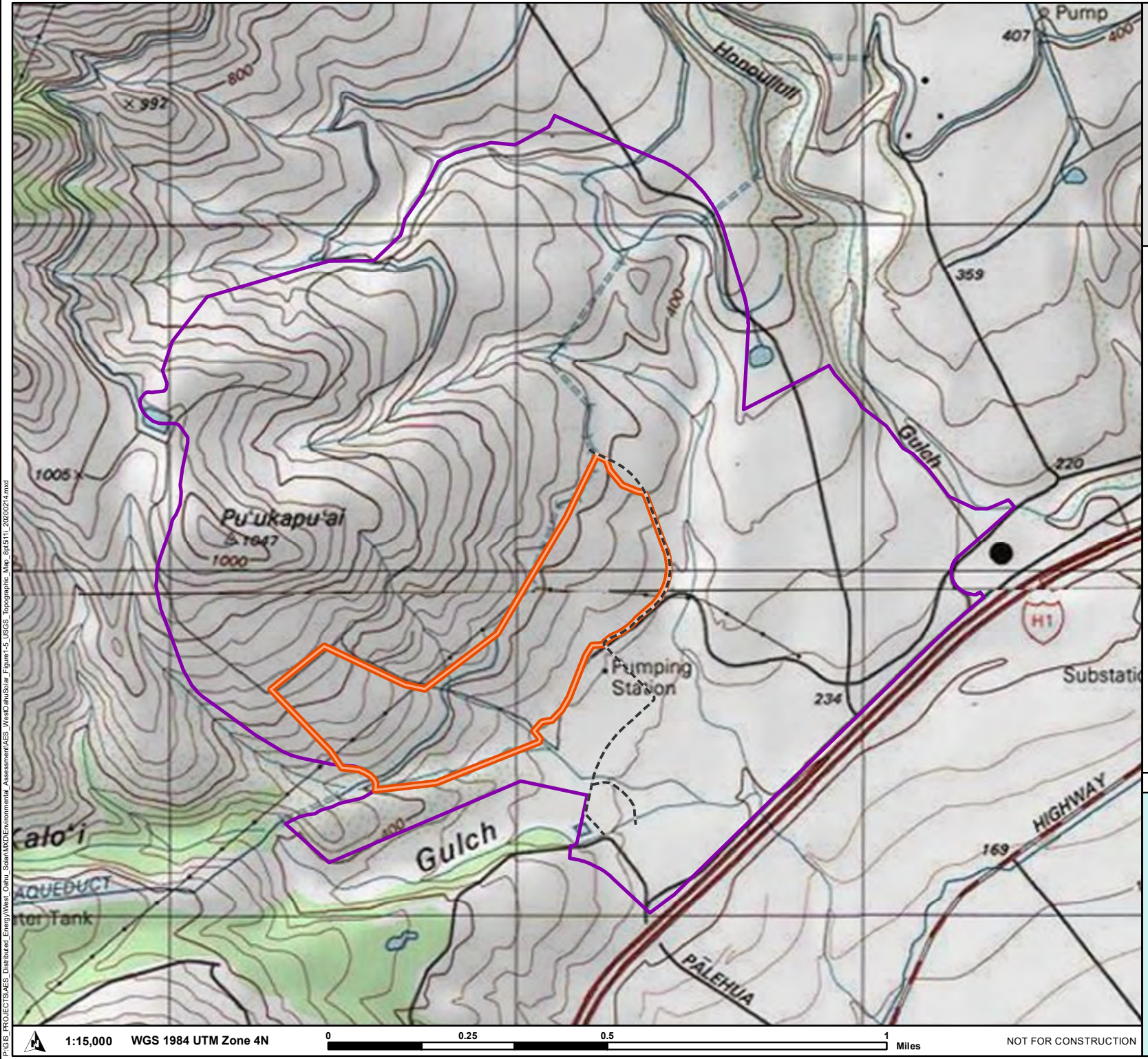


Figure 1-5

West Oahu Solar Plus Storage Project

AES Distributed Energy

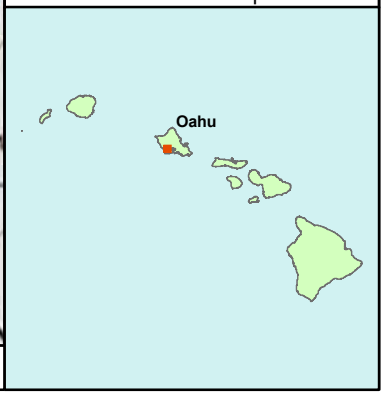
USGS Topographic Map

HONOLULU COUNTY, HI

Project Area
Property Boundary
Existing Access Road

TETRA TECH

Reference Map



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2 Description of the Proposed Project

The proposed Project consists of construction and operation of an approximately 12.5 MW ground-mounted solar photovoltaic system, coupled with a 50 MWh battery energy storage system and related interconnection and ancillary facilities. Specifically, it includes the following major components: (1) solar photovoltaic system, (2) battery energy storage system, (3) a network of electrical collector lines, (4) Project substation and Hawaiian Electric interconnection equipment, (5) communication equipment, and (6) service roads and fencing. In addition to these facilities, the Project area would be made available for compatible agricultural activities. Each of these components, as well as an overview of the associated construction, operations and maintenance activities, is described in the following sections. The preliminary site layout and schematics of the Project components are shown in Figure 2-1 and Figure 2-2. Representative photographs that show examples of the components at a similar project and associated construction activities are provided in Figures 2-3 and 2-4, respectively.

2.1 Project Components

2.1.1 Solar Photovoltaic System

The solar photovoltaic system would consist of a series of 405-watt modules mounted on a fixed-tilt racking system and related electrical equipment. Based on the preliminary site layout, it is anticipated that the Project would include four solar array areas, ranging in size from approximately 5 to 25 acres. Within each solar array area, the modules would be organized in rows (or “strings”); the row-to-row spacing would be approximately 22 feet (with approximately 8 feet of open space between adjacent rows). The racking system, which would be designed to support the modules as well as prevent wind uplift, would hold the modules at a fixed angle of 15 degrees facing toward the south. The racking system would include steel posts, spaced approximately every 17 feet (varies) and installed to a depth of approximately 6 feet (depending on specific soil conditions). Once mounted on the racking system, the highest point of the modules is expected to extend approximately 8.5 feet above the ground surface, with an average of approximately 3 feet of ground clearance below the modules.

The modules would produce direct current (DC) electricity at a maximum voltage of 1500 volts. Within each solar array area, the DC electricity from the modules would be transmitted via DC electrical wiring to a 2.8 MW central inverter, where it would be converted to alternating current (AC) electricity. The inverter would connect to a step-up transformer, which would increase the electrical voltage to 12.5 kV. Safety features incorporated into the solar photovoltaic system include mechanisms to allow for disconnection and rapid shutdown of the system, if needed; these would be installed throughout the solar arrays, and would include DC disconnects (which would allow the DC current between the modules to be interrupted before reaching the inverters) and AC disconnects (which would separate the inverters from the electrical grid).

The DC electrical wiring extending from the modules would be integrated into the above-ground portion of the racking system. At the terminus of each array disconnect, the wiring would be consolidated and directed to the inverter and transformer via underground trenching. The trenches would be up to approximately 10 feet wide and 4 feet deep in order to accommodate multiple circuits of DC electrical wiring, low-voltage AC electrical wiring and communications wiring; approximately 11,000 linear feet of trenching is anticipated for this wiring. The inverter and transformer for each of the solar array areas would be installed on a concrete equipment pad (also referred to as a power conversion station). A total of five equipment pads would be installed within the Project area; each would be approximately 3,480 square feet and would also support the battery units and communication equipment (see below).

2.1.2 Battery Energy Storage System

The battery energy storage system would include a total of ten 1,300-kilowatt (approximate) lithium-ion battery units, collectively providing approximately 50 MWh of total storage. The batteries would be charged with energy generated by the solar photovoltaic system and would allow the energy to be dispatched as needed to offset night-time customer demand and assist in grid stabilization. Each battery unit would be housed in a container approximately 10 feet (height) by 8 feet (width) by 53 feet (length); a total of 2 battery units would be installed at each of the five power conversion stations. Based on the preliminary battery configuration, each battery unit would include up to 44 racks of batteries (approximate) and would incorporate multiple layers of protection to avoid failures and to contain potential hazardous substances. Specific features would include integrated monitoring and circuit protection, a self-contained heating ventilation air cooling system, and a fire detection and suppression system specifically designed for lithium-ion battery energy storage systems. The fire detection and suppression system would incorporate specific controls with automatic safety responses in response to conditions including high battery temperature, high air temperature and the presence of smoke. The system would also be equipped with emergency stop buttons, which would isolate the battery units from the solar arrays and electrical grid.

2.1.3 Electrical Collector Lines

The electricity generated and stored within each of the solar array areas would be transmitted from the power conversion stations to the Project substation and interconnection equipment via a network of medium-voltage electrical collector lines. Similar to the DC electrical wiring from the solar modules, the medium-voltage electrical collector lines would be installed in underground trenching. Trenches for the electrical collector lines would be approximately 5 feet wide and 4 feet deep. In total, it is anticipated that the Project would include approximately 3,000 linear feet of trenching for the medium-voltage electrical collector lines.

2.1.4 Substation and Interconnection Equipment

The Project would include a substation, which would function to further increase the voltage of electricity to allow for integration into the Hawaiian Electric electrical grid. The Project substation and associated interconnection facilities would include equipment such as free-standing steel switch

structures, a transformer, breakers, utility poles, associated electrical lines, and centralized controls structure(s) for communication equipment (see below). These facilities would be constructed immediately adjacent to the existing Hawaiian Electric ‘Ewa Nui #42 46-kV sub-transmission line which traverses the Project area; they would occupy a total of approximately 9,464 square feet and would include concrete foundations, pole structures, containerized structure(s) and security fencing. A short overhead electrical connection (approximately 300 feet in length), including approximately three 60-foot-tall wood poles, would also be required for interconnection with the ‘Ewa Nui #42 46-kV sub-transmission line.

2.1.5 Communication Equipment

Communication equipment would be installed to interface with Hawaiian Electric’s supervisory control and data acquisition (SCADA) system so that the electricity generated and stored by the Project can be remotely controlled and dispatched.[7] The Project would also include an emergency management system that would allow all operations to be supervised and all system functions to be protected in response to real-time dispatch signals from Hawaiian Electric, as well as report production data, energy forecasts, and other system health data. This equipment would be housed within the various inverters located in each solar array area and in the Project substation, as well as within centralized control structure(s) also within the substation footprint. Most of the communications equipment would be connected via cabling, although some wireless features for inter-Project communications are being evaluated.

2.1.6 Service Roads and Fencing

The Project would be accessed via the existing gated entry from Pālehua Road and the existing network of former plantation roads within the UH West O‘ahu Mauka Lands property. Within the Project area, a series of new service roads would be installed to accommodate construction vehicles and to allow ongoing access for operations and maintenance. These roads would have a compacted gravel bed with a width of approximately 10 feet (plus compacted 5-foot shoulders), as well as the required clearance and turning radius needed for emergency response vehicles in accordance with fire code. The service roads would provide primary access to each of the solar array areas, including the power conversion stations, as well as the Project substation and interconnection equipment. The ample spacing between the rows of modules would allow for localized access within each of the solar array areas.

Fencing would be installed around the perimeter of the Project for general security purposes. The fence is expected to be approximately 7-foot-tall chain link (or similar); no barbed wire would be installed. Gates would be installed for pedestrian and vehicular access. The total fenced portion of the Project area is expected to be approximately 52 acres.

[7] The specific telecommunications requirements to facilitate interaction between the Project and Hawaiian Electric are currently being reviewed by Hawaiian Telecom.

2.1.7 Compatible Agricultural Activities

The Project would be located in an area that is designated by the State of Hawai‘i for agricultural land use and would be subject to the requirements of HRS Chapter 205, which specifies the permitted uses in the various state land use districts. Pursuant to HRS Chapter 205-2(d), solar energy facilities are a permitted use within the state agricultural district; however, as further clarified in HRS Chapter 205-4.5, those facilities in areas with Land Study Bureau (LSB) Class B and C soils require an SUP and must meet certain conditions relating to agricultural activities and decommissioning.[8] With respect to agricultural activities, HRS Chapter 205-4.5(a)(21)(A) requires that “the area occupied by the solar energy facilities is also made available for compatible agricultural activities[9] at a lease rate that is at least fifty percent below the fair market rent for comparable properties.” Following is a discussion of the proposed activities that would be conducted to meet this requirement; further discussion of compliance with HRS Chapter 205 is provided in Section 5.1.1.

2.1.7.1 Evaluation of Potential Agricultural Activities

Solar facilities provide a unique opportunity for co-location with agricultural activities, given that they typically have a minimal footprint with tracts of open space interspersed between the equipment, and involve relatively passive operation and maintenance activities. However, there are various factors that must be considered when seeking agricultural activities to be co-located with solar facilities. Specific factors that were considered for this Project include: (1) historic and current agricultural use, (2) water availability, and (3) suitable agricultural activities. A brief discussion of each of these considerations is provided below.

Historic and Current Agricultural Use

As previously described, the Project area was part of an extensive sugar cane and pineapple plantation that extended across O‘ahu’s ‘Ewa Plain. Cultivation occurred on a nearly continual basis from the 1920s until the plantation was closed in the 1990s. Since that time, the land within the Project area has been fallow and used intermittently for cattle grazing. Although remnant agricultural infrastructure is present onsite, none of it is believed to still be operable.

Most of the other nearly 900 acres of the UH West O‘ahu Mauka Lands property also comprise fallow, vacant land with some livestock pasturage, and remain available for agricultural activities. Scattered agricultural operations occur in the broader vicinity of the Project area; however, there are relatively extensive amounts of vacant agricultural lands throughout the region.

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[8] The LSB system rates the productivity of soils throughout the state based on characteristics including texture, slope, salinity, erodibility, and rainfall, and designates areas in categories ranging from A to E (with Class A representing the most productive soils and Class E representing the least productive soils). As further detailed in Section 3.7, the soils within the Project area are designated as Class B, D and E.

[9] Within the context of HRS Chapter 205-4.5, agricultural activities are understood to include: (1) cultivation of crops, including crops for bioenergy, flowers, vegetables, foliage, fruits, forage, and timber; (2) game and fish propagation; and (3) raising of livestock, including poultry, bees, fish, or other animal or aquatic life that are propagated for economic or personal use.

Water Availability

Given the highly arid conditions in the ʻEwa District, past agricultural activities within this region relied on imported water for irrigation. In particular, this area was served by the Waiahole Ditch, an approximately 26-mile-long tunnel and ditch system built in the early 1900s to deliver water from the windward side to the leeward side of Oʻahu. On average, the ditch delivered approximately 27 million gallons of water per day (Environment Hawaiʻi, 2000). In the 1990s, a legal challenge resulted in restoration of water flows to the streams in windward Oʻahu and a significant decrease in the amount of water delivered via the Waiahole Ditch.

Although remnant portions of the Waiahole Ditch remain within the Project area, this infrastructure no longer functions to deliver water; no functional irrigation infrastructure or water delivery system currently exists within the Project area. As part of the planning process for the Project, a request for guidance and input regarding potential water sources was submitted to the Board of Water Supply. Their response included a request for more information regarding the anticipated demands and indicated the need to first investigate the use of non-potable water for irrigation purposes. Installation of a groundwater well was determined to be cost-prohibitive given the temporary nature of the Project (per the 25-year PPA). Subsequent communication with the Board of Water Supply indicated that it may be possible to use the existing water tank as a source of irrigation water, but that this would need to be coordinated through UH West Oʻahu. In addition to coordinating with UH West Oʻahu about the availability of this water, AES is also investigating the technical and economic feasibility of the water transport and delivery infrastructure that would be required for this option, as well as other feasible sources of non-potable water, and will continue to work with the Board of Water Supply to identify possible water sources for irrigation purposes. However, based on currently available information, the viability of obtaining water for irrigation purposes is uncertain, such that planning for compatible agricultural activities assumes a lack of irrigation water.

Suitable Agricultural Activities

Solar facilities are considered to be highly compatible with agricultural activities, and there are a growing number of examples of successful dual use and the associated benefits to both solar and agricultural production (PRI, 2018; Scientific American, 2018). However, there are factors that contribute to certain types of agricultural activities being more or less suitable for co-location with solar facilities. When considering crop production, low-growing species are preferred as they can be located within the same space as the solar photovoltaic modules with little to no risk of reducing solar exposure, as compared to taller stature plants which can cast shadows across the modules as they grow in height. Given the proximity to the solar photovoltaic modules, it is also important that selected species are semi shade-tolerant. Any such low-growing and shade-tolerant species must also be well-suited for the site-specific conditions, which in this case includes relatively arid conditions and disturbed soils with a medium to high runoff potential.

Other agriculture activities, such as raising livestock, are also highly viable and provide dual use benefits. For example, use of the solar array areas for grazing animals not only provides affordable pasturage for

grazing, but also provides a form of natural vegetation management around the solar equipment. However, the size and characteristics of the livestock must be carefully considered. Grazing is typically limited to smaller animals (such as sheep and calves) as they easily fit between and beneath the solar photovoltaic modules and present little risk of damage to the equipment; goats are typically avoided as they tend to climb on the equipment. Beekeeping is also highly compatible with solar equipment and is successfully being conducted as part commercial solar projects across the United States (CleanTechnica, 2019; PRI, 2018; Scientific American, 2018).

2.1.7.2 Proposed Agricultural Activities

As part of the Project development process, AES engaged the services of former Hawai'i Department of Agriculture Chairperson and Deputy Director Scott Enright, and has proactively sought partners to develop a compatible agricultural plan for the Project. With the input and counsel of Mr. Enright, AES has worked with potential partners to explore opportunities that go beyond the statutory requirements to simply provide land for complementary agricultural uses, and instead seeks to provide meaningful contributions and generate agricultural products. To that end, various options for agricultural activities that could be conducted in parallel with the solar energy facilities within the Project area were examined, based on the considerations described above. The results of this effort indicate that the most promising agricultural activities that could be implemented as part of the Project are honey production and/or cattle grazing and production. As further detailed below, these activities are both compatible with solar energy facilities, well-suited to the site-specific conditions, and require minimal water resources.

Honey Production

Honeybees are a critical component of the agricultural system as they serve to pollinate a wide variety of crops. It is estimated that honeybees pollinate about one-sixth of the world's flowering plant species and more than 400 agricultural crops (American Beekeeping Federation, 2019; New Agriculturist, 2019). Examples of bee-pollinated plants in Hawaiʻi include fruit trees such as lychee, avocados, oranges and macadamia nut, and vegetables such as cucumbers, squash and watermelon. Through pollination, honeybees may significantly increase crop yields and contribute to higher quality fruit. It is estimated that honeybees contribute nearly $20 billion to the value of U.S. crop production (American Beekeeping Federation, 2019). In recent years, Hawaiʻi's honeybee population has been negatively affected by introduction and spread of the parasitic Varroa mite. Feral honeybee colonies have been particularly impacted, resulting in a declining number of colonies and loss of a major source of pollinators. Such impacts to feral colonies underscore the importance of managed hives for agricultural production in Hawaiʻi (CTAHR, 2009).

Beekeeping is considered to be highly compatible with solar facilities, as it is a relatively passive activity and requires minimal infrastructure. Furthermore, the general setting of the Project area, including the topography and surrounding vegetation make this location particularly suitable for beekeeping. Honeybees forage up to several miles in any direction; flowering plants within and surrounding the Project area, which include koa haole (*Leucaena leucocephala)*, sweet acacia (*Vachellia farnesiana*),

‘ilima (*Sida fallax*) and long-thorned kiawe (*Prosopis juliflora*), offer abundant pollen and nectar for bees. There is also expected to be adequate access to drinking water for bees throughout this region, such that a dedicated water source would not be needed within the Project area.

Aloha Bee LLC is an established beekeeping operation that manages more than 30 healthy honeybee colonies across O‘ahu and produces a variety of bee-related products. The partners in Aloha Bee LLC include renowned entomologist Dr. Steve Montgomery and Daniel Mills, an experienced beekeeper and honey producer. They are seeking to expand their operation and need additional land that is well-suited for placement of beehives. In coordination with Aloha Bee LLC, AES has incorporated specific beekeeping requirements into the site plan for the Project.

It is anticipated that a beekeeping operation within the Project area would involve installation of approximately four beekeeping stations. The stations would be located within the fenced perimeter of the solar array areas and would be accessible via the proposed service roads; they would also be sited at a reasonable distance from the Project facilities to minimize interference between the solar and beekeeping operations. Each station would include a packed gravel or cement pad foundation, approximately 40 square feet in area. The foundations would provide a stable surface to minimize the chances of the hives falling over, and would help to limit weeds and bugs in the vicinity of the hives. The hives would be installed on a series of cinder block stands placed directly on the foundation. In addition, the hives would be cordoned off to minimize potential damage from cattle (another proposed compatible agricultural use within the Project area, as described below). It is anticipated that the Project area could support a total of 20-60 hives. To launch the honey production operation, Aloha Bee LLC would establish existing hives in the Project area; the partners in Aloha Bee LLC also have access to additional hives and relationships within the beekeeping community to ensure a productive operation.

Activities associated with maintenance of the bee hives would be minimal, generally consisting of periodic inspections, replacement of hive equipment and/or bees, and honey harvesting. It is anticipated that beekeepers would conduct inspections on a routine basis (approximately once per month); inspections would be focused on checking the health and productivity of the individual hives and determining if any remedial actions are needed. Remedial actions could include treatment for invasive pests, replacement or care of queen bees, maintenance or expansion of hive boxes, or similar activities. In general, it is anticipated that the beekeeping stations would be accessed during daytime hours; however, some visits could occur during evening hours to accommodate transport of bees.

Through their operation within the Project area, Aloha Bee LLC expects to produce up to 500 gallons of honey annually; these products would be marketed for sale locally on O‘ahu. In addition to agricultural products, the beehives would also provide an important ecological service through pollination of commercial crops, home garden vegetables and fruits, as well as wild plants.

Cattle Production and Grazing

The UH West O‘ahu Mauka Lands property is used for cattle ranching as part of a rotational pasture system. These activities are managed by Henry Edward “Bud” Gibson and his firm Rocker G Livestock, a grass farming and livestock ranching operation. In total, Rocker G Livestock stewards and manages

approximately 3,200 acres of pastureland across Oʻahu, including the UH West Oʻahu Mauka Lands property. They care for three herds of cattle; two of the herds are beef cows (each with an average of 325 head) and one herd includes approximately 25 registered American Bucking Bull, Inc. cows which are raised as registered bucking and breeding bulls. These herds are rotated across the pasturelands, depending on rainfall, forage volume for fire prevention and erosion control purposes, as well as to provide security for the landowner.

Rocker G Livestock is seeking to maintain their current operation within the Project area. Based on consultation with owner Bud Gibson, cattle grazing facilities have been incorporated into the site plan for the Project. To maximize compatibility with the solar facilities, the Project area would be used specifically to graze and wean stocker-size (smaller) steer and heifers. Limiting the cattle within the Project area to smaller and younger animals would minimize potential damage to solar modules while still benefiting the overall ranching operation. These cattle would be managed in the same manner as Rocker G Livestock's current ranching operation. The animals would be rotated through fenced portions of the Project area with rotation management based on rainfall levels and forage growth and volume. In addition to supporting ongoing agricultural operations, grazing cattle within the Project area would also provide a sustainable form of vegetation management.

To support the proposed cattle production and grazing operation, AES would work with Rocker G Livestock to install support facilities and equipment within the Project area. Two cattle trap areas, each approximately 72 feet by 72 feet, would be installed. Each trap area would be equipped with a water trough set on a concrete slab, including an approximately 4-foot apron to minimize erosion caused by cattle traffic around the trough. Mineral tubs and external parasite control rubs would also be placed in the trap areas. A system for loading and unloading cattle would be constructed using a series of galvanized steel panels and gates.

Rocker G Livestock produces an average of more than 175,000 pounds of beef annually that is sold locally throughout the state. In addition to contributing an important source of local food production for Hawaiʻi, their operation also provides valuable land stewardship services including increased soil carbon storage, vegetation management, and fire prevention. Use of the Project area to maintain their current operation would help to further support these efforts.

2.1.7.3 Other Agricultural Alternatives Considered

Other alternatives for compatible agricultural activities were also explored; however, due to a number of factors, these options were deemed to be unviable. These include the following:

- Sheep Production and Grazing: AES actively engaged a sheep farmer from Waiʻanae to explore possible sheep production and grazing within the Project area. Unfortunately, due to the limited vegetation within the Project area along with relatively low rainfall, it was determined that sheep's aggressive feeding habits would pose a significant risk of denuding the Project area, thus resulting in possible erosion and runoff issues. Additionally, given the limited rainfall, it was determined that vegetation could not be effectively maintained to ensure a sufficient food

supply for the sheep without a rotational grazing effort that would be economically prohibitive. For these reasons, this agricultural activity was not pursued further.

- Food Crop Production: AES explored options for food crop production with various O‘ahu-based organizations. Given the limited rainfall and uncertainty of water resources for irrigation, as well as the relatively steep and rocky terrain, this option was not pursued further.
- Landscape Plant Propagation: AES also examined the option of native plant propagation for landscaping purposes, including possible re-landscaping needs at Makakilo Quarry, adjacent to the Project area. Although Grace Pacific, owner of the Makakilo Quarry, expressed an interest in purchasing the supply of plants, this option was not further pursued due to the limited rainfall, uncertainty of water resources for irrigation, and relatively steep and rocky terrain.

2.1.7.4 Future Agricultural Activity

As detailed above, AES will comply with HRS 205-4.5(a)(21)(A) by making the Project area available for honey production and cattle grazing, as well as providing support for the long-term success of these activities. In the event that the agricultural activities outlined above are determined to not be viable or an agriculture partner ceases operations or an interest in partnering, AES would seek other potential partners for similar agricultural activities and would continue to make the Project area available at a lease rate that is at least fifty percent below fair market rent for comparable properties.

At the end of the Project’s operational life, the Project would be decommissioned with the Project area returned to its existing condition (or comparable), as further discussion in Section 2.4. Following decommissioning and upon expiration of the agreement with AES, a full range of future agricultural activities would continue to be an option for UH as the landowner.

2.2 Construction Activities

The construction phase of the Project is expected to include transport and delivery of Project equipment and materials, site preparation, equipment installation, and revegetation and landscaping. Each of these activities is generally described below; representative photographs showing construction of a similar project are provided in Figure 2-4.

2.2.1 Transport and Delivery

The Project equipment would be transported to one of O‘ahu’s commercial harbors via a freight shipping company and offloaded to standard transportation trucks. The trucks would deliver the equipment to the Project area via existing State and County roadways. It is anticipated that a total of approximately 500 truck trips would be required to transport the Project equipment over the course of the construction phase.

No roadway improvements or other construction is expected to be required to accommodate the equipment transport. As further described in Section 3.12, a Traffic Impact Analysis Report (TIAR) concluded that neither construction nor operation of the Project would significantly impact traffic on

the surrounding roadways. Regardless, a traffic management plan would be developed, with implementation of appropriate measures to minimize traffic-related impacts.

2.2.2 Site Preparation

Initial site preparation would involve grubbing and vegetation clearing within the Project area, along with installation of best management practices (BMPs) as described below. Clearing and grubbing would be phased, and soil would be temporarily stabilized as appropriate. Service roads and staging areas would also be established. It is anticipated that the staging areas would rotate throughout the Project area as the Project is built out, with these areas installed incrementally as needed; in total, it is anticipated that staging would require approximately 12 acres (non-contiguous). For each staging area, some grading may be needed to level the ground surface, with geotextile materials and compacted gravel installed as needed. Similarly, installation of new service roads would also involve grading, smoothing and placement of geotextile material and compacted gravel. Clearing, grubbing, and grading would be conducted using equipment such as bulldozers, excavators, compactors, graders, and front-end loaders. Water trucks would be used to provide moisture for compaction as well as dust control during construction as needed.

Project implementation would incorporate BMPs to avoid and minimize potential impacts to the surrounding environment. In particular, BMPs would include various procedures, practices, treatments, structures and/or devices designed to eliminate and minimize the potential discharge of pollutants to downstream waters. The BMPs to be implemented would be determined in accordance with applicable regulatory requirements, including those associated with the National Pollution Discharge Elimination System (NPDES) program and the City and County of Honolulu's Rules Relating to Water Quality (Administrative Rules Section 20-3-63), which require approval of a Stormwater Pollution Prevent Plan (SWPPP) and Erosion and Sediment Control Plan (ESCP) prior to construction. As further discussed in Section 3.3.2, specific BMPs would address erosion prevention, sediment control, and good housekeeping. No ground disturbing activities would occur until BMPs have been properly implemented.

In addition, the Project would also incorporate a series of infiltration trenches to capture and treat stormwater in areas with increased impervious surfaces associated with the Project facilities. As further discussed in Section 3.3.2, the majority of the Project area, including the area beneath the solar modules, would require minimal grading such that the existing drainage patterns would not be altered. In general, grading would be focused around the service roads, equipment pads and substation foundation. The infiltration trenches would be located downgradient of these facilities and would be designed to retain and allow for infiltration or evapotranspiration of stormwater, as needed to reduce peak flows to pre-development levels. The size and design of the trenches would be based on site-specific conditions as well as the requirements of the City and County of Honolulu's Rules Relating to Water Quality and Rules Relating to Storm Drainage Standards (Administrative Rules Section 14-12.31).

2.2.3 Installation of Project Equipment

Following site preparation activities, the general sequence for construction would involve installation of the following: (1) racking system, (2) concrete equipment pads and substation foundation, (3) solar photovoltaic modules and associated wiring, (4) electrical collector lines, (5) electrical equipment, and (6) battery units. Overall, these facilities are being designed to specifically accommodate the existing topography of the site in order to minimize the amount of earthwork needed. As further detailed below, grading for installation of the Project equipment is expected to be limited to the areas comprising the equipment pads and substation foundation, as well as in localized areas within the solar arrays.

Overall, the extent of ground disturbance associated with the solar photovoltaic system is expected to be relatively minimal, as the racking system would be installed using structural posts and can tolerate the existing slopes within the Project area (based on the manufacturers' specifications); grading would be limited to localized areas as needed to smooth existing topography. The posts for the racking system would be installed using a hydraulic pile driver and/or augur for pre-drilling, with approximate depths of 6 feet (depending on soil conditions). In the event it is determined that the desired depth cannot be achieved, foundations would be pre-drilled and supported with concrete.[10] The frames and other components of the racking system would be bolted to the posts, with the solar photovoltaic modules affixed to the frames.

Trenches would be excavated for both the DC electrical wiring, as well as some AC low-voltage wiring and communications wiring (running from the solar photovoltaic modules to the power conversion stations) and the medium-voltage collector lines (running from the power conversion stations to the substation) using wheel- or track-mounted excavators (or similar). The trenches for the DC and low-voltage electrical wiring would be up to 10 feet wide and 4 feet deep to accommodate multiple circuits of wiring. The trenches for the medium-voltage collector lines would be up to 5 feet wide and 4 feet deep. Following placement of the electrical lines, the excavated soil would be backfilled into the trench and tamped back to the appropriate level of compaction per the design specifications. Although not anticipated, if the desired trench depth cannot be achieved (due to basalt rock or other prohibitive subsurface conditions), the electrical wiring or collector lines would be covered with concrete slurry in accordance with the applicable electrical code requirements.

The equipment pads and substation foundation would involve excavation up to approximately 3 feet in depth and installation of concrete. Certain interconnection facilities would be supported by steel pier foundations, which would be installed to an approximate depth of 10 – 15 feet. Excavated soil would either be used elsewhere within the Project area or hauled to an approved offsite facility. Concrete for the pads and foundation would be delivered in ready-mix concrete trucks; the Project would not include a concrete batch plant. Once the equipment pads and substation foundation have been installed, the battery units and various electrical equipment would be installed. All electrical equipment and wiring

[10] Ground screws, which are installed by auguring directly into the ground, are being considered as an alternative to the support posts for the racking system. Although a greater number of screws would be required, they would have a smaller overall footprint than the support posts.

would be installed and inspected in accordance with applicable code requirements and best industry practices.

Once fully installed, the Project equipment is expected to have a total areal extent of approximately 38.8 acres and a permanent footprint of approximately 2.2 acres, as summarized in Table 2-1.

Table 2-1. Approximate Extent of Project Components

Project Component	Quantity and Dimensions (approximate)	Total Area (approximate)	Permanent Footprint (approximate)
Solar Photovoltaic Modules[1]	43,008 modules (each approx. 22 ft^2) (2,304 posts for racking system)[2]	939,264 ft^2 (21.6 acres)	3,197 ft^2 (0.1 acres)
Power Conversion Stations (Battery Units and Electrical Equipment)	5 equipment pads (each approximately 3,480 ft^2)	17,400 ft^2 (0.4 acres)	17,400 ft^2 (0.4 acres)
Substation and Interconnection Equipment[3]	Substation foundation and interconnection equipment (9,464 ft^2)	9,464 ft^2 (0.2 acres)	9,464 ft^2 (0.2 acres)
Trenching (DC and Low-Voltage Electrical Wiring)	11,000 linear feet (10 feet wide)	110,000 ft^2 (2.5 acres)	0
Trenching (Medium-Voltage Collector Lines)	3,000 linear feet (5 feet wide)	15,000 ft^2 (0.3 acres)	0
Service Roads[4]	3,235 linear feet (20 feet wide)	64,710 ft^2 (1.5 acres)	64,710 ft^2 (1.5 acres)
Staging and Laydown Areas	To be rotated throughout Project area; up to 12 acres (non-contiguous)	522,720 ft^2 (12.0 acres)	0
Agricultural Facilities[5]	4 beekeeping stations (40 ft^2 each) 2 cattle trap areas (5,184 ft^2 each)	10,528 ft^2 (0.2 acre)	360 ft^2 (0.01 acre)
TOTAL		**38.8 acres**	**2.2 acres**

[1] The calculation of total area is based on the surface area of the modules. The calculation of permanent footprint is based on the dimensions of the post foundations; it is assumed that 60% of the posts would require a concrete pier with a diameter of approximately 20 inches.

[2] Ground screws, which are installed by auguring directly into the ground, are being considered as an alternative to the posts for the racking system. Although a greater number of screws would be required (approximately 7,100 screws), they would have a smaller diameter than the posts such that the permanent footprint of the screws would be less than that shown for the support posts.

[3] The exact requirements for the interconnection equipment are still being determined by Hawaiian Electric. It is currently assumed that an approximately 300-foot overhead electrical line with 3 supporting wooden poles would be required in addition to equipment within the footprint of the substation.

[4] The calculation of new service roads does not include existing access roads; new service roads are assumed to have a width of approximately 20 feet (i.e., 10-foot road width plus 5-foot compacted shoulders).

[5] The permanent footprint of the agricultural facilities is assumed to include four beekeeping stations and concrete pads for the water troughs (one in each cattle trap area).

2.2.4 Revegetation, Landscaping and Post-Construction Site Control

Following construction, areas that have been temporarily disturbed would be revegetated for soil stabilization and erosion control purposes. It is anticipated that revegetation would involve application

of hydroseeding, with a suitable mix of native and/or non-invasive grass species. Any species used for revegetation would also be considered in terms of compatibility with onsite agricultural activities (e.g., forage for grazing stock and/or pollinator plants for honeybees). Landscaping would also be installed to provide visual screening of Project equipment from adjacent areas to the extent practicable. It is anticipated that the landscaping would incorporate trees and shrubs in key locations, including native species that are ecologically and culturally appropriate for this location. It is anticipated that species selected for landscaping would not require long-term irrigation; irrigation would be provided during the initial establishment period following planting, likely using a temporary system. A detailed landscaping plan, including selection of appropriate species, would be developed prior to construction.

In addition to revegetation of temporarily disturbed areas, permanent BMPs would be implemented to address long-term stormwater requirements. To the extent practicable, the BMPs would incorporate low impact development (LID) design strategies and source control measures, in accordance with the requirements of the City and County of Honolulu's Rules Relating to Water Quality. The specific strategies and measures would be identified as part of a Stormwater Quality Strategic Plan, which would be submitted for approval prior to construction. As further discussed in Section 3.3.2, specific BMPs would address retention and biofiltration of stormwater.

2.3 Operations and Maintenance

Following construction and commissioning, the Project would generally involve passive operations for both solar power generation and agricultural activities. Normal operation of the Project would not require onsite personnel and, therefore, the facility would not be manned on a daily basis. Metering equipment would send solar photovoltaic system performance and production data to continuously-monitored servers; electronic notification would be sent to the operations and maintenance team if these data indicate the system is underperforming. If necessary, a technician would be dispatched to the Project to address any issues. AES would employ dedicated staff to remotely monitor the Project on a full-time basis.

Periodic maintenance and inspection of the facilities would occur intermittently over the course of Project operations, and would include testing and replacement of component parts on the inverters, transformers and substation equipment. Decommissioned parts would be salvaged or recycled to the extent feasible or properly disposed of in accordance with applicable regulations, consistent with the approach described in Section 2.4.

Vegetation within the Project area would be managed throughout the life of the Project. In addition to possible livestock grazing as part of the onsite agricultural activities, vegetation management could also include mowing, weed whacking, and localized application of herbicide, if needed. Vegetation would be actively monitored to ensure the cover is sufficient for erosion control as well as for agricultural purposes.

2.4 Decommissioning

Based on the approved PPA with Hawaiian Electric, the Project is expected to have an operational life of approximately 25 years (through 2046). At that point in time, the facility may be re-powered under a re-negotiated PPA (with subsequent permits/approvals) or decommissioned. Decommissioning would involve removal of all equipment associated with the Project and returning the Project area to substantially the same condition as existed prior to Project development. In accordance with the requirements of HRS Chapter 205-4.5(a)(21), financial assurance for decommissioning would be provided to the City & County of Honolulu Planning Commission prior to the commencement of commercial generation. The activities that would be expected to occur as part of decommissioning are summarized below; additional detail is provided in Appendix A.[11]

Decommissioning would commence once the Project has been fully de-energized and isolated from all external electrical connections, in coordination with Hawaiian Electric. Consistent with the measures described for construction and operation of the Project, BMPs would be implemented and maintained throughout the decommissioning phase as needed to avoid and minimize potential impacts to the surrounding environment, particularly those related to dust, erosion and stormwater. Once the site has been adequately prepared for decommissioning, the following equipment would be removed: (1) solar photovoltaic modules and racking system, including steel posts, (2) battery units, (3) inverters and transformers, (4) electrical wiring and connections, (5) substation components, (6) communication equipment, and (6) fencing.[12] All foundations would also be removed. The decommissioning would be conducted in accordance with industry standards, with all equipment and materials treated according to the highest and best use. Equipment and materials would be salvaged or recycled to the extent feasible and in coordination with licensed sub-contractors, local waste haulers and/or other facilities that recycle construction/demolition waste; the remaining materials would be disposed of by the contractor at authorized sites on Oʻahu, in accordance with applicable laws. All waste requiring special disposal (e.g., transformers) would be handled according to regulations that are in effect at the time of disposal. Following removal of Project equipment, site restoration would be conducted such that the physical conditions of the Project area are returned to substantially the same condition as existed prior to Project development; these activities would include (1) removal of gravel and other aggregate material, (2) localized grading and disking to match surrounding elevations and/or aerate soil, (3) replacement of topsoil, and (4) revegetation of disturbed areas with an appropriate hydroseed mix. Decommissioning would occur within 6-12 months of the conclusion of Project operation. Decommissioning plans would

[11] Decommissioning activities would be conducted in accordance with all relevant ordinances and regulatory requirements that are in place at the time of decommissioning. Because decommissioning would not be expected to occur for many years, and given that regulatory requirements could change, the applicable permitting and regulatory requirements would be reviewed with the appropriate local and state agencies prior to decommissioning activities to ensure compliance.

[12] The extent to which the service roads within the Project area would be removed would be coordinated with the landowner at the time of decommissioning.

be communicated with the landowner, the public and the regulatory agencies, prior to and during the decommissioning phase, as appropriate.

2.5 Environmental Management and Safety

In accordance with applicable federal, state and local regulations, as well as industry best practices, it is anticipated that a variety of environmental management and safety plans would be developed and implemented over the lifecycle of the Project. It is currently anticipated that the applicable plans would include those listed below.

- **Stormwater and Pollution Prevention Plan (SWPPP):** A SWPPP is a site-specific plan that identifies potential sources of stormwater pollution and describes stormwater control measures that would reduce or eliminate the potential pollutants. A SWPPP would be prepared and submitted as part of the application for a Notice of General Permit Coverage for construction-related stormwater runoff, in compliance with NPDES regulations.
- **Erosion and Sediment Control Plan (ESCP):** For projects that involve ground-disturbing activities, the City & County of Honolulu's Rules Relating to Water Quality require an ESCP, along with designation of a certified ESCP Coordinator. An ESCP is required to identify measures that would be implemented to reduce the risk of erosion, prevent the release of sediment-laden waters, and minimize pollutant discharge from entering the storm drain system and receiving waters.
- **Storm Water Quality Strategic Plan:** The City and County of Honolulu's Rules Relating to Water Quality also require a Storm Water Quality Strategic Plan for priority projects, which include all new development with land-disturbing activities of one acre or more (excluding staging areas and base yards); priority projects are required to include permanent structural BMPs to retain and/or treat stormwater onsite. The plan is required to address the pollutants that would be generated by Project activities and to identify the LID design strategies and source/treatment control BMPs that would be implemented.
- **Spill Prevention, Control and Countermeasure Plan (SPCC):** SPCC requirements are regulated by the U.S. Environmental Protection Agency (EPA) pursuant to 40 CFR Part 112 (*Oil Pollution Prevention*) and are designed to prevent discharges of oil and oil-related materials, as well as to minimize impacts of spills on public health and the environment. An SPCC Plan identifies the operating procedures that would be in place to prevent spills from occurring, control measures that would be installed to prevent a spill from reaching the environment, and countermeasures that would be used to contain, clean up, and mitigate the effects of a spill.
- **Traffic Management Plan (TMP):** A TMP would be prepared to address the potential construction impacts to the surrounding roadway network and would detail the measures that would be implemented to avoid, minimize and mitigate potential impacts based on Complete Streets principles.

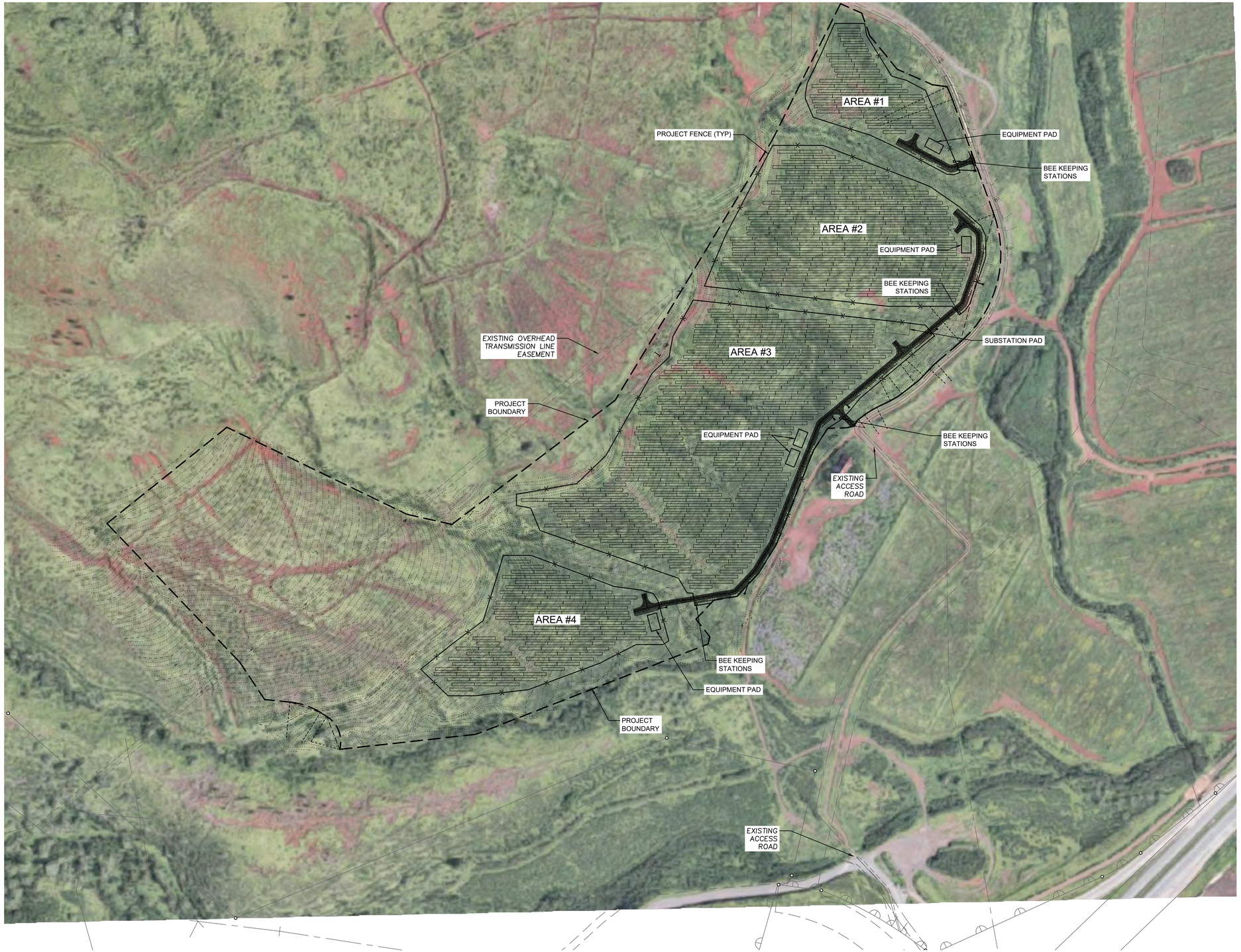
2.6 Project Schedule and Cost

Construction of the Project is expected to require approximately 9 to 12 months, beginning once all permits and approvals have been obtained. It is currently anticipated that construction would begin in approximately December 2020 and commercial operation would commence in approximately September 2021. The estimated dates for key milestones associated with Project construction are listed in Table 2-2. The total estimated cost of Project construction is approximately $46 million. The Project would be entirely funded with private financing; no public funds would be used.

Table 2-2. Estimated Construction Milestone Dates

Milestone	Estimated Date[1]
Obtain all required permits and approvals	Dec 2020
Begin construction	Dec 2020
Complete installation of solar and storage facilities	July 2021
Begin commercial operations	Sept 2021

[1] Estimated dates are subject to Interconnection Requirements Study.



N
W E
S

SCALE: 1" = 200'
0 200 400 FT

AES
Distributed Energy

AES Distributed Energy
282 Century Pl. Suite 2000
Louisville, CO 80027 USA

HDR
3J CONSULTING
CIVIL ENGINEERING
WATER RESOURCES
COMMUNITY PLANNING
9600 SW NIMBUS AVE, SUITE 100; BEAVERTON, OR 97008

SYSTEM DESCRIPTION

REVISIONS

REV	BY	DATE	DESCRIPTION

PE STAMP

AES WEST OAHU SOLAR
OAHU, HI

PROJECT NUMBER
19537
PHASE
ISSUED FOR REVIEW
MILESTONE
60% DESIGN

ELECTRICAL DESIGNER

STRUCTURAL DESIGNER

DATE 03-13-2020
SCALE 1"=200'

TITLE
AERIAL UNDERLAY

DRAWING
Figure 2-1

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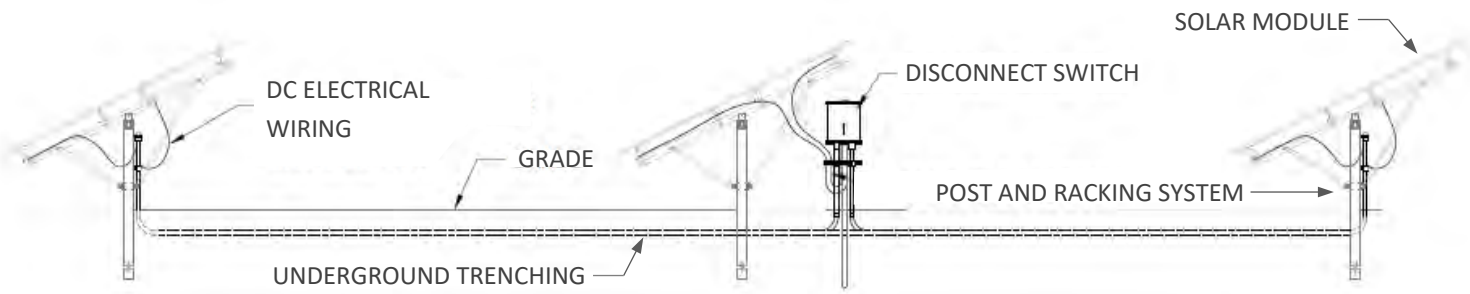
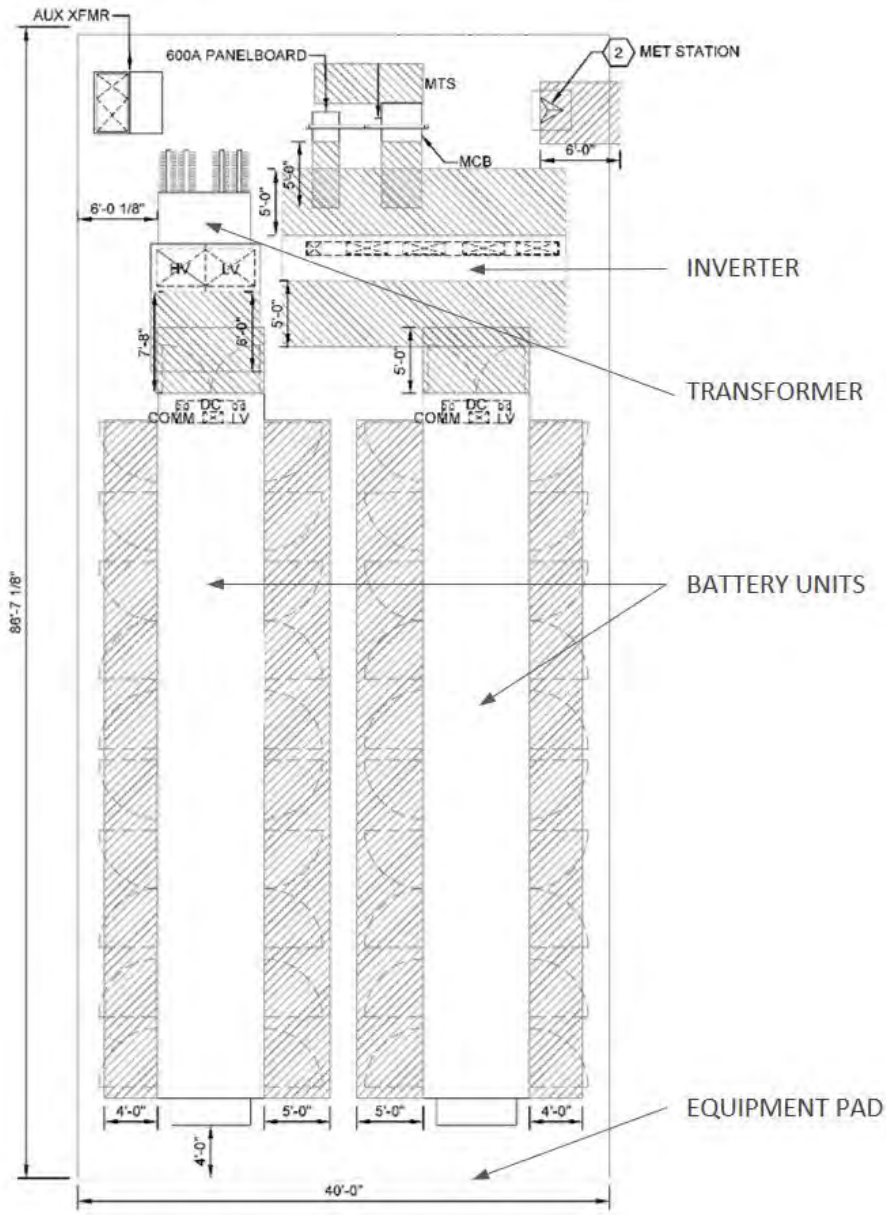


Solar Photovoltaic System (typical)



Power Conversion Station (typical)

Figure 2-2. Schematics of Solar Photovoltaic System and Power Conversion Stations

Photograph 1. View of typical solar photovoltaic modules on a fixed-tilt racking system (*O'ahu, Hawai'i*)

Photograph 2. View of typical solar photovoltaic modules on a fixed-tilt racking system (*O'ahu, Hawai'i*)

Figure 2-3. Representative Photographs of Similar Solar and Storage Project Equipment

Photograph 3. View of typical battery units and associated equipment on concrete equipment pad (*Lawai Solar Project; Kaua‘i, Hawai‘i*)

Photograph 4. View of typical substation and associated electrical equipment (*Lawai Solar Project; Kaua‘i, Hawai‘i*)

Figure 2-3. Representative Photographs of Similar Solar and Storage Project Equipment

Photograph 1. View of typical construction activities, including installation of the racking system for the solar photovoltaic modules and phased grading (*Lawai Solar Project; Kaua'i, Hawai'i*)

Photograph 2. View of typical construction activities, including installation of concrete pad for battery units and associated equipment (*Lawai Solar Project; Kaua'i, Hawai'i*)

Figure 2-4. Representative Photographs of Construction Activities

Photograph 3. View of typical construction activities, including installation of the solar photovoltaic modules and battery energy storage system (*Lawai Solar Project; Kaua‘i, Hawai‘i*)

Photograph 4. View of construction activities, including installation of the substation and associated electrical equipment (*Lawai Solar Project; Kaua‘i, Hawai‘i*)

Figure 2-4. Representative Photographs of Construction Activities

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3 Affected Environment, Potential Impacts and Mitigation Measures

This section describes the affected environment and potential impacts of the Project relative to applicable environmental resources. Mitigation measures or BMPs that would be implemented to avoid or minimize potential impacts are identified, where relevant. In accordance with HRS Chapter 343 and HAR §11-200.1, the description of the affected environment focuses on those resources and conditions potentially impacted by the Project, with the level of detail commensurate with the importance of the impact; resources that are not present (or otherwise do not apply) are not discussed.

3.1 Climate

3.1.1 Existing Conditions

In general, Hawai‘i’s climate is characterized by relatively mild temperatures and moderate humidity throughout the year (except at high elevations), with persistent northeasterly trade winds and infrequent severe storms. The summer months (May through September) are typically warmer and drier, with minimal storm events; trade winds are prevalent 80 to 95 percent of the time, when high-pressure systems tend to be located north and east of Hawai`i. During the winter months (October through April), the high-pressure systems are located farther to the south, decreasing the prevalence of the trade winds to about 50 to 80 percent of the time (WRCC, 2010).

The mountain ranges on O‘ahu are generally oriented in the northwestern to southeastern direction, which is perpendicular to the prevailing northeastern trade winds. As a result, the western (leeward) side of O‘ahu is drier and warmer than the windward side of the island. Given its leeward location, the Project area is characterized by relatively arid conditions. According to the Western Regional Climate Center, temperatures in this area range from an average maximum of 88.0 degrees Fahrenheit to an average minimum of 61.8 degrees Fahrenheit (WRCC, 2019). Mean annual rainfall for this area is approximately 27.7 inches. The lowest rainfall levels occur in the summer months and the highest levels occur in the winter months; mean monthly rainfall ranges from approximately 0.6 inches in June to approximately 4.1 inches in January (Giambelluca et al., 2013).

3.1.1.1 Climate Change

Greenhouse gases (including carbon dioxide [CO_2], methane, and nitrous oxide) are chemical compounds that are emitted as a result of natural processes and human activities. Greenhouse gases trap heat in the atmosphere, thus affecting the earth’s temperature. Scientific evidence indicates a trend of increasing global temperatures and other related climatic changes caused by an increase in global greenhouse gas emissions.

CO_2 emissions represent approximately 80 percent of total greenhouse gas emissions and therefore are used as a primary indicator for regional greenhouse gas emissions. The primary source of CO_2 and

overall greenhouse gas emissions is fossil fuel combustion. Concentrations of the earth's atmospheric CO_2 have increased approximately 45 percent over background levels, from 280 to over 410 parts per million, which is the highest level to occur in millions of years (Climate Change Commission, 2018).

In Hawaiʻi, total greenhouse gas emissions increased approximately 13 percent from 1990 to 2007 but have been declining since that time. In 2015, total greenhouse gas emissions were estimated to be approximately 21.3 million metric tons of CO_2 equivalent, which is roughly 4 percent lower than the levels in 1990. It is projected that total emissions will continue to decline, primarily as a result of changes in the energy industry in response to the state's RPS and energy efficiency standards (ICF and UHERO, 2019). As a member of the United States Climate Alliance, the State of Hawaiʻi has committed to reducing emissions 26 to 28 percent below 2005 levels by 2025. Furthermore, in 2018, the State enacted a statewide target to be carbon neutral, with sequestration of more atmospheric carbon and greenhouse gases than emitted within the State by no later than 2045 (U.S. Climate Alliance, 2019).

Climate change impacts for Hawaiʻi have been broadly investigated and are well documented; these include increasing air temperatures and associated heat waves, declining trade winds and rainfall levels, increasing intensity of storms and frequency of extreme weather events, rising sea levels, and increasing ocean temperature and acidification (Climate Change Commission, 2018; UH SeaGrant, 2014).

3.1.2 Potential Impacts and Mitigation Measures

Construction of the Project would not be expected to have a measurable effect on local climate conditions including temperature, rainfall, humidity or wind patterns. A limited amount of greenhouse gas emissions, which contribute to climate change, would result from construction of the Project, including the use of construction equipment and vehicles. Published data from the EPA indicate that 23.5 pounds of CO_2 are produced for every gallon of diesel fuel burned, and 19.6 pounds are produced for every gallon of gasoline used (EPA, 2018). Given the scale of the Project, impacts from these emissions would be temporary and localized and would not substantially affect regional or global greenhouse gas levels. Furthermore, Project vehicles and equipment would be maintained in proper working order and in compliance with federal and state emissions standards, thus minimizing emissions to the extent possible. As such, construction of the Project would be expected to have a negligible, short-term impact on greenhouse gas emissions and climate change.

Once constructed, the Project would generate clean renewable energy which would replace the burning of fossil fuel for the production of electricity, thus offsetting greenhouse gas emissions and providing a beneficial impact on climate conditions. In total, the Project is expected to offset the use of approximately 545,794 barrels of fuel and 64 tons of coal, and would decrease greenhouse gas emissions by approximately 244,394 tons over its lifetime (Hawaiian Electric, 2019a). Operation of the facility (e.g., employee vehicle use) would result in some greenhouse gas emissions (primarily CO_2); however, emission levels associated with these activities are expected to be very small in comparison to the reductions provided by the Project. As such, the Project would be expected to provide a net benefit relative to greenhouse gas emissions and climate conditions; no mitigation measures are proposed.

Over the lifetime of the Project, the effects of climate change are expected to be increasingly realized at a global and regional scale, and climate change variables could influence the conditions within the Project area. As noted above, these could include greater average air temperatures, lower average rainfall levels, a reduction in prevailing trade winds, and more frequent and intense storm events. Although concerning, these variables are not expected to substantially affect Project operations. Sea-level rise, widely considered a key consequence of climate change, is not expected to affect the Project area, as it is located at a sufficient distance and elevation from the shoreline. Based on mapping of the exposure area associated with approximately 3.2 feet of sea-level rise, the nearest areas of exposure are approximately 2 miles southeast of the Project area (Hawaiʻi Climate Change Mitigation and Adaptation Commission, 2017).

3.2 Geology, Topography and Soils

3.2.1 Existing Conditions

The island of Oʻahu was formed by two shield volcanoes that are now considered extinct: the Waiʻanae volcano formed the western portion of the island, and the Koʻolau volcano formed the eastern portion. Lava flows from these two volcanoes merged to form the central plain of Oʻahu. Both the Koʻolau and Waiʻanae volcanoes have been extensively eroded, and the remnants comprise the existing Waiʻanae and Koʻolau mountain ranges. Both mountain ranges have been deeply dissected through erosion, resulting in valleys, gullies and gulches, separated by steep ridges. The mountain ridges consist of basaltic rock overlain by residual soil and recent alluvium (derived from the weathered basalt), typically silty clays. The alluvial soils are gradually removed by sheet erosion and transported by surface runoff, accumulating in the lowlands as alluvial and colluvial deposits. The ʻEwa Plain, which extends south from the base of the Waiʻanae Mountains, is a limestone platform that formed as a coral reef in the Pleistocene era when sea levels were higher than present and has subsequently been exposed.

The Project area is located on the lower slopes of the southern Waiʻanae Mountains. The topography ranges from relatively flat to moderately sloping. The elevation along the southeastern boundary of the Project area is approximately 280 feet above mean sea level (amsl) and rises to approximately 675 feet amsl in the northwestern portion. Pu'u Kapuai, which rises to approximately 1,050 feet amsl, is located approximately 0.5 mile northwest of the Project area. Ephemeral drainages, which are tributaries to Kalo'i Gulch, run along the southern boundary and through the central portion of the Project area; these join with the two main branches of Kalo'i Gulch downgradient from the Project area before passing below the H-1 Freeway.

According to data published by the Natural Resources Conservation Service (NRCS), the majority of the soils within the Project area are identified as Mahana silty clay loam; small areas of Molokai silty clay loam and Kawaihapai clay loam are also present (see Figure 3-1). These soil types are generally described as well-drained, with a medium to high potential for runoff (NRCS, 2019). Infiltration rates measured within the Project area as part of geotechnical testing indicate an average rate of 11.7 inches per hour (Geolabs, Inc. 2019). The soils within the Project area have been highly modified over time,

given the extensive cultivation for the previous sugarcane plantation. Evidence of soil erosion, such as rills and small gullies, are present within portions of the Project area. A discussion of the classification of the soils within the site relative to agricultural productivity is provided in Section 3.7.1.2.

3.2.2 Potential Impacts and Mitigation Measures

Construction of the Project would involve temporary ground disturbance, with minor changes in local topography; no geologic features or landforms would be altered.

As described in Section 2.2, the Project has been sited and designed based on the existing topography of the site in order to minimize the amount of earthwork needed, with grading for installation of the solar photovoltaic equipment limited to smoothing existing topography in localized areas. Grading would also be required for installation of the equipment pads, substation foundation, and service roads, as well as for civil engineering purposes (e.g., stormwater retention and management). Other forms of ground disturbance would include trenching for installation of the electrical wiring and collector lines that would connect the solar arrays with the power conversion stations and substation. Although the extent of earthwork would be minimized to the extent possible, Project construction would result in localized topographic changes and disturbance of soils. The soils that would be affected have all been extensively disturbed by repeated discing and grading as part of previous agricultural activities within the Project area; as such, the Project would not disturb or otherwise modify any native soil formations. Regardless, construction activities would increase the potential for soil erosion in the form of either fugitive dust or suspended sediment in stormwater runoff. BMPs would be implemented to minimize the potential for construction-related erosion. BMPs related to water quality and air quality are discussed in Sections 3.3.2 and 3.9.2, respectively.

Over the long-term, operation and maintenance of the Project would involve little to no ground disturbance and therefore would not be expected to contribute to soil erosion. At the end of the operational phase, the Project facilities would be removed, as detailed in Section 2.4. Decommissioning activities would involve some degree of ground disturbance which could result in soil erosion; the above-referenced BMPs would be implemented to minimize the potential for erosion during decommissioning.

Given that the Project area has been extensively disturbed as part of previous site activities and that no major geologic features or landforms would be affected, construction and subsequent operation of the Project would not be expected to result in significant impacts to geology and topography. With implementation of BMPs, Project implementation would be expected to have a minor impact on soils.

3.3 Water Resources

3.3.1 Existing Conditions

3.3.1.1 Groundwater

Groundwater resources on Oʻahu have been delineated into a series of hydrologic units, primarily based on geologic and hydrologic characteristics. The Project area is located within the ʻEwa-Kunia aquifer system, one of several aquifer systems in the Pearl Harbor aquifer sector; the sustainable yield for the ʻEwa-Kunia system is 16 million gallons per day (CWRM, 2018; Nichols et al., 1996). The groundwater system in this region is composed of a freshwater lens overlying a brackish zone transitioning to a saltwater body. Groundwater moves generally toward the ocean through volcanic rocks but is impeded by a wedge of sediments (caprock) that overlay the volcanic rock near the coast. The ʻEwa caprock is a thick wedge of interbedded marine and terrestrial sediments that were deposited on the flanks of the Koʻolau and Waiʻanae volcanoes during sea level changes and isostatic subsidence of Oʻahu during the Pleistocene ice ages (Stearns and Chamberlain, 1967). No groundwater was encountered during geotechnical testing, which was conducted to depths of approximately 16.5 feet; however, groundwater levels may vary with seasonal rainfall, time of year and other environmental factors.

In cases where it is determined that special limits are required to properly manage groundwater resources, the State of Hawaiʻi Commission on Water Resource Management (CWRM) may designate a Water Management Area. If an area is designated as a Water Management Area, all existing and new source owners (except individual domestic users and those on rain catchment systems) must obtain a water use permit and justify their withdrawals and uses. The Pearl Harbor aquifer sector has been identified by CWRM as a Water Management Area (CWRM, 2005).

3.3.1.2 Surface Water

The Project area is within the upper portion of the Kaloʻi Gulch watershed. Surface water features within the Project area include tributaries to Kaloʻi Gulch and a portion of the Waiahole Ditch. No perennial streams or wetlands occur within the Project area.

The Kaloʻi Gulch system consists of numerous tributaries that originate in the Waiʻanae Mountain Range near Palikea Ridge and enjoin to form one channel just mauka of the H-1 Freeway (Parham et al., 2008). Tributaries to Kaloʻi Gulch run along the southern boundary and through the central portion of the Project area (Figure 3-2). Within and immediately adjacent to the Project area, the Kaloʻi Gulch tributaries have physical indicators of occasional surface water flow (e.g., defined bed and bank, ordinary high water mark), but the features are typically dry and only carry water during and immediately following rain events. They are defined by the State of Hawaiʻi Department of Aquatic Resources (DAR) as non-perennial, by the National Hydrography Dataset as intermittent, and by the National Wetland Inventory as a Freshwater Forested/Shrub Wetland (PSS3A - Palustrine, Scrub-Shrub, Broad-Leaved Evergreen, Temporary Flooded). Kaloʻi Gulch currently does not have a surface connection

to the ocean; it terminates approximately 0.3 mile from the shoreline near the Hoakalei County Club golf course. In terms of water quality, Kaloʻi Gulch is classified as a Class 2 inland water (DOH, 2013).[13]

The portion of the Waiahole Ditch within the Project area consists of a concrete ditch, with a metal pipe (roughly 4.5 inches in diameter) immediately adjacent to the ditch. It is identified by the National Hydrography Dataset as a canal/ditch and pipeline (Surface Aqueduct); the canal/ditch portion of the ditch system is mapped by the National Wetland Inventory as Riverine (R5UBFx - Riverine, unknown perennial, unconsolidated bottom, semi-permanently flooded, excavated). The Waiahole Ditch and associated pipeline feature are part of the Waiahole Ditch System, which was constructed in the early 1900s to transport water from the windward side of the Koʻolau Mountains to leeward Oʻahu to irrigate dry agricultural lands. Within the Project area, the ditch and pipeline no longer function to carry water.

3.3.1.3 Jurisdictional Waters of the U.S. (Including Wetlands)

Water features, including wetlands and streams, that are determined to be Waters of the U.S. are regulated by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act; placement of dredged or fill material within jurisdictional Waters of the U.S. requires authorization. To confirm whether the features within the Project area are subject to USACE jurisdiction, Tetra Tech conducted a jurisdictional delineation on May 9, 10, and 22, 2019, according to the 2015 Clean Water Rule (USACE and EPA, 2015). The results of the delineation indicated that although the tributaries to Kaloʻi Gulch within the Project area have a defined bed and bank and physical indicators of an ordinary high water mark, there is no evidence that these features directly or indirectly contribute flow to the Pacific Ocean, a traditional navigable water of the United States. The results of the delineation also indicated that the portion of the Waiahole Ditch and associated pipeline within the Project area do not appear to have a surface connection to downstream waters. Other features noted during the delineation include two erosional features, which do not appear to convey water frequently enough to have a defined bed and bank or indicators of an ordinary high water mark. No other potential Waters of the U.S. (including wetlands) were identified within the Project area.

The delineation report was submitted to the USACE for review and verification on July 22, 2019. On September 4, 2019, the USACE provided written confirmation that none of the features within the Project area are jurisdictional Waters of the U.S., and therefore, the features are not subject to regulation under the Clean Water Act. A copy of the delineation report and the USACE jurisdictional determination is provided in Appendix B.

[13] Pursuant to HAR §11-54, the objective of Class 2 waters is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class.

3.3.2 Potential Impacts and Mitigation Measures

3.3.2.1 Groundwater

Construction of the Project would involve installing the posts for the racking system to depths of approximately 6 feet, as well as excavation for the equipment pads and substation to depths of approximately 3 feet (with steel piers for support of certain interconnection equipment to depths of 10-15 feet). No direct interaction with groundwater is anticipated. Other potential impacts to groundwater include decreased recharge, availability, or quality. As further discussed below, implementation of the Project would result in the addition of impervious surfaces; however, there would still be sufficient open space for natural infiltration within and surrounding the Project area. Furthermore, the Project would incorporate stormwater retention features, such that decreased rates of groundwater recharge are not anticipated. Total water consumption for both construction and operation of the Project would be minimal. As such, the Project would not be expected to affect groundwater availability.

Construction would require the use of some hazardous materials, such as diesel fuel, gasoline and lubricants. Similar materials would also be occasionally used for operations and maintenance activities, as well as during decommissioning. If handled inappropriately, these materials could affect groundwater quality. However, as further discussed in Section 3.11, only a limited amount of these materials would be present onsite, and BMPs would be implemented to avoid and minimize the potential release of any such materials. With implementation of these measures, impacts to groundwater quality are expected to be negligible.

3.3.2.2 Surface Water

The Project has been designed to avoid surface water features within the Project area to the maximum extent practicable. The only direct impacts to surface water features would be associated with construction of a single crossing over the tributary to Kaloʻi Gulch that runs through the central portion of the Project area to allow for access between the solar arrays; it is anticipated that the crossing would involve installation of a box culvert. As this feature has been determined to be non-jurisdictional, construction of the road crossing would not require authorization under the Clean Water Act. Regardless, the crossing would be designed to have as small of a footprint as possible and to sufficiently convey flows during and following rain events. As such, the Project would not significantly affect the form or function of the tributary to Kaloʻi Gulch.

Indirect impacts to surface water features can include changes in drainage patterns, increased volume or velocity of stormwater runoff, and/or discharge of pollutants to downstream waters. To minimize the potential for indirect impacts, the Project would incorporate LID design techniques (specifically, Site Design Strategies) to maintain hydrologic and hydraulic functions and reduce the potential for erosion within the Project area. The Site Design Strategies consist of conserving natural areas, including soils and vegetation, minimizing soil compaction, and minimizing disturbance to the natural drainages. As described in Section 2.2, the majority of the grading activities would be concentrated around the Project components comprising new impervious areas (equipment pads, substation foundation and service roads) and in localized areas within the solar arrays, with minimal disturbance elsewhere onsite.

Furthermore, installation of the posts for the racking system would not be expected to heavily disturb or compact the existing ground beneath the solar photovoltaic modules, such that the existing topography and drainage patterns would largely be maintained. Given this design approach, the Project would not significantly alter the existing drainage patterns within the Project area.

The Project would increase the amount of impervious surface within the Project area, which would increase stormwater runoff.[14] As listed in Table 3-1, it is expected that impervious surfaces would increase by approximately 2.2 acres across the overall 97-acre Project area. The new impervious surfaces would be associated with the support foundations for the racking system, equipment pads, substation and interconnection facilities, service roads, and agricultural features (e.g., beekeeping stations and water troughs). Other than the area occupied by the support foundations for the racking system, the ground beneath the solar photovoltaic modules would be maintained as a natural, pervious surface that is able to absorb and infiltrate stormwater. In addition, as described in Section 2.1.1, the rows of solar photovoltaic modules would be widely spaced (with approximately 8 feet of open space between adjacent rows), thus providing wide swaths of open space for stormwater infiltration throughout the solar arrays. Disturbances to vegetated areas around the solar modules would be mitigated through hydroseeding, such that erosion would not be expected to occur downgradient of the modules. To further minimize the potential for stormwater-related impacts, the Project would also incorporate stormwater retention BMPs during and post-construction to retain and treat stormwater within the Project area; these BMPs are further discussed below.

Once operational, the water requirements for the Project would be limited to temporary irrigation for landscaping and filling of water troughs for cattle; the volume of water required for these activities would be minimal and would not measurably contribute to stormwater runoff. As detailed in Section 2.4, the Project would be decommissioned at end of its useful life, including removal of Project equipment and returning the Project area to its existing condition (or comparable), which would effectively reduce the amount of impervious surface area to the current level. Given the relatively minimal increase in impervious surfaces (and subsequent removal as part of Project decommissioning), coupled with the Site Design Strategies and stormwater retention measures, the Project would not be expected to substantially affect stormwater discharge from the Project area.

[14] The City and County of Honolulu's Rules Relating to Water Quality define an impervious surface as "a surface covering or pavement of a developed parcel of land that prevents the land's natural ability to absorb and infiltrate rainfall/ storm water. Impervious surfaces include, but are not limited to rooftops, walkways, patios, driveways, parking lots, storage areas, impervious concrete and asphalt, and any other continuous watertight pavement or covering."

Table 3-1. Impervious Surfaces Associated with Project Implementation

Project Component	Approximate Area[1] (acres)
Support Foundations for Solar Photovoltaic Modules[2]	0.1
Equipment Pads (Battery Units and Electrical Equipment)	0.4
Substation and Interconnection Facilities	0.2
Service Roads	1.5
Agricultural Facilities (Beekeeping Stations and Water Troughs)	0.01
Total Impervious Surface	**2.2**

[1] Additional detail regarding these calculations is provided as part of Table 2-1.

[2] The support foundations for the racking system would be distributed across the Project area such that the cumulative area of the foundations should not be considered as hydraulically connected to the other impervious areas associated with the Project.

Construction of the Project could temporarily increase sediment and other pollutants (for example, trace oil, grease, and fuel) in stormwater runoff, which could affect water quality in downstream waters. As described in Section 2.2, prior to construction of the Project, an ESCP would be prepared and submitted for approval in accordance with the requirements of the City and County of Honolulu's Rules Relating to Water Quality. In addition, a SWPPP would be prepared as part of the application for Notice of General Permit Coverage for construction-related stormwater runoff, pursuant to NPDES regulations. The ESCP and SWPPP would identify BMPs including erosion prevention, sediment control, and good housekeeping measures that would be implemented to prevent and minimize discharge of pollutants to downstream waters; in general, these are expected to include measures such as those listed below. The measures would be inspected by a designated ESCP Coordinator on a regular basis, with documentation of the inspection results and implementation of necessary corrective actions.

- Construction would be sequenced in a manner that reduces the amount and duration of exposed soils, as well as the onsite storage of equipment and materials that could result in discharge of pollutants.
- Construction activities involving movement or disturbance of soil would not occur during heavy rain events.
- Ground disturbance in areas with slopes exceeding 15 percent would be minimized to the extent possible. If work is required in areas with slopes that exceed 15 percent, the activities would be phased such that no more than 5 acres of soil would be exposed at any given time and slopes would be stabilized at all times other than immediately preceding (within 7 calendar days) or during active groundwork. Upstream runoff is expected to be captured and diverted by Waiahole Ditch; however, upstream runoff diversion measures (e.g., earth dikes, drainage swales, slope drains) and/or downgradient buffers would be provided as needed.

- In areas of ground disturbance with slopes less than 15 percent, temporary slope stabilization would be provided when grading is complete or when active groundwork is not planned to occur within 14 calendar days.
- Temporary slope stabilization would include rolled erosion control products, hydraulic mulch or hydroseed, hydraulic or bonded fiber matrix, and/or vegetation cover.
- Following the completion of ground disturbing activities, all disturbed areas would be stabilized with permanent erosion control measures (such as vegetation, gravel or pavers) and temporary erosion control measures would be removed.
- Soil compaction would be minimized by restricting vehicle and equipment use to appropriate areas and/or through soil conditioning.
- Perimeter controls, such as vegetated buffers, silt fence or sediment barriers (e.g., sandbags, fiber rolls, compost filter socks), would be installed along the perimeter of the Project area that could receive stormwater from areas subject to ground disturbance. A minimum of a 50-foot natural buffer or multiple layers of sediment barrier or silt fence would be installed along the perimeter that is immediately adjacent to Kaloʻi Gulch.
- Storm drain inlets that could receive stormwater from the Project area would be protected with sediment barriers or inlet protection devices. The sediment barriers and inlet protection devices would be unclogged and cleaned as needed, with collected sediment reincorporated into the Project area or disposed at an approved off-site location.
- Temporary drainage ditches would be installed to capture and convey sediment-laden water from areas of ground disturbance. The ditches would terminate at sediment basins. Velocity dissipation measures (e.g. riprap) would be installed at the outlet of the ditches to mitigate erosion in sediment basins. Sediment barriers would be installed along the downstream edge of the ditches to mitigate sediment transport.
- Temporary sediment basins would be installed within the Project area to collect and detain sediment and sediment-laden water from areas of ground disturbance. The sediment basins would be constructed in a manner that allows suspended solids to settle out before stormwater is discharged.
- Vehicular traffic within the Project area would be restricted to designated areas and all construction entrances and exits would be properly stabilized with an effective buffer and/or tire wash facilities to minimize tracking of sediment onto adjacent streets and other paved areas.
- Sediment or other pollutants from the Project area that are tracked or otherwise discharged to adjacent streets or other paved areas would be promptly cleaned using dry methods such as sweeping or vacuuming. Sediment or other pollutants would not be washed directly into storm drain inlets.

- Dust control would be provided through application of mulch and/or watering.
- Onsite storage of hazardous materials would be minimized; if onsite storage of hazardous materials is necessary, they would be properly stored in a designated area with secondary containment.
- Construction materials, hazardous substances, waste, stockpiles and other sources of potential pollution would not be stored in any buffer area, near drainage features or areas of concentrated flow, or proximate to a storm drain inlet.
- Proper use and waste disposal methods would be used for all hazardous materials. All leaks and spills would be promptly cleaned up. In the event that hazardous materials are discharged to the storm drain system, the City and County of Honolulu Department of Facility Maintenance, Honolulu Fire Department and Honolulu Police Department would be immediately notified.
- Heavy equipment would be inspected at the beginning of each workday for cleanliness and leaks. Should a leak be detected, heavy equipment operations would be postponed or halted until the leak is repaired and the equipment is cleaned.
- Washing of vehicles and equipment would only occur in designated, contained areas. Wash water would be evaporated, treated and or infiltrated as appropriate.
- If conducted onsite, concrete washout would occur in a designated area that is sufficient in size to contain all liquid and concrete waste, lined with polyethylene sheeting that is free of holes, tears or other defects. Washout facilities would be cleaned, or a new facility would be constructed once the washout is 75 percent full. Once concrete waste has hardened, the concrete would be broken up, removed, and disposed of as solid waste.
- Fueling and vehicle maintenance would either occur in an offsite facility or in a designated area with secondary containment. Spill pads would be used under vehicles and equipment.
- A waste collection area would be designated within the Project area. Waste would be promptly collected for disposal at an approved offsite location.
- Portable sanitary waste systems would not be installed near drainage features or the storm drain system, and would be properly secured, maintained, and serviced.
- Stockpiles would not be located within 50 feet of areas with concentrated flow. Sediment barriers or silt fence would be installed around the base, and stockpile would be properly covered when not in use.

In addition to the construction BMPs listed above, permanent features would be installed to provide long-term retention and biofiltration of stormwater within the Project area. Specifically, infiltration trenches would be installed in areas with increased impervious surfaces associated with the Project facilities and would be designed to retain and allow for infiltration or evapotranspiration of stormwater, as needed to reduce peak flows to pre-development values. The size and design of the trenches would

be based on site-specific conditions as well as the requirements of the City and County of Honolulu's Rules Relating to Water Quality and Rules Relating to Storm Drainage Standards; additional detail regarding the quantification of stormwater runoff and sizing of the infiltration trenches is provided in the Stormwater Management Design Memo contained in Appendix C. A Storm Water Quality Strategic Plan detailing the permanent stormwater design strategies, including the infiltration trenches, would be developed and submitted to DPP for approval prior to construction. The post-construction BMPs would be inspected during and following installation by a Certified Water Pollution Plan Preparer (CWPPP), with proper documentation of the inspection results and implementation of necessary corrective actions.

Implementation of BMPs, which would be detailed as part of an approved ESCP, SWPPP and Storm Water Quality Strategic Plan, would minimize the potential for discharge of sediment and other pollutants in stormwater runoff, such that significant water quality impacts to downstream waters are not anticipated. Accordingly, it is expected that the Project would be in compliance with the City and County of Honolulu's Rules Relating to Water Quality and Storm Drain Standards, as well as the State's water quality standards, which establishes basic water quality criteria and requires that water quality be maintained to protect existing uses as specified in HAR §11-54.

3.4 Biological Resources

3.4.1 Affected Environment

A field survey of biological resources within the Project area was conducted by Tetra Tech on January 31, 2019 and February 5, 2019. A follow-up survey was conducted on November 14, 2019 to address minor adjustments in the Project area. The purpose of the surveys was to characterize the existing habitat and assess the potential for state or federally listed threatened, endangered, or otherwise rare plants or animals to occur within the Project area. In general, the Project area has been extensively modified by previous agricultural use and the introduction of invasive species, which has resulted in a reduction of the number and abundance of native species and habitats suitable for native species. The results of the biological survey are summarized in Sections 3.4.1.1 and 3.4.2.1 below. Additional detail is provided in the Biological Resources Survey Report, which is contained in Appendix D.

3.4.1.1 Vegetation

The Project area is dominated by Koa Haole Scrub. This vegetation type is characterized by open to dense stands of non-native koa haole trees (*Leucaena leucocephala*), ranging from 4 to 8 feet in height. Guinea grass (*Urochloa maxima*) is the most abundant plant in the understory, although buffelgrass (*Cenchrus ciliaris*) is also occasionally present. Kiawe trees (*Prosopis pallida*) are sparsely scattered throughout the Project area. Other common species widely occurring in the Project area include klu (*Acacia farnesiana*), 'ilima (*Sida fallax*), 'uhaloa (*Waltheria indica*), and *Sida ciliaris*.

A total of 29 plant species were observed during the biological survey; a complete list is provided in the Biological Resources Survey Report (Appendix D). Of the species observed, only four are native to the

Hawaiian Islands, including hoary abutilon (*Abutilon incanum*), ʻilima, ʻuhaloa, and wiliwili (*Erythrina sandwicensis*). In the Project area, wiliwili are limited to several trees scattered in the gulch along the southern boundary. This endemic tree is relatively rare on Oʻahu primarily due to coastal development and insect pests, but is more abundant on Maui and Hawaiʻi Island. The remaining three native plant species occur throughout the Project area; all three species are indigenous (i.e., found in the Hawaiian Islands and elsewhere) and are common across the Hawaiian Islands (Wagner et al. 1999). The native ʻaʻaliʻi (*Dodonaea viscosa*) was also observed immediately outside the Project area. No federal or state-listed threatened, endangered, proposed listed, or candidate plant species were observed in the Project area during the biological survey.

3.4.1.2 Wildlife

A total of 21 bird species were observed during the biological survey. All of the observed avian species are non-native to the Hawaiian Islands and are commonly found in rural or agricultural areas. Zebra dove (*Geopelia striata*) and common myna (*Acridotheres tristis*) were the most commonly observed avian species during the survey within the Project area. A complete list of the bird species observed is provided in the Biological Resources Survey Report (Appendix D).

Two non-native terrestrial mammal species were observed in the Project area – cattle (*Bos taurus*) and small Indian mongoose (*Herpestes auropunctatus*). Although not observed, other introduced mammals, such as dogs (*Canis familiaris*), cats (*Felis catus*), house mice (*Mus musculus*), and rats (*Rattus* spp.) are likely to occur in the Project area.

Large insects observed during the biological survey include yellow garden spider (*Argiope aurantia*), globe skimmer (*Pantala flavescens*), fork-tailed bush katydid (*Scudderia furcata*), praying mantis (*Mantis religiosa*), large orange sulfur (*Phoebis agarithe*), gulf fritillary (*Agraulis vanillae*), and Carolina locust (*Dissosteira carolina*). Of these species, only the globe skimmer is native to the Hawaiian Islands.

Federally and State Listed Species

The Endangered Species Act (ESA) provides protection for species listed as threatened or endangered and their habitats, specifically those areas that have been designated as “critical habitat.” The ESA defines an endangered species as one that is “in danger of extinction throughout all or a significant portion of its range” and a threatened species as one that “is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” Critical habitat includes areas containing essential habitat features for threatened or endangered species, regardless of whether those areas are currently occupied by the species (16 U.S. Code [USC] § 1532). Endangered and threatened species are also protected under state law, pursuant to HRS Chapter 195D. HRS Chapter 195D-4 specifies that any species listed as endangered or threatened under the ESA shall also be listed as such under state law; other species may also be state listed as endangered or threatened based on habitat impacts, overutilization, disease or predation, or other specified factors. The ESA and HRS Chapter 195D are administered by the U.S. Fish and Wildlife Service (USFWS) and State of Hawaiʻi Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW), respectively.

No federally or state listed species were observed during the biological survey, nor has any portion of the Project area been designated as critical habitat. Although not observed during the biological survey, several federally or state listed species have the potential to occur within or traverse over the Project area. These species include ʻōpeʻapeʻa or Hawaiian hoary bat (*Lasiurus cinereus semotus*), pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*), ʻuaʼu or Hawaiian petrel (*Pterodroma sandwichensis*) and ʻaʼo or Newell's shearwater (*Puffinis auricularis newelli*). Each of these species is briefly described below.

Hawaiian Hoary Bat

The Hawaiian hoary bat or ʻōpeʻapeʻa is the only extant native land mammal present in the Hawaiian archipelago. It is federally and state listed as endangered due to apparent population declines and a lack of knowledge concerning its distribution, abundance, and habitat needs (USFWS 1998). Recent studies have found that this species is more abundant across the Hawaiian Islands than previously believed (USGS, 2019). It is widely distributed across the Hawaiian Islands, with breeding populations known to occur on Oʻahu, Maui, Molokaʻi, Kauaʻi and Hawaiʻi Island (Gorresen et al., 2013; Bonaccorso et al., 2015).

Hawaiian hoary bats are tree-roosting bats and roost in native and non-native vegetation, including ʻōhiʻa (*Metrosideros polymorpha*), hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Prosopis pallida*), avocado (*Persea americana*), mango (*Mangifera indica*), shower trees (*Cassia javanica*), pūkiawe (*Leptecophylla tameiameiae*), common ironwood (*Casuarina equisetifolia*), macadamia (*Macadamia* spp.), and fern clumps (USFWS, 1998; Mitchell et al., 2005; Gorresen et al., 2013). Hawaiian hoary bats are primarily solitary roosters; however, mothers and pups roost together (USFWS, 1998). Foraging occurs in open and semi-cluttered landscapes in a wide range of habitats and vegetation types, including open pastures, forest gaps and edges, and above forest canopies (Bonaccorso et al. 2015). Hawaiian hoary bats feed at night on a variety of night-flying insects, primarily aerial beetles and moths (Todd 2012).

The biological survey for the Project did not include focused surveys for the Hawaiian hoary bat (e.g., acoustic bat detectors or night vision goggles). As USFWS and DOFAW recognize all woody vegetation greater than 15 feet tall as potential bat roosting habitat (DOFAW, 2015; USFWS, 2019), Tetra Tech noted the presence of any such trees or shrubs within the Project area which could be used for roosting. Although the majority of the woody vegetation within the Project Area is relatively short and scrubby (e.g., koa haole), the scattered kiawe trees throughout the Project Area and the wiliwili trees within the southern tributary to Kaloʻi Gulch may provide potentially suitable roosting habitat. Given the species' wide range of foraging habitat, it is also likely that bats forage in or near the Project Area.

Systematic surveys for Hawaiian hoary bats are currently being conducted across Oʻahu as part of an island-wide occupancy and distribution study. The detector deployed near the West Loch Golf Course as part of this study, approximately 2.2 miles from the Project area, has recorded bats (Starcevich et al. 2019). This is the nearest known detection of a Hawaiian hoary bat.

Hawaiian Short-eared Owl

The Hawaiian short-eared owl or pueo is listed as endangered by the State of Hawaiʻi only on the island of Oʻahu; it is not a federally listed species. It is an endemic subspecies of the widespread short-eared owl (*Asio flammeus*) and is believed to have colonized the Hawaiian Islands after the arrival of Polynesians (Price and Cotín, 2018). Threats to this species include loss and degradation of habitat, predation by introduced mammals, and disease; other concerns relate to pesticides and other contaminants, food shortages, nest predation and human interaction (Pueo Project, 2019a).

Pueo are found on all of the main Hawaiian Islands, at elevations ranging from sea level to 8,000 feet. On Oʻahu they occupy a variety of habitats, including agricultural lands, grasslands, wetlands, shrublands, and native forests. It is suggested their habitat use may be influenced by food availability (Price and Cotín, 2018). Pueo are active during the day, with increased activity levels at dawn and dusk, and are commonly seen hovering or soaring over open areas. There is limited information regarding breeding of this species, but nests have been found throughout the year. Nests are made of scrapes in the ground lined with grasses and feather down (Price and Cotín, 2018; Mitchell et al., 2005).

As part of the biological survey, a survey specifically intended to detect pueo was conducted on the morning of February 5, 2019 (from civil twilight to 60 minutes after sunrise). Pueo were not seen or heard within the Project area during this initial survey. To increase detectability, three additional pueo surveys were conducted on September 26, November 14, and December 19, 2019; these surveys followed the Pueo Project Survey Protocol (Price and Cotín, 2018) and were conducted during twilight hours when pueo are more likely to be detected (M. Price/ UH Mānoa, pers. comm., September 2019; Cotín et al., 2018). Pueo were not seen or heard within the Project area during these surveys. Although not detected within the Project area, this species been reported to use the surrounding areas; the nearest known observation to the Project area is near the southern edge of the UH West Oʻahu campus (Price and Cotín, 2018, Pueo Project, 2019b). Given the habitat present, pueo could potentially forage or nest in and around the Project area. However, based on consultation with DOFAW biologists and Pueo Project researchers regarding the survey results and previous pueo detections in the vicinity, it is understood that pueo are not likely to use the Project area on a regular basis given the lack of detection during the surveys (A. Siddiqui/ DOFAW, pers. comm., October 2019).

Seabirds

The Hawaiian petrel and Newell's shearwater (collectively referred to as seabirds) are federally and state listed as endangered and threatened, respectively.

Hawaiian petrels are known to breed on Kauaʻi, Maui, Hawaiʻi, Lānaʻi and possibly Molokaʻi and Kahoʻolawe (Pyle and Pyle 2017; Mitchell et al., 2005). Although previously thought to be extirpated from Oʻahu, this species was recently detected on the windward slopes of Mt. Kaʻala (Young et al., 2019). Hawaiian petrels spend most of their life at sea, and rarely return to land outside of the breeding season (March to December). During the non-breeding season, they are found far offshore, primarily in equatorial waters of the eastern tropical Pacific. They nest in colonies, returning to the same nest site

each year. Colonies are typically located in high elevation, xeric habitats or wet, dense forests. Nesting occurs in burrows, crevices, or cracks in lava tubes (Mitchell et al., 2005).

Newell's shearwaters breed primarily on Kaua'i, but small populations also occur on Maui and Hawai'i. The species also possibly breeds on Moloka'i and was recently detected in two locations on O'ahu - one on the leeward slopes of Mount Ka'ala in the Wai'anae Mountains and another at Poamoho in the Ko'olau Mountains (KESRP, 2019; Young et al., 2019). Similar to the Hawaiian petrel, this species remains at sea during the non-breeding season. Breeding colonies are typically located on steep mountain slopes and cliffs, with nesting in burrows, generally beneath ferns and tree roots. During the breeding season (April – November), adults forage at sea during the day and return to the colony at night (KESRP, 2019; Mitchell et al., 2005).

Seabirds have not been documented in the Project area and suitable nesting habitat does not exist in the Project area. However, suitable nesting habitat may exist in upper elevations of the Wai'anae Mountains, suggesting the potential for these birds to fly over the Project area at night while transiting between nest sites and the ocean.

Waterbirds

Listed waterbird species that occur in Hawai'i include ae'o or Hawaiian stilt (*Himantopus mexicanus knudseni*), 'alea kea or Hawaiian coot (*Fulica alai*), and 'alea 'ula or Hawaiian common gallinule (*Gallinula galeata sandvicensis*). No suitable habitat for listed waterbirds occurs in the Project area, and none of these species were observed during the biological survey.

3.4.2 Potential Impacts and Mitigation Measures

3.4.2.1 Vegetation

Direct impacts to vegetation would occur primarily as a result of clearing and ground disturbance during construction. However, as described above, the Project area has been extensively disturbed as part of previous agricultural operations, with existing vegetation largely comprised of non-native species. No federally or state listed endangered, threatened, or candidate plant species have been identified within the Project area, and no portion of the Project area has been designated as critical habitat for any listed plant species. The three indigenous plant species that occur within the Project area - hoary abutilon, 'ilima and 'uhaloa - are common throughout the Hawaiian Islands. The endemic wiliwili tree occurs within the tributary to Kalo'i Gulch along the southern boundary of the Project area; however, this species would not be directly impacted by the Project because no ground disturbance would occur within the gulch.

Following construction, all temporarily disturbed areas would be revegetated to stabilize soil and prevent erosion; as described in Section 2.2.4, it is anticipated that revegetation would involve application of hydroseeding using a suitable mix of native and/or non-invasive grass species. In addition to revegetation of temporarily disturbed areas, landscaping would also be installed to provide visual screening of Project equipment from adjacent areas to the extent practicable. It is anticipated that the

landscaping would incorporate trees and shrubs in key locations and would include native species that are ecologically and culturally appropriate for this location, as practicable.

Ground disturbance, as well as the movement of construction and operation equipment and personnel in the Project area, could also indirectly impact vegetation through the introduction or spread of invasive species. To minimize the potential for introduction and spread of invasive species, the following measures would be implemented:

- Construction equipment, materials and vehicles arriving from outside of the island of Oʻahu would be washed and/or visually inspected (as appropriate) for excessive debris, plant materials, and invasive or harmful non-native species before transportation to the Project area; import of materials that are known or likely to contain seeds or propagules of invasive species would be prohibited.
- Due to concerns with spreading the fungal pathogen responsible for Rapid ʻŌhiʻa Death, no plants, clothing, or gear sourced from Hawaiʻi Island would be permitted for use within the Project area. All other equipment, tools, or vehicles sourced from Hawaiʻi Island would follow established Rapid ʻŌhiʻa Death decontamination protocols.
- Offsite sources of revegetation materials (such as seed mixes, gravel, and mulches) would be certified as weed-free or inspected before transport to the Project area.
- All areas that are hydroseeded would be monitored for six months after hydroseeding to identify invasive plants that establish from seeds inadvertently introduced as part of the seed mix; all invasive plants identified within the hydroseeded areas would be removed.

Following construction, little to no ground disturbance is anticipated during Project operations. Vegetation within the Project area would be routinely managed either through grazing animals and/or mechancial means. Operations staff and agricultural partners would actively monitor the vegetation to ensure the cover is sufficient for erosion control while ensuring an adequate food supply for livestock. Decommissioning of the Project, at the end of its useful life, would involve removal of the Project facilities and returning the site to its existing condition (or similar), including revegetation with a suitable mix of species.

As the Project area is characterized by highly disturbed, non-native vegetation with very few native plant species present and would be revegetated with suitable species (with BMPs implemented to minimize the introduction and spread of invasive species), implementation of the Project is not expected to have more than a minor impact on vegetation within the Project area.

3.4.2.2 Wildlife

As described in Section 3.4.1, the Project area has been extensively disturbed by previous agricultural activities, which has reduced the presence of native wildlife and their suitable habitats. Nearly all of the wildlife observed during the biological survey are non-native species. Although not observed, several threatened and endangered wildlife species could occur within or traverse over the Project area.

Potential impacts and associated mitigation measures specific to listed wildlife species are discussed in the following subsections.

Direct impacts to wildlife as a result of Project implementation could occur as a result of collision with vehicles and equipment during construction. In addition, there is potential for native and non-native birds to collide with the Project facilities, particularly the solar photovoltaic modules. However, based on avian mortality data from various sources in the United States, avian mortality rates at utility-scale solar projects are estimated to be considerably lower than that associated with other types of energy projects (wind facilities, fossil fuel power plants), roads, and buildings (Walston et al. 2016). The potential for direct impacts would be minimized through implementation of measures described in the subsections below.

Indirect impacts to wildlife may include temporary disturbance and/or habitat loss. Temporary disturbance of wildlife within the Project area would routinely occur throughout the construction period due to increased activity and noise levels, including the use of construction vehicles and equipment. Following construction, activity and noise levels within the Project area would generally be limited to occasional facility maintenance and agricultural activities. As detailed in Section 3.10, operation of the electrical equipment would also generate some sound. It is expected that wildlife would exhibit avoidance behavior and relocate to avoid Project-related activity and noise, both during the construction and operational phases of the Project, as needed.

In addition to temporary displacement, the Project would also result in some habitat loss. As detailed in Section 2.2, the Project is expected to have a permanent footprint of approximately 2.2 acres, which would reduce the availability of habitat within the Project area. However, the affected habitat is highly disturbed and predominantly comprised of non-native species. Furthermore, a substantial amount of habitat would remain intact, both within the Project area and in the surrounding vicinity. It is expected that wildlife species would readily occupy the remaining habitat, such that temporary displacement or habitat loss would not be expected to measurably affect the size or stability of any wildlife populations.

Federally and State Listed Species

Although no federally and state listed wildlife species have been observed or documented within the Project area, several could occur within or traverse over the Project area. This section discusses potential impacts to each of these species; a comprehensive list of the mitigation measures that would be implemented to avoid and minimize impacts is provided at the end of the section. The list of mitigation measures incorporates recommendations provided by USFWS and DOFAW in response to a request for input regarding potential species occurrence and measures to avoid and minimize impacts to those species; copies of the correspondence from USFWS and DOFAW are contained in Appendix E.

Hawaiian Hoary Bat

Based on the existing habitat, Hawaiian hoary bats could forage in the Project area. It is also possible that Hawaiian hoary bats could roost in trees or shrubs 15 feet or taller, including the scattered kiawe trees throughout the Project area and the wiliwili trees within the southern tributary to Kaloʻi Gulch.

Construction-related impacts to the Hawaiian hoary bat could occur as a result of removing roost trees that contain young bats. Specifically, if trees or shrubs suitable for bat roosting (i.e., those greater than 15 feet in height) are cleared during the Hawaiian hoary bat birthing and pupping season, there is a risk that juvenile bats that cannot yet fly on their own could inadvertently be harmed or killed. Specific measures to avoid removal of roost trees that contain young bats would be incorporated into the Project such that direct impacts to roosting bats and their young are not anticipated; these measures are described in the following subsection.

Indirect impacts could include temporary displacement and/or permanent loss of foraging and roosting habitat. However, construction activities would generally occur during daylight hours when bats are not typically foraging, such that the potential for disturbance would be minimal. Given the relatively limited roosting habitat within the Project area and the extent of suitable roosting and foraging habitat available in the vicinity, the potential for impacts associated with permanent habitat loss is also expected to be minimal.

Once operational, the Project would not include any activities that would be expected to disturb or otherwise impact Hawaiian hoary bats. It has been generally suggested that bats could mistake solar photovoltaic modules for water, or artificial lighting at night could attract insect prey to the panels which could in turn attract bats to forage near infrastructure (Harrison et al., 2016; Gibson et al., 2017); however, there is no experimental, observational or scientific literature regarding this potential impact to bats (Harrison et al. 2016, Taylor et al. 2019). In addition, measures (as listed at the end of this section) would be implemented to avoid and minimize potential impacts associated with artificial night lighting to the extent possible.

Hawaiian Short-eared Owl

The Project area includes suitable foraging and nesting habitat for pueo. However, as described above, the species was not detected during surveys conducted within the Project area per the Pueo Project Survey Protocol; based on consultation with DOFAW biologists and Pueo Project researchers regarding the survey results and previous pueo detections in the vicinity, it is understood that pueo are not likely to use the Project area on a regular basis given the lack of detection during the surveys (A. Siddiqui/ DOFAW, pers. comm., October 2019).

In the event that pueo occur within the Project area, Project implementation could impact the species, such as through disturbance or removal of a nest. Pre-construction surveys would be conducted, and other associated measures would be implemented to avoid and minimize potential direct impacts to pueo, should they occur. Indirect impacts may include temporary disturbance and/or habitat loss. As previously discussed, a substantial amount of habitat would remain intact, both within the Project area and in the surrounding vicinity. It is expected that the pueo would readily occupy other nearby habitat,

such that temporary displacement or habitat loss would not be expected to significantly affect the species.

In general, operational activities within the Project area would not be expected to affect pueo. As pueo are sensitive to light pollution, it has been generally suggested that solar panels could reflect sunlight or moonlight thus disorienting the birds; however, there are no known data or other evidence regarding this potential impact to pueo. Based on available data and literature, mortality of avian species associated with solar facilities, including collision with solar photovoltaic panels, is not known to have been documented at any utility-scale solar project in Hawaiʻi. Avian mortality has been recorded at solar projects outside of Hawaiʻi; while panel collision has been reported, the cause of avian death at these projects is typically unknown (Kagan et al. 2014, WEST 2014, Walston et al. 2016, Dwyer et al. 2018). Furthermore, the applicability of the limited avian mortality data from outside of Hawaiʻi is unknown due to differences in project scale, species behavior, and nearby habitats. Overall, avian mortality due to utility-scale solar facilities has been estimated to be considerably less than avian mortality due to other human-caused sources of avian deaths such as roads, buildings, and other types of energy projects (Walston et al. 2016).

Seabirds

Although unlikely, it is possible that Hawaiian petrels and Newell's shearwaters could fly over the Project area in transit between the ocean and upland breeding sites. Seabirds are attracted to lights, which can cause disorientation (Banko et al., 1991; Ainley et al., 1997; Mitchell et al., 2005). Fledging seabirds are especially affected by artificial lighting and can become exhausted from circling the light sources, resulting in grounding. Once grounded, the birds are vulnerable to predation by small mammals (e.g., cats and mongoose). Similar to owls, it has been generally suggested that solar photovoltaic panels could reflect moonlight, which could disorient the birds; however, there is no known evidence regarding this potential impact to Hawaiian seabirds. Measures that are intended to avoid and minimize the potential impacts from artificial night lights would be implemented as part of the Project, as described below.

Waterbirds

The three listed Hawaiian waterbirds were not observed in the Project area and are not expected to occur in the Project area; however, these species could traverse nearby the Project area. Direct impacts to listed waterbirds are not anticipated during construction as the Project does not currently contain suitable habitat for waterbird species, nor would suitable waterbird habitat be created as a result of the Project.

During operation, there is limited potential for Project features to attract listed waterbirds to the area. At solar facilities in the continental U.S., some waterbird species have been documented to collide with solar panels, presumably because the birds perceive the panels to be bodies of water and collide with the panels while attempting a water landing (Kagan et al. 2014, WEST 2014, Walston et al. 2016). This hypothesis is termed the “lake effect.” However, there is not enough scientific evidence to conclude whether water-dependent birds are attracted to solar arrays or how proximity to water sources may be

related to avian mortality at solar facilities. Much more research is needed to investigate whether water-dependent birds are actually attracted to solar arrays, and how proximity to water sources relates to avian mortality at the facilities. According to Kagan et al. (2014), the "lake effect" may be more likely to occur if water is otherwise limited in the surrounding environment, such as in a desert or dense forest (Kagan et al. 2014). There has been no evidence from operating solar facilities in Hawaiʻi to suggest the lake effect occurs in Hawaiʻi. In addition, it is possible the lake effect would not occur in Hawaiʻi, where water is generally not limited in the surrounding environment.

3.4.2.3 Impact Avoidance and Minimization Measures

Consistent with recommendations provided by USFWS and DOFAW, the measures listed below would be implemented to avoid and minimize potential Project-related impacts. With implementation of these measures, the Project would not be expected to result in significant adverse impacts to wildlife, including federally and state-listed species.

- No trees or shrubs greater than 15 feet tall would be trimmed or removed during the Hawaiian hoary bat birthing and pupping season (June 1 and September 15).
- Any fences that are erected as part of the Project would not have barbed wire to prevent entanglements of the Hawaiian hoary bat, unless required for safety and security purposes (e.g., surrounding the electrical substation).
- A wildlife education and observation program (WEOP) would be implemented for all construction and regular on-site staff. Staff would be trained to identify listed species that may be found on-site (including Hawaiian hoary bat, pueo, Hawaiian seabirds and waterbirds) and to take appropriate steps if downed wildlife are found. If a federally or state-listed species is observed to be impacted by the Project, a systematic post-construction monitoring program would be developed and implemented, as appropriate.
- Construction site and access road speed limits would be established and enforced during the construction period.
- Construction activities would be restricted to daylight hours as much as possible during the seabird peak fallout period (September 15–December 15) to avoid the use of nighttime lighting that could attract seabirds.
- Should any nighttime construction be required, construction lighting would be shielded or directed downward and fitted with non-white lights if construction safety is not compromised to minimize the attractiveness of construction lights to seabirds. Lighting would also be directed away from the solar arrays to minimize the potential for reflection.
- Should nighttime construction be required during the seabird peak fallout period, a biological monitor would be present in the construction area from approximately 0.5-hour before sunset to 0.5-hour after sunrise to watch for the presence of seabirds. Should a seabird (or other listed species) be observed and appear to be affected by the lighting, the monitor would notify the

construction manager to reduce or turn off construction lighting until the individual(s) move out of the area.

- Operational on-site lighting would consist of fixtures that are shielded or directed downward to prevent upward radiation, triggered by motion detector, and fitted with non-white light bulbs, to the extent possible. Lighting would also be directed away from the solar arrays to minimize the potential for reflection.
- Construction of overhead lines would be minimized to reduce the collision risk for seabird species.
- Prior to clearing vegetation within the Project area, pre-construction pueo surveys would be conducted by a qualified biologist following the Pueo Project survey protocol. If a ground nest or an owl nesting on the ground is observed, an approximately 50-foot buffer would be established and marked in the field. In accordance with existing protocol for UH West Oʻahu, a designated UH West Oʻahu representative would be contacted immediately, and that representative would provide notification to DOFAW. No vegetation clearing would occur until pueo nesting ceases.
- If a live pueo is observed on-site by Project staff all activities within 50 feet of the bird would cease, and the bird would not be approached.
- No rodent baiting would occur as part of the Project to prevent secondary poisoning from toxins in pueo prey.
- No surface water features would be created by the Project during construction or operation to avoid attracting waterbirds to areas with sub-optimal habitat.

3.5 Historic Properties

3.5.1 Affected Environment

To identify, document and assess the significance of historic properties within the Project area, an archaeological inventory survey (AIS) was conducted by Cultural Surveys Hawaiʻi. The AIS included background research (with sources including archival documents, historic maps, Land Commission Awards [LCAs], and previous archaeological reports) to construct a history of land use and to determine if historic properties have been previously recorded in or near the Project area, as well as to formulate a predictive model of the types and locations of historic properties that would be expected to occur. The field component included a 100 percent pedestrian inspection of the Project area to identify any potential historic properties within the Project area. The results of the background research and field investigation were documented in a Draft AIS Report, which has been submitted and is pending review by the State of Hawaiʻi Historic Preservation Division (SHPD) in compliance with HRS Chapter 6E and HAR §13-284. The findings of the AIS are summarized below; a copy of the Draft AIS Report is provided in Appendix F.

The Project area is located within the ahupuaʻa of Honouliuli, which stretches from the summit of the Waiʻanae Mountains to the west shore of Pearl Harbor in the east, and is separated from the Pearl Harbor entrance channel and the ocean by Puʻuloa Ahupuaʻa on its southeast side. Background research indicates little traditional land use occurred in the portion of Honouliuli Ahupuaʻa in which the Project area is situated. Large settlements were primarily concentrated near the coast, near marine and estuarine resources, or in the irrigated lowlands suitable for wetland cultivation. Indigenous activities that might have occurred in the vicinity of the Project area, which is situated between the limestone plain and upland forest resources, are believed to have been limited to dryland agriculture within gulches or near springs, and mauka to makai trails and associated temporary shelters. However, any evidence of traditional land use that might have occurred in the area is likely to have been eliminated by historic agricultural and ranching activities that spanned this region through most of the mid-twentieth century. From 1913 to 1916, the Waiahole Ditch was constructed to transport water from the windward side of Oʻahu, through tunnels in the Koʻolau Mountains, to irrigate agricultural fields for the Oahu Sugar Company in ʻEwa. Most of the Project area and the surrounding lands were being cultivated by Oahu Sugar Company by 1925. Small residential camps associated with the plantation were the only settlements found in the upper slopes in the early twentieth century; historic maps show "Pump Camp 5" located within the Project area. Various roads and fence lines related to agricultural and/or ranching activities in the region are known to have existed in the Project area at one time. Previous archaeological studies have documented various plantation-era historic properties in the vicinity of the Project area; these include walls, alignments, mounds, ditches and other irrigation features, as well as the Waiahole Ditch (Dega et al., 1998). As part of the current AIS fieldwork, two historic properties were documented within the Project area, as follows:

- **Historic irrigation and plantation infrastructure (State Inventory of Historic Places [SIHP] # 50-80-08-5593):** This historic property was originally identified by Dega et al. (1998) as part of a 1998 AIS conducted for the UH West Oʻahu campus. SIHP # 50-80-08-5593 consists of an historic irrigation system and plantation infrastructure, including a mill building and pump station, bridges, troughs, transport ditches, pipes, culvert, sluice gate and various other features related to water retention and movement; based on the previous documentation, the boundaries of this site extend well beyond the current Project area. As part of the current AIS, components of SIHP # 50-80-08-5593 were documented extending from outside the northwestern boundary and through the central portion of the Project area toward the southeast. Two new features of SIHP # 50-80-08-5593 were documented: drain pipes (Feature 1) and a complex of water control features related to the pump house and mill located just southeast of the project area (Feature 2A through 2E).
- **Waiahole Ditch System (SIHP # 50-80-09-2268):** The Waiahole Ditch System was also identified as a historic property by Dega et al. (1998). SIHP # 50-80-09-2268 consists of the entire ditch system, which spans approximately 22 miles to transport water from the windward side of the Koʻolau Mountains across central Oʻahu to the ʻEwa Plain. The portion of the ditch in the vicinity of the Project area is not part of the main Waiahole Ditch that carries water from windward

O‘ahu (most of which is still in use); rather it is one of several ditches that extends from a reservoir fed by the main Waiahole Ditch. While the remnant of the ditch within the Project area is undoubtably part of the Waiahole Ditch System as a whole, the portion within the Project area and its components are in remnant condition. Within the Project area, the ditch extends along the northwestern border, then crosses through the central portion and exits across the southern boundary, beyond which it continues in a southwesterly direction. Seven new features were documented within the Project area: a culvert and bridge (Feature E), two ditch portions with metal pipes and sluice gate components (Features F and G), a metal drainage flume (Feature H), a bridge components of the ditch (Features I and J), and culvert and tunnel feature with metal sluice gate (Feature K).

No indications of traditional land use were observed, nor were remnants of Pump Camp 5 identified within the Project area.

3.5.2 Potential Impacts and Mitigation Measures

For a historic property to be considered significant, it must possess integrity of location, design, setting, materials, workmanship, feeling, and/or association and meet one or more of the following cultural/historic criteria, in accordance with HAR §13-284-6:

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 because of associations with traditional cultural practices once carried out, or still carried out, at the property or because of associations with traditional beliefs, events or oral accounts—these associations being important to the group’s history and cultural identity.

The sites documented as part of the AIS were assessed for their significance based on these criteria. The preliminary evaluation of integrity, significance and recommended mitigation is summarized in Table 3-2; these conclusions are subject to review and concurrence by SHPD.

Table 3-2. Historic Property Integrity, Significance and Recommended Mitigation

SIHP #	Description	Integrity							Significance	Recommended Mitigation
		Location	Design	Setting	Materials	Workmans	Feeling	Association		
50-80-08-5593	Historic irrigation system and plantation infrastructure	●	●		●	●			Criterion d	No further work
50-80-09-2268	Waiahole Ditch System	●							Criteria a, c, d	No further work

As summarized in Table 3-2, the historic irrigation and plantation infrastructure (SIHP # 50-80-08-5593) was assessed as significant only under Criterion d. This historic property has yielded information on land utilization and agricultural history of the ‘Ewa Plain. However, it is not associated with specific, impactful events in the area, unlike the Waiahole Ditch, which immeasurably altered the entirety of the landscape. Much of the irrigation system has been buried and destroyed by erosion and livestock. Therefore, the historic property possesses diminished but sufficient integrity of location, design, materials, and workmanship, for which it is significant. Based on the condition and context of the historic plantation infrastructure remnants, no further work is recommended for those portions of SIHP # 50-80-08-5593 within the Project area. Sufficient information regarding the location, extent, function, and age of the historic properties has been generated as part of the current AIS to mitigate any adverse effect resulting from the Project.

The Waiahole Ditch System (SIHP # 50-80-09-2268) was assessed as significant under Criteria a, c, and d. The historic property has yielded information on the agricultural history of the area and contributed greatly to the development and evolution of the ‘Ewa Plain throughout its history. However, within the project area, the historic property only retains sufficient integrity of location, which is also diminished in portions of the Project area due to erosion and neglect. While there are some portions that retain some integrity of design, materials, and workmanship within the Project area, this integrity is very diminished. While the overall ditch is significant, the remnant portion of SIHP # 50-80-09-2268 within the Project area does not retain sufficient integrity to be considered significant; therefore, no further work is recommended. This conclusion is consistent with the conclusions of the Dega et al. 1998 study, which was accepted by SHPD.

Implementation of the Project would affect portions of these historic properties within the Project area; however, based on the conclusions regarding the significance and documentation to date, pursuant to HAR §13-284-7 and subject to review and concurrence by SHPD, the effect determination for the Project is “no historic properties affected” with a recommendation for no further historic preservation work.

3.6 Cultural Resources

3.6.1 Affected Environment

Pursuant to the requirements of HRS Chapter 343, Cultural Surveys Hawaiʻi conducted a cultural impact assessment (CIA) to evaluate the potential effect of the Project on cultural beliefs, practices, and resources, including traditional cultural properties. The assessment included archival research regarding Hawaiian activities including kaʻao (legends), wahi pana (storied places),ʻōlelo noʻeau (proverbs), oli (chants), mele (songs), traditional moʻolelo (stories), traditional subsistence and gathering methods, ritual and ceremonial practices; background research focused on land transformation, development, and population changes beginning with the early post-Contact era to the present day. Cultural documents, primary and secondary cultural and historical sources, historic maps, and photographs were reviewed for information pertaining to the Project area. Community consultation was also conducted to obtain input from knowledgeable individuals regarding present and past uses, cultural sites, traditional gathering practices, cultural association and any associated cultural concerns. This effort included outreach to approximately 70 Hawaiian organizations, agencies and community members. A total of 12 people responded, with one providing written testimony and three kamaʻāina (Native-born) and/or kūpuna (elders) participating in formal interviews, as follows:

- Christian Kaimanu Yee - kamaʻāina and knowledgeable of moʻolelo and wahi pana
- Shad Kāne - member of Kapolei Hawaiian Civic Club, Chair of the Oʻahu Council of Hawaiian Civic Clubs Committee on the Preservation of Historic Sites and Cultural Properties, Aliʻi Ai Moku of the Kapuāiwa Chapter of the Royal Order of Kamehameha Ekahi, and ʻEwa Moku Representative on the State Aha Moku Advisory Committee
- Lynette Paglinawan - cultural practitioner and educator; teaches a course on Native Hawaiian Healing at UH West Oʻahu
- Tom Berg - former Councilman, District 1

Based on information gathered from the archival research and community consultation, no culturally significant resources were identified within the Project area. At present, there is no documentation or community input indicating traditional or customary Native Hawaiian rights are currently being exercised within the Project area. While no cultural resources, practices, or beliefs were identified as currently existing within the Project area, there is a rich cultural history of traditional or customary Native Hawaiian rights exercised within the Honouliuli Ahupuaʻa. A summary of the discussion contained in the Draft CIA Report is provided below; a copy of the Draft CIA Report is contained in Appendix G.

Honouliuli Ahupuaʻa is the largest ahupuaʻa in the moku of ʻEwa. Early historical accounts indicate that pre-Contact settlement in this ahupuaʻa was centered around the rich cultivated lands of Honouliuli ʻIli (where Honouliuli Stream empties into the ocean) which provided for extensive wetland taro cultivation and abundant coastal resources. An extensive coastal plain consisting of an exposed limestone platform also included recurrent use habitations for fishermen and gatherers, and sometimes gardeners.

Dissolution pits and caves that formed in exposed limestone outcroppings were accessed for water that accumulated via a subterranean or karst system; this water also contained nutrient-rich sediment that allowed for cultivation of plants such as taro or kalo (*Calocasia esculenta*), ti or kī (*Cordyline fruticosa*), and Indian mulberry or noni (*Morinda citrifolia*) within the pits (McAllister, 1933). The upland dry forest areas were used for hunting and gathering of forest resources, but likely not for widespread permanent settlement. In the intermediate area between the limestone plain and the upland forests, in the vicinity of the Project area, indigenous Hawaiian activities would have been limited to dryland agriculture within gulches or near springs, and mauka to makai trails and associated temporary shelters. No evidence of traditional gathering practices in the vicinity of the Project area was encountered.

In traditional times, trails were well used for travel within the ahupuaʻa between mauka and makai areas and laterally between ahupuaʻa. A historical trail system existed on Oʻahu extending from Honolulu to Waiʻanae. A cross-ahupuaʻa (east-west) trail passed through Honouliuli inland of Puʻu o Kapolei, and continued along the coast to Waiʻanae following the route of the modern Farrington Highway; this trail was approximately 0.9 mile (1.5 kilometers) southeast of the Project area. Another main trail extending up the central plain of Oʻahu was approximately 1.8 miles (3 kilometers) to the east (see Figure 6 in the CIA; Appendix G). Early historic maps also depict a trail branching off the cross-ahupuaʻa trail into the uplands in the Pālehua area. An 1825 map shows this trail passing a couple hundred meters southwest of the Project area (see Figure 7 in the CIA; Appendix G). A 1919 map shows an unimproved road alignment (labeled as Pālehua Road) south of the Project area, approximating the traditional Hawaiian footpath into the uplands on the north slope of Puʻu Makakilo, as well as a less formal trail into the uplands skirting the west side of Puʻu Kapuaʻi to the west of the Project area (see Figure 16 in the CIA; Appendix G). A subsequent map (1922) shows the road to Pālehua as arcing through the southwest portion of the Project area before traversing the north side of Puʻu Makakilo. However, the alignment indicated on the 1922 map is believed to be an approximation, as all other maps show the location further to the southwest toward Puʻu Makakilo; furthermore, no trail was identified on the ground along the alignment indicated on the 1922 map during either of the AIS studies conducted in this area (Dega et al., 1998; Welser et al., 2020). The Pālehua trail may always have been somewhat braided, but is not believed to have extended into the Project area. Access into the southeastern Waiʻanae Mountains today is facilitated by Makakilo Drive. Based on the available information, no historic trails are known to be extant within the Project area.

As previously described in Section 3.4.1.2, faunal resources that occur in Honouliuli Ahupuaʼa include the pueo or Hawaiian short-eared owl and the ōpeʼapeʼa or Hawaiian hoary bat; these are both endemic species and are federally and/or state listed as endangered. Culturally, the pueo is one of the most important ʻaumākua gods and ancestral deities of the family (Valeri, 1985). As part of the CIA, Mr. Tom Berg provided input that the pueo has "a direct connection to Native Hawaiian family lineage in ʻEwa Beach," noting that the pueo is the ʻaumakua for the Michael Lee family. He described the Project area as being within a "pueo (owl) foraging and breeding ecosystem," and stated that historic records indicate the pueo is most abundant on the slopes from Puʼu Kapuaʼi to West Loch. He added that "Hunehune Gulch, Kaloʼi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from

mountain to sea to court, mate, forage, and raise their brood." Mr. Berg also provided input that the Project area is inhabited by the ōpe'ape'a, noting that in 1910, the species was documented by the State of Hawaiʻi within a half-mile of the Project area. While ʻōpeʻapeʻa are rarely documented as ʻaumakua, they fit the intersection of classes of animals (mammal and bird) and intersection of two domains (air and land) that would make them an appropriate manifestation of the ʻaumakua (Valeri, 1985). Both pueo and ʻōpeʻapeʻa are greatly celebrated in the moʻolelo of Hawaiʻi's past.

3.6.2 Potential Impacts and Mitigation Measures

Based on information gathered as part of the community consultation, the participants in the CIA process provided input regarding potential Project-related impacts to cultural resources. Mr. Shad Kāne stated he is not in opposition to the Project, noting that the Project area has been previously disturbed by sugarcane production.

Ms. Lynette Paglinawan expressed concern regarding the effects of the Project on the ao kuewa, the realm of the homeless spirits. Based on input provided by Ms. Paglinawan, it is understood that "the area from Waimānalo Gulch over to Kapolei to the location of UHWO was known by very early residents there to be the place where ao kuewa, wandering spirits, congregated from makai to mauka up Pālehua and especially near the cluster of wiliwili trees in Kaupeʻa." Ms. Paglinawan stated that the development of the moku of ʻEwa including the ahupuaʻa of Honouliuli resulted in the displacement of the ao kuewa, noting that "we destroyed the habitat of the ao kuewa which is the wiliwili trees." She expressed her concerns regarding the effect of the Project on the ao kuewa, which she believes are attracted to energy. She also expressed her concerns of the effect of the spirits on the solar panels, noting "that's high energy. It will be like going to the game room." Ms. Paglinawan stated that the Project should be mindful of the locations of ancient trails, as these are still used by spirits to travel from mauka to makai within Honouliuli Ahupuaʻa. Ms. Paglinawan also recommended planting "a wall of trees" surrounding the Project area as restitution to the spirits who may be displaced by the Project; she also noted that planting of "a wall of trees" around the Project area would have other benefits including the production of oxygen and providing a habitat for Native Hawaiian birds. Finally, Ms. Paglinawan expressed concern regarding psychological impacts for the people that encounter the spirits, noting trauma on workers at the UH West Oʻahu, as well as families who live in the area. She was particularly concerned for the children who encounter these spirits, noting her belief that children "see many more things than adults do." As described in Section 2.2.4, it is anticipated that landscaping for the Project would incorporate trees and shrubs in key locations and would include native species that are ecologically and culturally appropriate for this location.

Mr. Tom Berg expressed concern for the pueo and ōpe'ape'a, stating that the Project will "encroach on prime pueo habitat, considered to be graded A+ - 'a ten' - when it comes to the degree of pueo habitat in use on this project site." Mr. Berg expressed concern that the "property in question will not receive the proper protocol to conclude no endangered species inhabit the area." He recommended that "a thorough and complete protocol is adopted to repeat the inventory exercise for pueo and ʻōpeʻapeʻa over the course of a calendar year would be in order so the Project does not inadvertently contribute to

more endangered species habitat loss." He also recommended consulting with Dr. Melissa Price and Dr. Javier Cotín (The Pueo Project) and Afsheen Siddiqi (DOFAW) regarding pueo survey protocol. In addition, Mr. Berg also expressed his concern for the possible negative aspects of lighting operations at an adjacent parcel which may reflect off of a solar panel into "the flight patterns of migrating birds and the ʻōpeʻapeʻa and pueo in particular need to be addressed."

As discussed in Section 3.4, consistent with the recommendations provided, both Dr. Melissa Price (Pueo Project researcher) and Afsheen Siddiqi (DOFAW biologist) were consulted and surveys were conducted for pueo following the Pueo Project survey protocol (Price and Cotín, 2018). Focused surveys were not conducted for the Hawaiian hoary bat; however, potentially suitable foraging was noted as part of the general biological survey. Although neither pueo nor Hawaiian hoary bat were observed within the Project area, both could potentially occur and have been previously documented in proximity to the Project area. Recommended avoidance and minimizations measures identified by USFWS and DOFAW, as well as input from Pueo Project researchers, have been incorporated into the Project. With implementation of the avoidance and minimization measures listed in Section 3.4.2.3, the Project would not be expected to significantly affect either pueo or the Hawaiian hoary bat; additional detail is provided in Section 3.4.

As previously discussed, no historic trails are known to be extant within the Project area. As such, development of the Project area would not be expected to impact traditional Hawaiian trails or access to upland resources.

3.6.2.1 Ka Paʻakai Analysis

In Ka Paʻakai v. Land Use Commission, 94 Hawaiʻi 31, 74, 7 P.3d 1068, 1084 (2000), the Court held the following analysis be conducted:

- The identity and scope of valued cultural, historical, or natural resources in the petition area, including the extent to which traditional and customary native Hawaiian rights are exercised in the project area;
- The extent to which those resources–including traditional and customary native Hawaiian rights–will be affected or impaired by the proposed action; and
- The feasible action, if any, to be taken by the Land Use Commission to reasonably protect native Hawaiian rights if they are found to exist.

As described above, no cultural resources, practices, or beliefs have been identified as existing within the Project area, nor is there any indication that traditional or customary Native Hawaiian rights are currently being exercised within any portion of the Project area. Although traditional Hawaiian trails were used to travel across the ahupuaʻa and for access to the nearby uplands, none of these trails are believed to be have been located within the Project area.

Based on information gathered from the cultural and historical background, and the community consultation, culturally significant resources have been identified elsewhere within Honouliuli Ahupuaʻa.

Although not within the Project area, documentation and testimony indicates traditional or customary Native Hawaiian rights are possessed and are currently being exercised within Honouliuli Ahupuaʻa by ahupuaʻa tenants who are descendants of Native Hawaiians who inhabited the Hawaiian Islands prior to 1778 (Hawaiʻi State Constitution, Article XII, Section 7). While no cultural resources, practices, or beliefs were identified as currently existing within the Project area, Honouliuli Ahupuaʻa maintains a rich cultural history in the exercising of traditional or customary Native Hawaiian rights. The Project is not expected to affect or impair traditional and customary Native Hawaiian rights exercised elsewhere in Honouliuli Ahupuaʻa. Additional detail supporting the Ka Paʻakai Analysis is provided in the Draft CIA Report (Appendix G).

3.7 Land Use

3.7.1 Affected Environment

3.7.1.1 General Land Use

Historically, the area within and surrounding the Project area was put into cultivation in the 1920s as part of an extensive sugar cane and pineapple plantation that extended across Oʻahu's ʻEwa Plain. The plantation included agricultural fields, irrigation and other associated infrastructure, as well as plantation camps and housing. Since closure of the plantation in the 1990s, the Project area has not been cultivated and has been used intermittently for cattle grazing. As discussed in Section 2.1.7, agricultural activities within the Project area are constrained by the arid conditions, lack of infrastructure, and uncertainty of water availability for irrigation.

The Project area and surrounding lands are part of a 991-acre area referred to as the UH West Oʻahu Mauka Lands property, which was acquired as part of the development of the UH West Oʻahu campus; approximately 273 acres of this property, including the Project area, was identified in their Land Use Plan for development of an energy farm (UH, 2015).

Surrounding land uses include open space and a range of agricultural, industrial, residential, and other uses. The southern and western portions of the property are bordered by vacant land, with Makakilo Quarry and the residential community of Makakilo located just beyond. The area to the north generally comprises open space associated with the Waiʻanae Mountains. To the northeast is the former Honouliuli Internment Camp site, which NPS is currently working to incorporate as a National Monument. The eastern portion of the property is bordered by Honouliuli Gulch and a variety of agricultural operations; further east is Kunia Road and the Village Park community. The southeastern edge of the property is bordered by the H-1 Freeway, beyond which is the UH West Oʻahu campus and the city of Kapolei.

3.7.1.2 Land Use Controls

Land use in Hawaiʻi is generally controlled by state land use and county zoning designations. Under HRS Chapter 205-2, the State Land Use Commission has the authority to designate all land within the state as one of four districts - urban, rural, agricultural, or conservation - based on the general activities and uses

of the land. Land use is also regulated by the various counties through zoning boundaries, within which development standards are specified for various activities. The relevant state and county land use designations are briefly described below and are further discussed in Section 5.

State Land Use District

As shown in Figure 3-3, the Project area is entirely within the state agricultural district. HRS Chapter 205 specifies the uses that are permitted within the agricultural district, with consideration given to the LSB classification system. The LSB system rates the agricultural productivity of soils throughout the state based on characteristics including texture, slope, salinity, erodibility, and rainfall, and designates areas in categories ranging from A to E (with Class A representing the most productive soils and Class E representing the least productive soils). As shown in Figure 3-4, the Project area includes areas that have been designated as having LSB Class B, D and E soils.

Pursuant to HRS Chapter 205-2(d), solar energy facilities are a permitted use within the state agricultural district; however, as further clarified in HRS Chapter 205-4.5, those facilities in areas with LSB Class B and C soils require an SUP and must meet certain conditions relating to agricultural activities and decommissioning. Specifically, these conditions identified in HRS Chapter 205-4.5(a)(21) require that (A) the area occupied by the solar energy facilities is also made available for compatible agricultural activities at a lease rate that is at least fifty percent below the fair market rent for comparable properties; (B) proof of financial security to decommission the facility is provided to the satisfaction of the appropriate county planning commission prior to date of commencement of commercial generation; and (C) solar energy facilities shall be decommissioned at the owner's expense, with equipment removed within 12 months of the conclusion of operation and restoration of disturbed earth to substantially the same physical condition as existed prior to development of the facility.

Important Agricultural Lands

In addition to establishing the state land use districts, HRS Chapter 205 (Part III) establishes the basis for designation of important agricultural land (IAL) as a means to conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency, and assure the availability of agriculturally suitable lands. HRS Chapter 205-42 defines IALs as those lands that "(1) are capable of producing sustained high agricultural yields when treated and managed according to accepted farming methods and technology; (2) contribute to the State's economic base and produce agricultural commodities for export or local consumption; or (3) are needed to promote the expansion of agricultural activities and income for the future, even if currently not in production."

HRS Chapter 205 identifies specific standards and criteria for the identification of IALs and establishes three processes by which IALs may be designated: (1) identification and designation of public lands per HRS Chapter 205-44.5; (2) voluntary petition by a landowner per HRS Chapter 205-45; and (3)

mandatory identification of potential IALs by each county per HRS Chapter 205-47.[15] No portion of the Project area is designated as IAL. As state-owned land, the Project area was not included in the City & County of Honolulu's recommendation of lands for IAL designation per Resolution No. 18-233, CD1, FD1 (Honolulu City Council, 2019).

City & County of Honolulu Zoning Designation

The Project area is entirely within the City & County of Honolulu Restricted Agricultural (AG-1) zoning district, as shown in Figure 3-5. The City & County of Honolulu's Land Use Ordinance (LUO) identifies the uses that are considered appropriate in each zoning district and the minimum standards and conditions that must be met if those uses are to be permitted. As further discussed in Section 5.2.3, the Project is expected to be considered a "Type B utility installation" per DPP's Solar Farm Guidelines (DPP, 2019). According to LUO Table 21-3 (Master Use Table), which specifies the permitted uses and structures in each zoning district, Type B utility installations are permitted in all zoning districts with issuance of a Conditional Use Permit (CUP) minor, subject to compliance with the specific development standards, district development standards and general development standards outlined in the LUO.

3.7.2 Potential Impacts and Mitigation Measures

The Project area comprises approximately 97 acres, all within the state agricultural district and county AG-1 zoning district, as described above. While the primary land use would change to accommodate the solar energy generation and storage components, the Project area would also be made available for compatible agricultural uses, including beekeeping and cattle production and grazing. As described in Section 2.1.7, use of the Project area for other agricultural uses, such as cultivation of crops, is not feasible due to the arid conditions, lack of infrastructure, and uncertainty of water availability for irrigation.

As described above and shown on Figure 3-6, the Project equipment would occupy areas designated as having LSB Class B, D, and E soils. Table 3-3 provides the approximate acreage of each LSB soil class within the permanent footprint of the Project facilities, as well as the approximate acreage of each LSB soil class within the overall Project area. As shown, the Project facilities would permanently occupy only a fraction of the overall Project area, with less than five percent of the Project area's LSB Class B soils and less than one percent of the Project area's LSB Class D and E soils within the permanent Project footprint. Pursuant to HRS Chapter 205-4.5, the Project is a permitted use on these soil types with issuance of an SUP, assuming compliance with the provisions described in Section 3.7.1, which relate to decommissioning, proof of financial security, and making the Project area available for compatible agricultural activities at a lease rate below fair market rent. As no portion of the Project area has been designated as IAL, the Project would be in compliance with HRS Chapter 205 (Part III).

[15] This requirement involves identification and mapping of potential IALs by the county planning department (with input through a public involvement process), submittal to the county council for decision-making, and transmittal to the Land Use Commission for further action.

At the county level, the Project is a permitted use with issuance of a CUP minor, assuming compliance with the applicable standards identified in the LUO. Additional detail regarding compliance with the provisions of HRS Chapter 205 (and the SUP process) and the LUO standards (and CUP minor permit process) is provided in Sections 5.1.1 and 5.2.3, respectively.

Table 3-3. Project Acreage by LSB Soil Classification

Area	LSB Soil Class (acres)					Total Area (acres)
	A	B	C	D	E	
Permanent Footprint of Project Facilities[1,2]	0.0	2.04	0.0	0.15	0.003	2.2
Overall Project Area	0.0	47.7	0.0	36.0	13.1	96.8
Percentage of Project Area Occupied by Project Footprint	0.0%	4.3%	0.0%	0.4%	0.02%	2.3%

[1] Additional detail regarding calculation of the permanent project footprint is provided as part of Table 2-1.

As of 2018, a total of approximately 127,698 acres on O‘ahu (or approximately 33 percent of the island) were designated within the state agricultural district (DBEDT, 2019b). A recent USDA census indicates that approximately 71,795 acres on O‘ahu are occupied by farmland, with approximately 23,067 acres of crops (USDA, 2019). These data suggest that an extensive amount of land within the agricultural district on the island of O‘ahu are fallow or are otherwise not actively used for agricultural purposes. This trend is evident in the general vicinity of the Project area, with a substantial amount of available agricultural land that is currently unused, including areas within the broader UH West O‘ahu Mauka Lands property.

Given the local land use context, the lack of infrastructure, uncertainty of water availability for irrigation and associated site constraints, and that the Project area would be made available for ongoing compatible agricultural uses, implementation of the Project would not have a significant adverse impact on agricultural production. Rather, it would balance the state’s renewable energy and agricultural needs, and would allow for productive, sustainable use of the land. The Project area would comprise less than 10 percent of the overall 991-acre UH West O‘ahu Mauka Lands property and would not preclude future agricultural activities from occurring on the remainder of this land. The permanent footprint of the Project facilities would occupy a small fraction of the Project area, with the remaining area available for compatible agricultural uses. Furthermore, at the end of the Project’s operational life, the facilities would be decommissioned, and the Project area would be returned to its existing condition (or comparable), thereby maintaining the potential for a full range of future agricultural activities. As the Project would comply with the provisions of HRS Chapter 205 and the LUO, it is considered a permitted use and conforms with both the state and county’s intended land use for this area. For all of the above reasons, Project implementation would not have a significant adverse impact on land use.

3.8 Visual Resources

3.8.1 Affected Environment

The Project area is located on the lower slopes of the southern Waiʻanae Mountains and is surrounded by the ʻEwa plain, which is an expansive plain extending from the base of the Waiʻanae Mountains to the shoreline. The topography of the site is relatively flat to moderately sloping, with elevations ranging from approximately 280 – 675 feet amsl. Given the geography, the visual setting of this region includes broad sweeping views across the ʻEwa plain, with the Waiʻanae Mountains and Pacific Ocean as the backdrop.

As described throughout this document, much of the ʻEwa District was historically part of an extensive agricultural plantation with cultivation of sugar cane and pineapple, which contributed to the overall rural character of the district with views dominated by expansive agricultural fields and the surrounding natural features. This area was subsequently designated by the City and County of Honolulu's General Plan and ʻEwa Development Plan as the island's secondary urban center, thus directing future growth and promoting rapid development throughout the region. A wide range of commercial, industrial, residential, and recreational, and government facilities have been constructed and are continuing to be installed within the City of Kapolei and the surrounding areas.

Given the extent of urbanization in this region, the built environment is now a dominant component of the visual setting, while the natural landscape still serves as a backdrop. Within Kapolei and the surrounding communities in the ʻEwa District, the viewshed is generally characterized by urbanization and associated man-made features, such as residential structures, commercial buildings, industrial development, as well as the in-progress Honolulu Rail Transit system, which includes an elevated guideway and associated facilities. Despite the extent of development, there remain frequent opportunities for views of the surrounding natural landscape, including the Waiʻanae Mountains and the Pacific Ocean, from areas within and surrounding the urban center. Major roadways that provide landscape views toward the Waiʻanae Mountains in the vicinity of the Project area include H-1 Freeway and Farrington Highway (which run parallel to the southern edge of the Project area) and Kualakaʻi Parkway and Kunia Road (which run perpendicular to the southern edge of the Project area).

Important public views and vistas in this region are identified in Table 3-2 of the ʻEwa Development Plan; these include views of the Waiʻanae Mountains from H-1 Freeway between Kunia Road and Kaloʻi Gulch and from Kunia Road, and general mauka and makai views (DPP, 2013).

3.8.2 Potential Impacts and Mitigation Measures

Visual impacts are generally defined in terms of a project's physical characteristics and potential visibility, as well as the extent to which the project's presence would change the perceived visual character and quality of the environment in which it would be located. Importantly, the Project is a temporary use, limited by the 25-year PPA. At the end of the Project's operational life, decommissioning would include removal of all equipment associated with the Project and returning the Project area to

substantially the same condition as existed prior to Project development as required by HRS Chapter 205-4.5(a)(21). During construction and operation, where visible and noticeable, the Project may introduce visual contrast and have the potential to create visual effects within the surrounding areas. The potential visual effects anticipated as a result of construction and operation of the Project are discussed below.

3.8.2.1 Methodology

An initial assessment of the geographic extent of potential Project views was conducted through a viewshed analysis, which evaluated potential visibility of the solar photovoltaic modules at distances up to 5 miles from the Project area. This analysis focused on the solar photovoltaic modules because they are the Project component that would occupy the most space, and therefore, would introduce the greatest source of contrast into the landscape setting. The viewshed anlaysis assumed "bare earth" conditions, meaning identification of areas with potential views of the Project were based on topography only. As a result, the analysis is conservative as it does not account for screening by intervening structures, vegetation or other features. Based on the viewshed analysis, it is anticipated that potential views of the Project would be primarily from the southeast, east and northeast, with limited areas of potential visibility in higher-elevation areas to the west and southwest.

The results of the viewshed analysis were used to identify specific locations for further assessment of potential visibility; these locations are referred to as representative viewpoints. Photographs of the Project area were taken from the representative viewpoints and were used to prepare photographic simulations to illustrate potential views of the Project. Seven representative viewpoints, which generally represent locations with high levels of viewer sensitivity and/or potential for impacts to existing visual resources, were selected for development of simulations. The simulations allow for a comparison of the existing landscape and the expected landscape once the Project is constructed.

Potential visual impacts were characterized by determining the level of visual contrast introduced by the Project based on comparing existing conditions and photo simulations. Visual contrast is a means to evaluate the level of modification to existing landscape features. Existing landscape is defined by the visual characteristics (form, line, color, and texture) associated with the landform (including water), vegetation, and existing development. The level of visual contrast introduced by a project can be measured by changes in the visual characteristics that would occur as a result of project implementation. The greater the difference between the character elements found within the existing landscape and with a proposed project, the more apparent the level of visual contrast. The following general criteria[16] were used when evaluating the degree of contrast:

- None—The element contrast is not visible or perceived
- Weak—The element contrast can be seen but does not attract attention

[16] These criteria are based on the Bureau of Land Managements (BLM) Visual Resource Management (VRM) system, a process using the concept of "contrast" to objectively measure potential changes to the landscape features.

- Moderate—The element contrast begins to attract attention and begins to dominate the characteristic landscape
- Strong—The element contrast demands attention, would not be overlooked, and is dominant in the landscape

The degree of visibility of the Project based on this analysis is discussed in the following section.

3.8.2.2 Potential Effects Analysis

Construction Impacts

Short-term visual effects would occur during construction of the Project as a result of construction activities on the site and the presence of equipment and crews. As described in Section 2.2, construction activities associated with the solar and battery storage facilities would include clearing portions of the Project area, grading and stockpiling soil, trenching for installation of electrical wiring and collector lines, excavation for the equipment pads and substation foundation, delivery and installation of the Project components, and installation of service roads and perimeter fencing. These activities would be visible to varying degrees from surrounding locations, including nearby roadways (such as H-1 Freeway, Farrington Highway, Kualakaʻi Parkway, Kunia Road and local streets), as well as from surrounding residential neighborhoods and public spaces. In many areas, intervening structures and vegetation screen views toward the Project area, such that resulting views are either fragmented or blocked; however, unobstructed views occur in some locations. For example, travelers along H-1 Freeway, Farrington Highway and Kualakaʻi Parkway would have unobstructed views within the foreground as they approach the Project area; residents around the perimeter of nearby neighborhoods, particularly those located on the lower slopes of the Waiʻanae Mountains with an elevated viewing position, would also have clear views toward the Project area. Construction activities would be visible from these locations but would be seen in the context of surrounding development including high-voltage transmission lines, Makakilo Quarry and the in-progress rail transit system. Furthermore, visual impacts associated with construction activities would be short-term, as construction equipment and crews would be removed from the Project area once construction is complete.

Operation and Maintenance Impacts

During the 25-year lifetime of the Project, visual effects associated with operation and maintenance of the Project would result from the visibility of the above-ground Project components, including the solar photovoltaic modules, battery units and associated electrical equipment, substation and interconnection facilities, and perimeter fencing. Based on the viewshed analysis, it is anticipated that views would be primarily from areas southeast, east and northeast of the Project area. Overall, the solar photovoltaic modules are expected to be the most visually prominent component of the Project. The regular geometric forms and strong horizontal and vertical lines associated with the modules would contrast with the organic forms and natural colors of the existing landform and vegetation; in some cases, this effect would be diminished by the geometric shape of nearby agricultural fields. The dark, bluish-gray color of the modules would be set against the dull green and brown hues of the surrounding vegetation; in addition, the color contrast associated with the modules would vary throughout the day

as the sun moves across the sky. Although the modules would contrast with elements of the existing landscape, their overall visual effect would vary depending on the extent of visibility, distance of the viewer, and the surrounding context of other existing modifications to the natural landscape. For example, it is anticipated that contrast would be stronger for viewers located within approximately one mile and with unobstructed views of the Project area. Contrast is anticipated to be weaker for viewers that are located at a greater distance (as texture and color become muted and less detailed) and in areas that are screened by topography and/or structures associated with intervening residential and commercial development.

In addition to the contrast added by the solar photovoltaic modules, the substation and interconnection facilities would introduce vertical and geometric structures into the landscape; the substation equipment would generally consist of open metal structures and the interconnection equipment would include three 60-foot-tall wood poles. Similarly, the perimeter fence would add an additional vertical element to the Project area. These features would also contrast with the surrounding natural environment, though they are not likely to be as prominent as the solar arrays and would be smaller than existing transmission lines and structures throughout the region.

As described above, the Project would be visible to varying degrees from surrounding locations; the most prominent views are expected to be from segments of nearby roadways approaching the Project area and from some residences along the perimeter of nearby neighborhoods. As further discussed below, views from the Makakilo neighborhood, located to the west, would be partially blocked by intervening topography. From residential areas located to the south and east, views toward the Project area are dominated by the broader Waiʻanae mountain range; the Project area would be located on the lower slopes of the mountains and in many cases would be screened by intervening development and/or vegetation. Where visible, the Project would be seen in the context of other man-made modifications which have introduced vertical and/or geometric forms and colors that contrast with the natural landscape setting, including residential and commercial structures, high-voltage transmission lines and structures, roadways, Makakilo Quarry and the in-progress rail transit system. The presence of these existing features reduces the form, line, and color contrast introduced by the Project components. Furthermore, in most instances, the Project is seen in the background, beyond the existing development, which helps to reduce scale contrast presented by the Project. The solar photovoltaic modules may attract attention but would not be a dominant feature in the landscape due to the distance of the Project from the viewer and the existing development in which the Project would be seen. As such, it is expected that visual contrast would generally be weak.

As noted in Section 3.8.1, important public views are identified in Table 3-2 of the ʻEwa Development Plan and include views of the Waiʻanae Mountains from H-1 Freeway between Kunia Road and Kaloʻi Gulch and from Kunia Road, and general mauka and makai views (DPP, 2013). From the segment of H-1 Freeway between Kunia Road and Kaloʻi Gulch (as identified in the ʻEwa Development Plan), the majority of views toward the Project area are screened by topography and/or vegetation along the edge of the highway. The exception is a short stretch near Kaloʻi Gulch, where there is a break in the vegetation and travelers (eastbound and westbound) would have unobstructed views toward the

Project as they pass the Project area.[17] However, these views are expected to be very brief as travelers would only be adjacent to the Project area for a short distance, and their attention would likely be directed toward the road ahead. Furthermore, the viewplanes in this area are dominated by broader landscape views of the Waiʻanae Mountains and Pacific Ocean; the Project would be located on the lower slopes of the Waiʻanae Mountains and would not obstruct broader landscape views due to the low profile of the solar photovoltaic modules.

The segment of Kunia Road identified in the ʻEwa Development Plan has relatively open views toward the Waiʻanae Mountains as the road parallels existing agricultural fields. Northbound travelers would be parallel to the Project at the far southern end of Kunia Road (near the H-1 Freeway interchange), and views would most likely be focused toward the northwest along the full extent of the Waiʻanae mountain range. If northbound travelers were to look directly west, views toward the Project area would be partially screened by intermittent vegetation along the edge of Kunia Road. Furthermore, any visible portions of the Project would be seen at a distance of approximately 2 miles; at this distance, the solar arrays may be distinguishable, but their texture and color would be muted and less detailed, thus reducing contrast. Given the distance from the Project area and the limited viewing time from a moving vehicle, it is anticipated that the Project would create weak contrast or would not be perceived by northbound travelers. For southbound travelers, views would similarly be focused toward the Waiʻanae Mountains or south toward the ocean. Although the Project area is within the viewplane, it is partially screened by existing topography and is at a distance of approximately 2 to 3 miles. Furthermore, visible portions of the Project would be seen in the context of other development, including a high-voltage transmission and distribution lines and surrounding commercial development. Southbound travelers would have similar views as northbound travelers as they pass the Project near the H-1 Freeway interchange. Given the distance from the Project and existing man-made features that are also within the viewplane, it is anticipated that the Project (where visible) would create weak contrast for southbound travelers. Furthermore, the Project would not obstruct views of the Waiʻanae Mountains due to the low profile of the solar photovoltaic modules.

Typical views from the segments of H-1 Freeway and Kunia Road identified in the ʻEwa Development Plan are shown on Figure 3-7. As shown in these photographs and as described above, views toward the Project area would be at least partially blocked by existing topography, vegetation and intervening structures located along the roadway corridors; views of the broader Waiʻanae Range would not be affected, such that the Project would not be expected to substantially degrade these viewplanes.

[17] A visual simulation was not prepared from this specific location as it was considered to be unsafe to obtain photography from within the highway rights-of-way; however, the views are expected to be similar in nature to those illustrated in the simulation from the nearby Farrington Highway.

Visual Effects at Representative Viewpoints

This section presents the results of the site-specific impact evaluation based on the visual simulations (Figure 3-8) for the 25-year operational span of the Project. Thereafter, decommissioning would include removal of all equipment associated with the Project and returning the Project area to substantially the same condition as existed prior to Project development, as required by HRS Chapter 205-4.5(a)(21). The discussion for each representative viewpoint includes a brief introduction identifying the representative viewpoint location and setting, a description of the existing landscape conditions, and a summary of the with-Project conditions.

- **Representative Viewpoint 1 - Farrington Highway:** Farrington Highway runs parallel to the Project area and passes through a variety of urban development, agricultural and natural landscape settings. Views toward the Waiʻanae Mountains from along the highway vary from open to partially or completely screened. Farrington Highway passes within approximately one mile of the southern boundary of the Project area. In areas without screening, travelers along Farrington Highway near the Project area would have unobstructed views of the Project components. The geometric form and bluish-gray color of the solar modules would contrast with the surrounding muted green and brown hues of the surrounding vegetation. The scale, form and color of the solar photovoltaic modules would attract viewers' attention; however, due to the low profile of the solar arrays and the broader context of the Waiʻanae Mountains, the Project would not dominate landscape views. As such, the Project would introduce moderate visual contrast. These impacts would be short term because travelers would only be approaching and parallel to the Project area for a limited time and their focus would primarily be on the road ahead.
- **Representative Viewpoint 2 - Kualakaʻi Parkway near Mile Marker (MM) 1.5:** Kualakaʻi Parkway is a 2.5-mile-long highway that connects the H-1 Freeway to Kapolei Parkway. The parkway passes residential and other development, as well as agricultural lands. As shown in Figure 3-8, the rail transit system is being constructed parallel to Kualakaʻi Parkway, with the Keoneʻae station (and an associated elevated pedestrian walkway across the roadway) located approximately 1.2 miles southeast of the Project area. Views toward the Waiʻanae Mountains from along the parkway are generally open and unobstructed. Kualakaʻi Parkway ends at the H-1 Freeway, approximately 0.5 miles south of the Project area. Representative viewpoint 2 is located approximately 1.4 miles southeast of the Project area. Travelers along Kualakaʻi Parkway would have mostly open unobstructed views as they approach the Project, except where blocked by the rail transit facilities. Views of the Waiʻanae Mountains would remain unobstructed due to the low profile of the solar photovoltaic modules. Although the dark geometric forms contrast with the green and browns of the surrounding vegetation, the Project would be seen in the context of man-made modifications, most notably the rail transit system. Other man-made modifications include streetlights, a high-voltage transmission line along the east side of the roadway, buildings associated with the UH West Oʻahu campus, and the Makakilo Quarry. Due to the distance of the viewer from the Project and the existing man-made

modifications visible within the viewplane, the Project may attract attention but would appear as a subordinate feature to the other man-made modifications located closer to the viewer. As such, the Project would introduce weak visual contrast. These impacts would be short term because travelers would only be approaching the Project area for a limited time and their focus would likely be on the road ahead.

- **Representative Viewpoint 3 – Kualakaʻi Parkway near MM 0.5:** Representative Viewpoint 3 is located near the southern end of the Kualakaʻi Parkway, approximately 0.5 mile north of Kapolei Parkway. Along this segment of the parkway, views toward the Project area are partially screened by vegetation and/or development associated with UH West Oʻahu. This representative viewpoint is located approximately 2 miles south of the Project area. From this segment of Kualakaʻi Parkway, the Project would be partially visible. Views of the Waiʻanae Mountains would remain unobstructed due to the low profile of the solar photovoltaic modules. In addition, the dark gray geometric forms of the solar array would appear similar to some of the university building roofs, reducing contrast for form, line and color. At a distance of 2 miles, the form of the solar array would be distinguishable; however, the texture and color would muted and less detailed, further reducing contrast. Visible portions of the Project would also be seen in the context of other man-made features such as streetlights and high-voltage transmission lines. Given the distance of the viewer from the Project, the similarity of form and color as existing development, and the man-made modifications visible in the immediate foreground, the Project may attract attention but would appear as a subordinate feature. As such, the Project would introduce weak to no visual contrast. These impacts would be short term because travelers would only be approaching the Project area for a limited time and their focus would likely be on the road ahead.
- **Representative Viewpoint 4 - Geiger Park:** This viewpoint represents an approximately 10-acre community park located northwest of Geiger Road and Kapolei Parkway, approximately 3.5 miles southeast of the Project area. The park is surrounded by residential development and consists of baseball fields, tennis courts, playground and picnic areas. Patrons within the park have open views toward the Waiʻanae Mountains; however, the lower slopes of the mountains are partially screened by residential development and associated landscaping, including landscaping around the northern perimeter of the park. From this viewpoint, the Project would be completely screened by structures and existing vegetation. As such, the Project would not introduce visual contrast.
- **Representative Viewpoints 5 through 7 - Makakilo Neighborhood:** The Makakilo Neighborhood is located on the lower southern slopes of the Waiʻanae Mountains, just north of Makakilo Quarry, and approximately 0.3 miles from the western edge of the Project area. Residences located along the perimeter of the neighborhood have elevated open views either toward the Waiʻanae Mountains and/or the shoreline and ocean. From within the neighborhood, views of the surrounding landscape are primarily screened by residential development and associated landscaping. Views toward the Project area are generally limited to residences located along the

northeastern perimeter of the neighborhood who have elevated unobstructed views to the northeast. Portions of the Project would be screened by the rolling slopes of the surrounding mountains; however, the western extent of the solar arrays would be visible. The blue-gray color of the modules would contrast with the green and brown hues of the surrounding landscape. However, the blue-gray color of the modules and irregular form would be similar to other features that are visible in the background (e.g., Pearl Harbor). In addition, the Project would be seen in the context of surrounding urbanization, including residential and commercial development, roadways, and high-voltage transmission lines. Although the Project would attract attention due its close proximity to viewers, the Project would appear as a co-dominant feature with other development. As such, the Project would introduce moderate visual contrast for these residences.

As discussed throughout this section, the Project would be visible to varying degrees from surrounding areas during its 25-year operational period; however, it would not obstruct or impede views of the Waiʻanae Mountains, Pacific Ocean or other scenic resources. Thereafter, decommissioning would include removal of all equipment associated with the Project and returning the Project area to substantially the same condition as existed prior to Project development, as required under HRS Chapter 205-4.5(a)(21). The Project facilities would introduce new visual elements within the landscape, but these would be seen in the context of other development including high-voltage transmission lines, commercial and residential structures, the rail transit system, Makakilo Quarry and other man-made features. The Project area is located on the lower slopes of the Waiʻanae Range and views of the Project area from the H-1 Freeway and Kunia Road (as identified in the ʻEwa Development Plan) would be at least partially screened by existing topography, vegetation and intervening structures located along the roadway corridors; views of the broader Waiʻanae Range would not be affected, such that these identified viewplanes would not be substantially degraded. For these reasons, the Project is not expected to result in a significant adverse effect on visual resources.

3.8.2.3 Glare Analysis

In addition to introducing new elements into the visual landscape, the Project also has the potential to produce glare.[18] In general, solar modules are designed to absorb rather than reflect sunlight and incorporate a surface material that allows sunlight to pass with minimal reflection. The modules also have an anti-reflective coating that further reduces reflectivity. Regardless, solar facilities still have the potential to result in some degree of glare.

[18] As an industry standard, the term "glint and glare" analysis is typically used to describe an analysis of potential ocular impacts to defined receptors. As a point of clarification, ForgeSolar defines glint and glare in the following statement: "Glint is typically defined as a momentary flash of bright light, often caused by a reflection off a moving source. A typical example of glint is a momentary solar reflection from a moving car. Glare is defined as a continuous source of bright light. Glare is generally associated with stationary objects, which, due to the slow relative movement of the sun, reflect sunlight for a longer duration." Based on the ForgeSolar definitions of glint and glare and the stationary nature of the solar photovoltaic modules (fixed tilt), the potential reflectance from the Project is referred to as glare.

To evaluate the potential for glare associated with the Project, Tetra Tech completed a glare analysis using the Solar Glare Hazard Analysis Tool (SGHAT) software through an online tool (GlareGauge) developed by Sandia National Laboratories and hosted by ForgeSolar. The SGHAT software is considered an industry-best practice and conservative model that effectively models the potential for glare at defined receptors from solar energy generating facilities. It provides a quantitative assessment of (1) when and where glare has the potential to occur throughout the year for a defined solar array polygon, and (2) potential effects on the human eye at locations where glare is predicted. Based on the predicted retinal irradiance (intensity) and subtended angle (size/distance) of the glare source to receptor, GlareGauge categorizes potential glare where it is predicted by the model to occur in accordance with three tiers of severity (ocular hazards) that are shown by different colors in the model output. Red glare is glare that is predicted with a potential for permanent eye damage (retinal burn). Yellow glare is glare that is predicted with a potential for temporary after-image. Green glare is glare that is predicted with a low potential for temporary after-image. These categories of glare are calculated using a typical observer's blink response time, ocular transmission coefficient (the amount of radiation absorbed in the eye prior to reaching the retina), pupil diameter, and eye focal length (the distance between where rays intersect in the eye and the retina).

A total of three glare analyses were conducted for the Project. The first two analyses included three segmented traffic routes (H-1 Freeway, Farrington Highway, and Kualakaʻi Parkway) and three observation points from the surrounding community (to the west, south and east). Analysis 1 represents the point of view from an average first floor residential/commercial structure and typical commuter car, while Analysis 2 represents the point of view from an average second floor residential/commercial structure and typical semi-tractor-trailer truck. The third analysis included 14 final approach flight paths and two air traffic control towers (ATCTs) associated with Kalaeloa Airport (John Rodgers Field; JRF), Daniel K. Inouye International Airport (Honolulu International; HNL) and Wheeler Army Airfield (HHI). The location of each of these receptors is shown in Figures 3-9 and 3-10. A detailed discussion of the input features associated with each analysis is provided in the Glare Analysis Report, contained in Appendix H.

The results of the analysis indicate that none of the residential/commercial OPs would experience glare as a result of the Project. As summarized in Table 3-4, Analysis 1 and 2 predicted that a limited amount of green glare (the least severe type of glare) would occur at two segments along Farrington Highway (Farrington-1 and Farrington-2) and at two segments along H-1 Freeway (H1-2 and H1-3) southeast of the Project area. In addition, a very limited amount of yellow glare (85 combined annual minutes) was predicted along one segment of H-1 Freeway (HI-3). In addition, Analysis 3 predicted a limited amount of green glare along three of the final approach paths and the ATCT for Daniel K. Inouye International Airport, located approximately eight miles east of the Project. A detailed discussion of the results is provided in the Glare Analysis Report, contained in Appendix H.

Table 3-4. Summary of Predicted Glare at Defined Receptors

Receptor[1]	Type of Glare	Annual Minutes[2]	Minutes Per Day	Time of Day	Time of Year
Farrington-1	Green	1,608	Less than 15 min.	6:00 - 7:00 pm	April to May; mid-July to mid-September
Farrington-2	Green	4,840	Less than 15 min.	6:00 - 7:00 pm	April to mid-September
H1-2	Green	118	Less than 15 min.	6:00 - 7:00 pm	April to mid-May; August to mid-September
H1-3	Green	2,624	Less than 15 min.	6:00 - 7:00 pm	April to May; July to mid-September
H1-3	Yellow	50	Less than 5 min.	6:00 - 7:00 pm	Mid-May to mid-July
HNL RWY 22L	Green	847	Less than 10 min.	6:00 - 7:00 pm	Mid-April to May; mid-August to September
HNL RWY 22R	Green	866	Less than 10 min.	6:00 - 7:00 pm	Mid-April to May; mid-August to September
HNL RWY 26L	Green	2,149	Less than 10 min.	6:00 - 7:00 pm	Mid-May to August
HNL ATCT	Green	749	Less than 10 min.	6:00 - 7:00 pm	Mid-May to August

[1] The location of each receptor is shown in Figures 3-9 and 3-10.

[2] The annual minutes shown for each roadway segment is based on the results of Analysis 2 (the point of view from an average second floor residential/commercial structure and typical semi-tractor-trailer truck); these results are greater than those for Analysis 1 (the point of view from an average first floor residential/commercial structure and typical commuter car).

It is important to note that the GlareGauge model is conservative in that it does not account for varying ambient conditions (i.e., cloudy days, precipitation), atmospheric attenuation, intervening topography not located within the defined array layouts, or screening by existing or proposed vegetation and structures (including fences or walls). In the case of this Project, Pu'u Kapuai and other topographic features associated with the Wai'anae Mountains are located to the west and northwest of the Project and may shade the Project from the sun's position during the evening hours at certain times of the year. In addition, an existing berm and vegetation is located along portions of the northern side of H-1 Freeway, which would be expected to at least partially screen Project views from vehicular traffic along the modeled segments of H-1 Freeway (see Figure 3-7); views of portions of the Project from vehicular traffic along the modeled segments of Farrington Highway may also be intermittently screened by vegetation and other existing features.

As summarized in Table 3-4, occurrences of glare resulting from the Project are expected to be limited; any glare experienced would occur intermittently in the evening hours and would not occur for a period longer than 15 minutes. Furthermore, based on the conservative nature of the model, the results may predict glare at locations where glare will not actually be experienced, such that actual glare conditions are likely to be less than predicted. For these reasons, glare impacts associated with the Project are expected to be minimal. The glare analysis results are further discussed relative to applicable Federal Aviation Administration (FAA) requirements in Section 3.12.2.5.

3.9 Air Quality

3.9.1 Affected Environment

In general, the existing air quality in the vicinity of the Project area is considered to be relatively good because of the low levels of development and exposure to trade winds which help to disperse emissions. The main sources of pollutant air emissions in this region are associated with emissions from vehicles on Interstate H-1 and other nearby roadways, as well as dust and other air pollutants associated with ongoing quarry and agricultural activities on nearby properties.

Under the authority of the Clean Air Act, the EPA has established nationwide air quality standards to protect public health and welfare. These federal standards, known as National Ambient Air Quality Standards (NAAQS), represent the maximum allowable atmospheric concentrations for six criteria pollutants: carbon monoxide (CO), nitrogen dioxide (NO_2), SO_2, ozone, lead, and particulate matter (respirable particulate matter less than or equal to 10 micrometers in diameter [PM_{10}] and respirable particulate matter less than or equal to 2.5 micrometers in diameter [$PM_{2.5}$]). The NAAQS are based primarily on evidence of acute and chronic (or short-term and long-term) health effects and apply to outdoor locations to which the general public has access. Primary standards relate to limits for protection of public health; secondary standards relate to limits for protection of public welfare (e.g., decreased visibility; damage to animals, crops, and vegetation). Based on measurements of ambient criteria pollutant data, the EPA designates areas as having air quality equal to or better than NAAQS (attainment) or worse than NAAQS (non-attainment). Hawai‘i is designated as having attainment status for all criteria pollutants[19] (DOH, 2016).

Pursuant to HRS Chapter 342B (*Air Pollution Control*), the Clean Air Branch of the State of Hawai‘i Department of Health (DOH) is responsible for implementing air pollution control in the State and has established Hawai‘i ambient air quality standards (HAAQS), which in some cases are more stringent than the comparable federal standards or address pollutants that are not covered by the federal standards. The HAAQS are based primarily on health effects data, but also reflect other considerations, such as protection of crops, protection of materials, or avoidance of nuisance conditions (such as objectionable odors). Both the federal and state ambient air quality standards are listed in Table 3-5.

[19] The monitoring stations near Kilauea volcano on Hawai‘i Island regularly exceed the NAAQS for SO_2 and occasionally exceed the NAAQS for $PM_{2.5}$. The volcano is considered a natural, uncontrollable event; therefore, the State requests exclusion of these exceedances from the determination of attainment.

Table 3-5. Federal and State Ambient Air Quality Standards

Air Pollutant	Averaging Time	Ambient Air Quality Standards		
		Hawai`i State Standard (ppm)	Federal Primary Standard (ppm)	Federal Secondary Standard
Carbon Monoxide (CO)	1-hour	9 ppm	35 ppm	--
	8-hour	4.4 ppm	9 ppm	--
Nitrogen Dioxide (NO_2)	1-hour	--	0.1 ppm	--
	Annual	0.04 ppm	0.053 ppm	0.053 ppm
PM_{10}	24-hour	150 µg/m^3	150 µg/m^3	--
	Annual	50 µg/m^3	--	--
$PM_{2.5}$	24-hour	--	35 µg/m^3	35 µg/m^3
	Annual	--	12 µg/m^3	15 µg/m^3
Ozone (O_3)	8-hour	0.08 ppm	0.07 ppm	0.07 ppm
Sulfur Dioxide (SO_2)	1-hour	--	0.075 ppm	--
	3-hour	0.5 ppm	--	0.5 ppm
	24-hour	0.14 ppm	--	--
	Annual	0.03 ppm	--	--
Lead (Pb)	3-month (rolling)	1.5 µg/m^3	0.15 µg/m^3	0.15 µg/m^3
Hydrogen Sulfide	1-hour	0.025 ppm	--	--

ppm = parts per million by volume; µg/m^3 = micrograms per cubic meter of air

SOURCE: HAR §11-59 and *Code of Federal Regulations* (CFR), Title 40, Part 50.

EPA and DOH maintain a network of air quality monitoring stations throughout the islands. The closest air quality monitoring station to the Project site is in Kapolei, approximately 4 miles southwest of the Project site. The station is located within Kapolei Business Park (approximately 1.5 miles from Malakole Street in Campbell Industrial Park). This station was established in 2002, with the primary objective of monitoring for population exposure. All of the NAAQS and HAAQS pollutants are monitored at this station. Available data from the Kapolei station indicate that criteria pollutant levels remain below both the State and Federal ambient air quality standards (DOH, 2019).

3.9.2 Potential Impacts and Mitigation Measures

Construction of the Project would result in short-term impacts to air quality, primarily as a result of vehicle exhaust emissions and fugitive dust particles from disturbed soils. Vehicle exhaust emissions would be generated by heavy construction equipment operating within the Project area, trucks delivering construction materials and Project components to the site, and vehicles used by construction workers commuting to and from the Project area. These activities would result in emissions of air pollutants including CO_2, nitrogen oxides, sulfur oxides, PM_{10}, and $PM_{2.5}$.

Emissions would occur over the approximately 9-month construction period, with potential impacts generally limited to areas within and immediately surrounding the Project area. Given the nature of the construction activities, the emissions would be temporary, intermittent, and localized in nature. In comparison to overall emissions in the region, these contributions are relatively small and would not be expected to affect attainment of the federal or state ambient air quality standards.

State law (HAR §11-60.1, Air Pollution Control) requires that the best practical operation or treatment be implemented during construction activities such that there is not discharge of visible fugitive dust beyond the property lot line. To comply with these requirements and to minimize any other adverse effects on air quality, the BMPs listed below would be implemented (in addition to those listed in Section 3.3.2). With implementation of these BMPs, construction-related impact to air quality are expected to be less than significant.

- All construction vehicles and equipment would be properly maintained according to manufacturer's specifications.
- To the extent feasible, off-road and portable diesel powered equipment, including but not limited to bulldozers, graders, cranes, loaders, scrapers, backhoes, generator sets, compressors, auxiliary power units, would be fueled with motor vehicle diesel fuel.
- The number of vehicles accessing and moving within the project area would be limited to the extent possible. Vehicles speed on unpaved roads within the Project area would be limited to 25 miles per hour or less.
- Vehicles and equipment would not be allowed to idle for extended periods of time (i.e., more than 20 minutes).
- All trucks hauling soil or other loose materials would be covered.
- Water trucks or sprinkler systems (with no chemical additives) would be used to control fugitive dust within the Project area.
- Carpooling among construction workers would be encouraged to minimize construction-related traffic and associated emissions.

As previously described, areas that have been temporarily disturbed would be revegetated, and the vegetation would be actively monitored and maintained at levels necessary to minimize the potential for erosion and fugitive dust. Operation of the Project would result in minor emissions associated with vehicle exhaust and fugitive dust from vehicles and equipment used to perform operation and maintenance activities, as well as those associated with compatible agricultural activities. As described in Section 3.12, it is estimated that there would be no more than four one-way vehicle trips per day for routine operations and maintenance of the solar facilities over the lifetime of the Project. None of the equipment associated with the solar arrays, battery units and ancillary facilities (e.g., inverters and control equipment, transformers, switches, etc.) emit air pollutants of any kind. Consequently, it is anticipated that emissions associated with Project operations and maintenance would be very low and

would not significantly affect air quality. At a broader scale, as discussed in Section 3.1, the Project would provide a net benefit by replacing energy generated by burning fossil fuels with renewable energy, thereby reducing emissions of greenhouse gases.

At the end of operations, the Project would be decommissioned with all Project equipment removed and the site returned to existing conditions (or similar). Similar to construction, these activities would result in short-term impacts associated with vehicle exhaust emissions and fugitive dust particles from disturbed soils; the previously-referenced BMPs would be implemented to minimize these emissions. Given the temporary nature of decommissioning activities, and with implementation of BMPs, impacts to air quality as a result of decommissioning would be less than significant.

3.10 Noise

3.10.1 Affected Environment

The degree of audibility of a new or modified sound source is dependent in a large part upon the relative level of the existing acoustic environment. The assessment of the acoustic environment considers all areas that could be potentially affected by construction or operational noise resulting from the Project and includes a wide range of noise settings.

The Project area, as well as the adjoining parcels, are within the Restricted Agriculture (AG-1) zoning district (see Figure 3-5). As discussed in Section 3.7, other nearby land uses include open space, industrial and residential areas. Land to the northwest of the Project area consists of forested or other natural landscapes associated with Pālehua and the slopes of the Waiʻanae Mountains. The former Honouliuli Internment Camp site, which NPS is working to incorporate as a National Monument, is located approximately 1 mile to the northeast. Makakilo Quarry, an active quarry which is a significant source of industrial noise resulting from blasting, heavy machinery, and trucking, is located approximately 0.6 mile southwest of the Project area. Residential areas in Makakilo are located just north of the quarry, with the closest residential structure approximately 0.3 mile from the Project area. The UH West Oʻahu campus is located approximately one mile south of the Project, on the other side of the H-1 Freeway. In the vicinity of the Project area, the H-1 Freeway is a two-way, six-lane divided highway.

Noise sensitive receptors include residences, outdoor public facilities and areas, hospitals, schools and other similar facilities. The Honouliuli National Monument, Makakilo residences, and UH West Oʻahu campus are all considered noise sensitive receptors.

3.10.1.1 Noise Standards

The State of Hawaiʻi has adopted statewide noise standards, set forth in HAR §11-46 ("Community Noise Control"); these are administered by DOH. The stated purpose of the standards is to "provide for the prevention, control, and abatement of noise pollution in the State from the following noise sources: stationary noise sources (such as air-conditioning units, exhaust systems, generators, compressors, and pumps); and equipment related to agricultural, construction, and industrial activities." Sound from

ongoing maintenance activities is considered part of routine operation and the combined total of ongoing maintenance and routine operation are subject to the sound level limits. Sound from construction and the occasional, major equipment overhauls during operations and maintenance is regulated as construction activity.

The noise standards are the maximum permissible sound levels, as measured from the property line, and vary according to underlying zoning district. The daytime and nighttime maximum permissible sound levels for the three classes of receiving zoning districts, provided in A-weighted decibels (dBA), are summarized in Table 3-6. For mixed zoning districts, the primary zoning designation is used to determine the applicable zoning district class.

Table 3-6. Maximum Permissible Sound Levels by Zoning District

Receiving Zoning District	Maximum Permissible Sound Level (dBA)	
	Daytime (7:00am – 10:00pm)	Nighttime (10:00pm – 7:00am)
Class A: All areas equivalent to land zoned residential, conservation, preservation, public space, or similar type	55	45
Class B: All areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type	60	50
Class C: All areas equivalent to lands zoned agriculture, county, industrial, or similar type	70	70
Source: HAR §11-46, "Community Noise Control."		

As the Project area and all adjoining parcels are within the Restricted Agriculture zoning district (see Figure 3-5), the areas immediately adjacent to the Project fall within the Class C Receiving Zoning District. The nearest noise sensitive receptors are the residential homes to the southwest; these qualify as a Class A Receiving Zoning District. Sound levels received in these locations cannot exceed 55 dBA during the day or 45 dBA at night at the property limits. The noise standards are assumed to be absolute and independent of the existing acoustic environment; therefore, no baseline sound survey is required to assess conformity.

Pursuant to HAR §11-46-7, a permit may be obtained for operation of an excessive noise source (e.g., construction equipment) beyond the maximum permissible sound levels. Factors that are considered in granting of such permits include whether the activity is in the public interest and whether the best available noise control technology has been incorporated into the activity.

3.10.2 Potential Impacts and Mitigation Measures

3.10.2.1 Construction Impacts

For the purpose of this analysis, potential noise impacts were assessed for the following phases of construction: (1) demolition; (2) site preparation and grading; (3) trenching and road construction; (4)

equipment installation; and (5) commissioning. Noise levels resulting from construction activities vary greatly depending on the type of equipment, the specific equipment model, the operations being performed, and the overall condition of the equipment. A construction sound source database was compiled for the Project based on construction equipment that is typically used for construction of solar energy facilities and reference information from the EPA and the Federal Highway Administration (FHWA) Construction Noise Handbook (Table 3-7) (FHWA, 2006).

Table 3-7. Summary of Anticipated Construction-Related Noise

Phase of Construction	Construction Equipment	Load Factor %	Maximum L_{max} Equipment Noise Level at 50 ft (15 m) dBA	Composite L_{eq} Noise Level at 1000 ft (305 m) Average Daytime dBA
Demolition	(3) Excavators (168 hp) (2) Rubber Tired Dozers (357 hp)	57 59	85 85	64
Mass Grading	(2) Graders (174 hp) (2) Rubber Tired Dozers (357 hp) (2) Scrapers (313 hp) (2) Tractors/Loaders/Backhoes (108 hp) (2) Water Trucks (189 hp)	57 59 72 55 50	85 85 89 85 80	68
Fine Grading - Road Construction	(1) Other Equipment (190 hp) (1) Rough Terrain Forklifts (93 hp) (2) Tractors/Loaders/Backhoes (108 hp) (1) Water Trucks (189 hp)	62 60 55 50	80 85 85 80	62
Trenching / Infrastructure Construction	(1) Generator Sets (549 hp) (1) Rubber Tired Loaders (164 hp) (2) Tractors/Loaders/Backhoes (108 hp) (1) Trenchers (63 hp) (1) Water Trucks (189 hp)	74 54 55 75 50	81 85 85 83 80	62
Building Construction / PV Installation	(1) Cranes (399 hp) (2) Forklifts (145 hp) (1) Generator Sets (549 hp) (1) Other Equipment (190 hp) (1) Tractors/Loaders/Backhoes (108 hp) (1) Water Trucks (189 hp)	43 30 74 62 55 50	83 85 81 80 85 80	60
NOTE: Data were compiled and methodologies developed in part from FHWA (2006).				

In addition to the above listed construction equipment, pile driving may also be used for installation of the posts for the racking system. Pile driving can generate high noise levels, with noise generated from both the ram striking the pile, as well as the operating steam, air, or diesel exhaust as it is exhausted

from the cylinder.[20] Assuming a load or usage factor of 20 percent (FHWA, 2006), it is expected that sound from pile driving would attenuate to 70 dBA at a distance of approximately 1,000 feet and would attenuate to below 60 dBA within 1 linear mile of the construction activity, depending on meteorological and topographical effects.

Construction sound would attenuate with increased distance from the source. Although not considered in the analysis, other factors including vegetation, terrain and obstacles such as buildings would act to further limit the impact of construction noise levels. Actual received sound levels would fluctuate, depending on the construction activity, equipment type, and separation distances between source and receiver. The variation in power and usage imposes additional complexity in characterizing construction noise levels. The analysis conservatively assumes all phased construction equipment operating simultaneously; however, equipment is generally not operated continuously.

Based on the anticipated construction-related noise levels listed in Table 3-7, construction noise would be periodically audible at offsite locations and potentially in excess of the HAR §11-46 Class A maximum permissible sound limits; however, it is expected to be comparable to noise produced by other adjacent land uses, including agricultural machinery in nearby agricultural areas and industrial equipment at the nearby Makakilo Quarry. Construction-related traffic, such as trucks traveling to and from the Project site on public roads, would also generate noise and contribute to overall sound levels; however, as discussed in Section 3.12, construction-related traffic would be minimal. Traffic-related noise generated by the Project would be short-term and comparable to existing noise levels along the local road network and the H-1 Freeway.

Overall, construction would generate noise that exceeds the ambient levels and has the potential to cause a temporary and short-term disturbance. Reasonable efforts would be made to minimize the noise levels associated with Project construction to the extent practicable, including measures such as those listed below.

- Construction activities would not occur between 7:00 pm and 7:00 am on weekdays or Saturday, or at any time on Sunday within 500 feet of an occupied residence.
- Construction site and access road speed limits would be established and enforced during the construction period.
- Electrically-powered equipment will be used instead of pneumatic or internal combustion powered equipment, where feasible.
- Material stockpiles and mobile equipment staging, parking, and maintenance areas would be located as far as practicable from noise-sensitive receptors.
- The use of noise-producing signals, including horns, whistles, alarms, and bells would be for safety warning purposes only.

[20] Hydraulic impact hammers do not generate exhaust-related noise.

- No Project-related public address or music system would be audible at any adjacent receptor.
- All noise-producing construction equipment and vehicles using internal combustion engines would be equipped with mufflers, air-inlet silencers where appropriate, and any other shrouds, shields, or other noise-reducing features in good operating condition that meet or exceed original factory specification. Mobile or fixed "package" equipment (e.g., arc-welders, air compressors) will be equipped with shrouds and noise control features that are readily available for that type of equipment.

As construction noise would be temporary in nature, and with implementation of the measures listed above, no long-term or otherwise significant noise impacts are anticipated as a result of Project construction. If necessary, a noise permit would be obtained during construction to allow for exceedances of the maximum permissible sound levels.

3.10.2.2 Operational Impacts

Sound sources considered in the acoustic analysis for Project operations include the centralized inverters and transformers associated with the solar arrays and the substation. The principal sources of noise are the electrical components of the inverters, the step-up transformer within the substation, and cooling-ventilation fans associated with transformers and battery storage.

Each solar array would include a 2.8 MW central inverter, transformer, battery storage containers, and associated ventilation fans. Each inverter would generate a noise level of about 80 dBA at a distance of 10 feet; it is expected that the enclosure would provide 15 to 20 dBA of noise reduction, reducing the inverter noise to approximately 63 to 65 dBA at a distance of 10 feet from the enclosure. The distribution transformers are estimated to produce a noise level of about 58 dBA at a distance of six feet.

Substations have switching, protection and control equipment and a transformer, which generate sound that is generally described as a low humming. There are three main sound sources associated with a transformer: core noise, load noise and noise generated by the operation of the cooling equipment. The core is the principal noise source and does not vary significantly with electrical load. The load noise is primarily caused by the load current in the transformer's conducting coils (or windings) and consequently the main frequency of this sound is twice the supply frequency: 100 Hz for 50 Hz transformers and 120 Hz for 60 Hz transformers. The cooling equipment (fans and pumps) may also be an important noise component, depending on fan design. During air forced cooling method, cooling fan noise is produced in addition to the core noise. The resulting audible sound from a substation is a combination of hum and the broadband fan noise.

Transformers are designed and catalogued by MVA rating. Just as horsepower ratings designate the power capacity of an electric motor, a transformer's MVA rating indicates its maximum power output capacity. The American National Standards Institute (ANSI) and the International Electrotechnical Commission (IEC) have established methodologies for measurement of noise from transformers and other electrical devices. Measurements involve taking reference sound level measurements using microphones positioned 0.3 m (1 ft) from a tautly drawn string that encircles the device at a height

above grade set at one-half the overall height of the device. The transformer noise output is the average of all measurements taken around the perimeter, incorporating contributions from both cooling fans and auxiliary equipment. The National Electrical Manufacturers Association (NEMA) published standards TR1-1993 (R2000) also establishes the maximum noise level allowed for transformers, voltage regulators, and shunt reactors based on the equipment's method of cooling its dielectric fluid (air-cooled vs. oil-cooled) and the electric power rating. The Project substation transformer would have a NEMA rating of 72 dBA.

The solar modules would not be within 100 feet of the property line, nor would they be expected to generate low-level sound beyond the Project area. The solar array inverters and transformers are generally considered a low-level source of noise, limited to daytime hours when the solar arrays are generating electricity. After sunset, when the modules no longer receive solar radiation, the inverters would not produce noise; the transformers would be energized but likely operating under low noise condition using natural draft cooling (i.e., fans would not be running due to lower nighttime heat loads). The location of the Project substation relative to the property line makes it unlikely that either the adjacent Class C Receiving Zoning District or the nearby Class A Receiving Zoning District would be impacted by noise levels above the maximum permissible sound levels listed in Table 3-6.

Operational noise associated with the Project is not expected to significantly impact any noise sensitive receptors, especially in the context of the industrial and agricultural activities in the Project vicinity. Any operational noise impacts associated with the Project are expected to be below the maximum permissible sound levels for the Class A Receiving Class District, which applies to all areas zoned for uses including residential, conservation, preservation, public space, or other similar uses. As such, it is anticipated that noise impacts associated with the Project would be less than significant.

3.11 Hazardous Materials

3.11.1 Affected Environment

A Phase I Environmental Site Assessment was conducted for the Project area in March 2019. A Phase I Environmental Site Assessment is part of the due diligence process intended to identify potential or existing environmental contamination liabilities and to assess whether current or historical property uses have impacted the soil or groundwater beneath the property and could pose a threat to the environment and/or human health. The Phase I Environmental Site Assessment was conducted in accordance with ASTM International (ASTM) "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, Designation E 1527-13" (ASTM E 1527-13; ASTM, 2013). This effort typically involves (1) a review of site land use history, geology, hydrogeology, and site and vicinity environmental records; (2) a visual site reconnaissance; and (3) interviews with persons knowledgeable about the property. It identifies recognized environmental conditions (REC), controlled

REC (CREC), historical REC (HREC), and *de minimis* conditions in connection with the previous and current uses and ownership of the property.[21]

No RECs, CRECs, HRECs, or *de minimis* conditions were identified in connection with the Project area. It was noted that based on the historical use of the property as part of a sugar cane and pineapple plantation, environmentally persistent agricultural chemicals may have been applied and thus may be present in surface and shallow subsurface soils at the site. It was also noted that a concrete irrigation flume located in the central portion of the property includes caulking, which could possibly contain asbestos.

3.11.2 Potential Impacts and Mitigation Measures

Based on the results of the Phase I Environmental Site Assessment, no hazardous materials are known to be present within the Project area. In the event the concrete irrigation flume is removed from the Project area, the caulking would be sampled to determine whether asbestos-containing material is present prior to removal. If asbestos is present, appropriate abatement protocols would be implemented in accordance with applicable regulations.

No extremely hazardous materials as defined by 40 CFR 355 (*List of Extremely Hazardous Substances and Their Threshold Planning Quantities*) would be produced, used, stored, transported, or disposed as part of the Project. Construction and operations activities would require the use of some hazardous materials, such as fuels (e.g., gasoline and diesel fuel) and lubricants, which could adversely affect the environment if accidentally released. However, only a limited amount of these materials would be present onsite and BMPs would be implemented to avoid and minimize potential impacts. As detailed in Section 3.3.2.2, BMPs would include proper storage procedures (including secondary containment), routine inspection of vehicles and equipment for leaks, fueling and vehicle maintenance in offsite facilities or designated areas with secondary containment (with use of spill pads), and proper waste collection and disposal methods.

During the operational phase of the Project, oil-based products would be stored within the Project area, as the transformers use oil for insulation and cooling. Transformer oil is typically mineral oil or seed oil that is considered nontoxic and a non-hazardous substance; it does not contain polychlorinated biphenyls or compounds listed as extremely hazardous under 40 CFR 355. Transformers at the substation would be ground-mounted units constructed on concrete pads with secondary spill containment traps designed to minimize the possibility of accidental leakage. Furthermore, an SPCC Plan would be prepared, in accordance with the requirements of 40 CFR 112 (*Oil Pollution Prevention*). The plan would identify all oil storage containers, secondary containment and oil spill controls, inspection and testing protocols, training procedures, security measures, emergency response and notification procedures, key Project and regulatory contacts, and reporting requirements. Given the relatively small

[21] A REC is the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property.

quantities and nature of the oil-based products, combined with secondary containment and other procedures that would be established as part of the SPCC Plan, the potential for oil-related spills and the associated effects are expected to be minimal.

As described in Section 2.1.2, the Project would include a battery energy storage system with a total of ten 1,300-kilowatt lithium-ion battery units. Each battery unit would incorporate multiple layers of protection to avoid failures and to contain potential hazardous substances. Specific features would include integrated monitoring and circuit protection, a self-contained heating ventilation air cooling system, and a fire detection and clean agent suppression system specifically designed for lithium-ion battery energy storage systems. Specific safety controls would include:

- Batteries would be stored in completely contained, leak-proof containers;
- Temperature/smoke/fire sensors, alarms, and aerosol fire extinguishing systems would be installed in every battery container;
- Each battery container would be controlled by remote power disconnect switches; and
- Battery system would undergo qualification testing prior to commercial operation.

In the event a lithium-ion battery requires replacement, the battery system would be disconnected and de-energized to allow for battery removal and replacement; the old battery would be properly packaged and transported to an approved recycling facility. All stages of this process would be conducted in accordance with all relevant regulatory requirements in place at the time of replacement. In particular, transportation of the lithium-ion batteries would be conducted in accordance with U.S. Department of Transportation Pipeline and Hazardous Material Administration regulations, including 49 CFR 173.185 (*Lithium Cells and Batteries*). This regulation includes requirements related to testing, proper packaging (such that the batteries are completely enclosed and are separated from contact from other equipment, devices, or conductive materials), and safety measures (including those related to preventing rupture, external short circuits, and reverse current flow).

As described in Section 2.4, at the end of its operational life, the Project would be decommissioned, including removal of all Project equipment and returning the Project area to substantially the same condition as existed prior to Project development. As part of the decommissioning process, removal and treatment of the battery system would be conducted in the same manner as described above for battery replacement during the operational phase. Adherence to the applicable regulatory requirements would minimize potential hazards related to use, handling, transport, and disposal of batteries throughout Project operations and decommissioning. As such, Project implementation would not be expected to result in any significant impacts related to hazardous materials.

3.12 Transportation and Traffic

3.12.1Affected Environment

3.12.1.1 Harbors

There are two deep draft harbors in Oʻahu, including Honolulu Harbor and Kalaeloa Barbers Point Harbor. The Project area is located approximately 4.5 miles northeast of Kalaeloa Barbers Point Harbor and approximately 13 miles northwest of Honolulu Harbor. Both harbors are heavy lift facilities that are able to accommodate delivery, unloading and temporary storage of equipment and materials for the Project.

3.12.1.2 Roadways

A network of state, county, and privately-owned roadways provide access to the Project area and surrounding areas. The key roadways used to access the Project area include the following:

- **H-1 Freeway**: H-1 Freeway, which is under the jurisdiction of the State of Hawaiʻi Department of Transportation (DOT, Highways Division) is generally an east-west, two-way divided freeway which begins to the west in the vicinity of the Palailai Interchange then extends through Kapolei, ʻEwa, Waipahu, Airport Industrial Area, and Central Honolulu before terminating to the east and continuing on as Kalanianaʻole Highway. The H-1 Freeway is approximately 27.1 miles long. In the vicinity of the Project, the H-1 Freeway is a two-way, six-lane divided highway which provides three lanes in each direction. The H-1 Freeway in the vicinity of the Project has a posted speed limit of 60 mph.
- **Kualakaʻi Parkway**: Kualakaʻi Parkway is generally a two-way, 4-6 lane, divided, north-south State roadway that begins at its intersection with the H-1 Westbound on-/off-ramps and terminates to the south at its intersection with Kapolei Parkway. Kualakaʻi Parkway provides regional access to and from locations such as Hoʻopili, Ka Makana Alii, and the Kroc Center. The posted speed limit is 35 miles per hour (mph).
- **Pālehua Road**: Pālehua Road is generally a two-way, two-lane, undivided, east-west private roadway that begins at its intersection with the H-1 Westbound on-/off-ramps and terminates to the west as the entrance to Makakilo Quarry. The portion of the roadway nearest the Project access serves as a haul road for Makakilo Quarry and is used exclusively by local traffic. Currently, there is no posted speed limit.

A Traffic Impact Analysis Report (TIAR) prepared for the Project collected data regarding existing traffic volumes. Based on the traffic count data, the weekday morning and afternoon peak hours of traffic were between 6:30am and 7:30am and between 3:45pm and 4:45pm, respectively. The TIAR also provided the existing intersection levels of service (LOS) at two intersections in the vicinity of the Project area. LOS is a qualitative measure used to describe condition of traffic flow at intersections, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F. The LOS levels at the Pālehua Road and H-1 westbound on-/off-ramp and the Kualakaʻi Parkway and H-1 eastbound on-/off-

ramp are summarized below. In general, traffic along Kualakaʻi Parkway is higher in the northbound direction during the morning peak hour and higher in the southbound direction during the afternoon peak hour largely due to commuter traffic.

- **Pālehua Road and H-1 Freeway westbound on-/off-ramp**: The signalized intersection operates at LOS B or better during both morning and afternoon peak hours and does not experience significant delays or queuing during either peak period. All individual movements currently operate at LOS D or better during the morning and afternoon peak hours of traffic.
- **Kualakaʻi Parkway and H-1 Freeway eastbound on-/off-ramp**: The signalized intersection operates at overall LOS A and does not experience significant delays or queuing during the morning or afternoon peak hours. All individual movements currently operate at LOS D or better during the morning and afternoon peak hours of traffic.

In addition to the current traffic conditions, future traffic conditions without the Project were estimated to provide a baseline for evaluation of potential Project-related impacts; this projection is based on the anticipated Project construction completion date of 2021. Future traffic conditions without the Project reflect traffic increases due to regional growth, as well as specific developments that are currently under construction or are anticipated to affect traffic conditions; this includes an 8 percent annual growth rate as further discussed in the TIAR (see Appendix I). The projected baseline intersection LOS at both intersections during the weekday midday peak hour are as follows:

- **Pālehua Road and H-1 Freeway Westbound on-/off-ramp**: With the projected traffic increase associated with growth and development, the signalized intersection is anticipated to operate at an overall LOS B during morning peak hours of traffic and LOS C during evening peak hours of traffic. Degradation of LOS from existing conditions can be attributed to background traffic growth in the region as a result of development in West Oʻahu. However, all movements at the intersection are expected to continue operating at LOS D or better during morning and evening hours of traffic.
- **Kualakaʻi Parkway and H-1 Freeway Eastbound on-/off-ramp**: The signalized intersection is anticipated to continue operating at an overall LOS A during the morning and evening peak hours. In addition, all individual movement LOS are expected to remain the same as existing LOS with all approaches operating at LOS D or better during both morning and evening peak hours of traffic.

3.12.1.3 Public Transit

Public transit services on Oʻahu include TheBus and TheHandi-Van, both of which are operated by the City and County of Honolulu. TheBus provides service to the Project vicinity via Route 40, which runs between Ala Moana Center and Mākaha Tower. The closest bus stop to the Project area is located at the UH West Oʻahu campus, approximately 1 mile away. TheHandi-Van, which is a public transit service for persons with disabilities, provides all-day service in areas located within 0.75 mile of Route 40.

Honolulu Rail Transit, a rapid transit system that will connect West Oʻahu with downtown Honolulu and Ala Moana Center, is in the process of being constructed. The system will include approximately 20 miles of elevated guideway and 21 rail stations. The route runs along Kualakaʻi Parkway and parallel to Farrington Highway, approximately one mile south of the Project area. The nearest station to the Project area will be the Keoneʻae (UH West Oʻahu) Station, approximately 1.2 mile southeast of the Project area adjacent to Kualakaʻi Parkway. These facilities are currently under construction; the segment from East Kapolei to Aloha Stadium is expected to open for passenger service in Fall 2020.

3.12.1.4 Bicycle and Pedestrian Facilities

There are currently no bicycle or pedestrian facilities in the vicinity of the Project area. No pedestrians were observed during the morning or evening peak hours at either the Pālehua Road and H-1 Freeway westbound on-/off-ramp or the Kualakaʻi Parkway and H-1 Freeway eastbound on-/off-ramp during the traffic impact analysis (ATA 2019). The draft update to the 2012 Oʻahu Bike Plan Update shows planned improvements for non-motorized travel in the vicinity of the Project, including a buffered bike lane along Makakilo Loop (a proposed extension of Makakilo Drive connecting to Kualakaʻi Parkway), and a bike lane and shared used path extending from H-1 Freeway south along Kualakaʻi Parkway (DTS, 2019). These projects are identified as Priority 2 projects; the plans for implementation is unknown.

3.12.1.5 Airports

The nearest airport to the Project area is Kalaeloa Airport (JRF), approximately 3.6 miles to the south. Kalaeloa Airport is operated as part of the airport system for the State of Hawaiʻi and serves as a general aviation reliever airport for the Daniel K. Inouye International Airport. It provides air traffic control functions from 6:00am to 10:00pm daily but is available as an alternate facility at all times. The Daniel K. Inouye International Airport (HNL), the state's largest airport, is located approximately 8 miles southeast of the Project area (DOT, 2019). There are no privately-owned runways on Oʻahu; however, there are several military airfields on Oʻahu including Wheeler Army Airfield, Hickam Air Force Base, and Marine Corps Base Hawaiʻi Kaneohe Bay.

3.12.2 Potential Impacts and Mitigation Measures

3.12.2.1 Harbors

The equipment and materials required for Project construction would be transported by barge to either Honolulu Harbor or Kalaeloa Barbers Point Harbor. The equipment and materials would be offloaded from the barges and transferred to trucks for delivery to the Project area. In general, the equipment and materials required for the Project would be expected to be handled as general containerized cargo and would not be expected to place an unusual demand on the harbor facilities.

3.12.2.2 Roadways

Construction

During construction, the anticipated number of workers expected to be at the Project site each day ranges from 10 to 160 workers, with a daily average of approximately 55 workers over the course of the

construction phase. An estimated 500 tractor trailer loads would make deliveries to the Project site over the course of the construction phase.

To evaluate potential traffic impacts associated with Project construction, it was assumed a maximum of 40 tractor trailers would arrive, unload, and depart the Project site on any given day. Twenty (20) of these tractor trailers were assumed to arrive, unload, and depart during both morning and evening peak hours of traffic. A single heavy and wide load delivery would also be needed; however, this would occur outside of daily peak hours of traffic and would have no effect on commuter traffic. Table 3-8 summarizes the construction trips generation used for the analysis of traffic impacts.

Table 3-8. Construction Trip Generation

Type of Construction Trip	Weekday Morning (AM) Peak Hour		Weekday Afternoon (PM) Peak Hour	
	Enter	Exit	Enter	Exit
Construction Workers	55	0	0	55
Tractor Trailers	20	20	20	20
TOTAL	**75**	**20**	**20**	**75**

Based on the anticipated number of construction trips, it is anticipated that the signalized intersection for Pālehua Road and the H-1 Freeway Westbound on-/off-ramp would continue operating at LOS B during the morning peak hours and LOS C during the peak evening hours; all individual movements are expected to continue operating at LOS D or better. The signalized intersection for Kualakaʻi Parkway and the H-1 Freeway Eastbound on-/off-ramp would continue operating at overall LOS A during the morning and evening peak hours; all individual movements are expected to remain the same as the existing LOS, with all approaches operating at LOS D or better during both morning and evening peak hours. Given the length of the existing access road leading from Pālehua Road to the Project area, it is not expected that any construction vehicle queue would reach the H-1 Freeway Westbound intersection and adversely affect traffic conditions. A detailed comparison of the LOS between without-Project conditions and during-construction conditions for the year 2021 is provided in the TIAR (see Appendix I).

Based on the results of the TIAR, Project construction is not expected to measurably affect overall the level of service at the signalized intersections adjacent to the Project area. However, recognizing that construction could result in minor, localized impacts to traffic and the roadway network, a Traffic Management Plan (TMP) would be prepared prior to construction. The TMP would describe the potential impacts to the surrounding roadway network and would detail the measures that would be implemented to avoid, minimize and mitigate potential impacts based on Complete Streets principles. It is expected that the measures would include the following:

- Delivery of construction materials and equipment using oversized trucks would occur during off-peak traffic hours. Other deliveries of construction materials and equipment would be timed to occur during off-peak traffic hours to the extent practicable.

- If any construction projects are planned to occur on nearby properties during the same time frame, the timing of deliveries would be coordinated to minimize traffic-related impacts.
- Notification regarding the status of Project construction and potential traffic impacts would be provided to area representatives, the neighborhood board, area residents and businesses, emergency personnel (fire, ambulance, and police), and public transit services (TheBus and TheHandi-Van), as appropriate.
- If Project vehicles result in damage to an existing roadway or sidewalk, the roadway or sidewalk will be promptly repaired in accordance with current design standards and Americans with Disabilities Act requirements.
- Existing pedestrian, bicycle and vehicle access/crossings shall be maintained with the highest safety measures during construction. If it is determined that roadway, sidewalk or crosswalk closures are necessary, alternate routes would be provided for vehicles, pedestrians, and bicyclists that are safe and clearly marked.

The TMP would be submitted to DOT, the City and County of Honolulu Department of Transportation Services (DTS), and DPP for review and approval prior to construction. With implementation of these measures, construction-related impacts to traffic and the roadway network are expected to be less than significant.

Operations and Maintenance Activities

Once operational, it is anticipated that the Project would have 1-2 employees regularly visiting the site for operations activities. Therefore, the Project is forecast to generate two trips during the morning and evening peak hours of operation, although the Project does not require full-time staff to be on-site every day. Upon completion of the Project (and accounting for regional growth and specific developments), the two signalized intersections adjacent to the Project area are projected to operate at the same overall and individual movement LOS as the baseline without-project conditions (as described under existing conditions). As such, Project operations would not be expected to measurably impact traffic on roads surrounding the Project area. Additional detail regarding the LOS for the without-Project conditions and with-Project conditions for the year 2021 is provided in the TIAR (see Appendix I).

3.12.2.3 Public Transit

Public transit services in the vicinity of the Project include TheBus, TheHandi-Van and the future Honolulu Rail Transit. The nearest public transit facilities, which include a bus stop and rail transit station, are located at least one mile from the Project area. Implementation of the Project is not expected to directly or indirectly affect these facilities or transit services.

3.12.2.4 Bicycle and Pedestrian Facilities

As there are currently no bicycle or pedestrian facilities in the vicinity of the Project area, no Project-related impacts would occur.

3.12.2.5 Airports

FAA requires that land uses adjacent to or in the immediate vicinity of an airport be compatible with normal airport operations, including land and takeoff of aircraft (FAA Order 5190.6B). In response to this mandate, the State of Hawai‘i Office of Planning issued a Technical Assistance Memorandum (TAM-2016-1) to provide guidance for development and activities that may pose potential hazards including attraction of hazardous wildlife, glint/glare hazard or an aerial obstruction hazard. This guidance identifies solar photovoltaic panels as one of the many land use practices that may present a hazard to existing flight paths; specific concerns related to solar photovoltaic facilities are identified as:

- Potential glare and glint caused by parabolic troughs and heliostats that might cause temporary loss of vision to pilots on arrival or departure, or to Air Traffic Control personnel in the control tower;
- Electromagnetic interference with on-and off-airport radar systems that may pick up a false signal from the metal components of the mirrors with impacts that can vary based on solar tracking activity;
- Physical penetrations of navigable airspace from power towers that extend into Part 77 imaginary surfaces, terminal instrument procedures (TERPS) surfaces, or the path of radio emitting navigational aids; and
- Thermal plumes emitted by the power tower that produce unexpected upward moving air columns into navigable air space.

The Project would not include parabolic troughs, heliostats, mirrors or power towers, such that none of the identified concerns would occur as a result of the Project. However, TAM-2016-1 recommends filing Form 7460-1 with the FAA pursuant to CFR Title 14 Part 77.9 if the Project is within 3 nautical miles of an airport or has a footprint approaching 1 acre.

Glare

According to 78 FR 63276, the FAA has determined that “glint and glare from solar energy systems could result in an ocular impact to pilots and/or air traffic control (ATC) facilities and compromise the safety of the air transportation system.” FAA recommends that glare analyses for solar facilities be performed on a site-specific basis using SGHAT as the standard for measuring potential ocular impact as a result of solar facilities (78 FR 63276; FAA, 2018). The FAA has developed the following criteria for analysis of solar energy projects located on jurisdictional airports: (1) no potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATCT) cab; and (2) no potential for glare or “low potential for after-image” along the final approach path[22] for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan. This guidance specifically applies to solar facilities located on

[22] The final approach path is defined as two miles from 50 feet above the landing threshold using a standard three-degree glidepath.

federally-obligated airport property; it is not mandatory for a proposed solar installation that is not on an airport (and for which a Form 7460-1 is filed with FAA), but is considered to be an industry best practice for solar facilities in general.

The FAA Notice Criteria Tool (NCT) reports whether a proposed structure is in proximity to a jurisdictional air navigation facility and if formal submission to the FAA Obstruction Evaluation Group (OEG) under CFR Title 14 Part 77.9 (Safe, Efficient Use, and Preservation of the Navigable Airspace) is recommended. The NCT also identifies final approach flight paths that may be considered vulnerable to a proposed structure's impact on navigation signal reception. The NCT was utilized to determine if the Project is located within an FAA-identified impact area based on the Project boundaries and height above ground surface. The FAA NCT Report stated that a formal filing with the FAA OEG is recommended, and referenced Kalaeloa Airport (JRF), Daniel K. Inouye International Airport (Honolulu International, HNL), and Wheeler Army Airfield (HHI). Based on this information, these three airport facilities were included in the SGHAT analysis conducted for the Project.

As described in Section 3.8.2.3, the SGHAT analysis included 14 final approach flight paths and two air traffic control towers (ATCTs) associated with Kalaeloa Airport, Daniel K. Inouye International Airport and Wheeler Army Airfield. The results of the analysis indicate that no glare would be experienced at Kalaeloa Airport or Wheeler Army Airfield. A limited amount of green glare was predicted for three of the final approach paths and the ATCT for Daniel K. Inouye International Airport; these results are summarized in Table 3-4 with additional detail provided in the Glare Analysis Report (Appendix H). As the Daniel K. Inouye International Airport is located approximately 8 miles from the Project area and the potential occurrence of glare is extremely limited (less than 10 minutes per day during certain months of the year), the Project is not expected to significantly impact airport facilities as a result of glare. As recommended by the NCT, the Project will be formally filed with the FAA OEG to confirm these conclusions; in addition, DOT Airports Division will be consulted regarding these results. Once the Project is operational, in the unlikely event that it is determined that the Project is creating a hazardous condition for pilots, AES would immediately mitigate the hazard upon notification by FAA and/or DOT Airports Division.

Radio Frequency Interference

Solar photovoltaic systems have also been known to emit radio frequency interference to aviation-dedicated radio signals, disrupting the reliability of air-to-ground communications. The Federal Communications Commission (FCC) regulates radio frequency (RF) devices contained in electronic-electrical products that are capable of emitting radio frequency energy by radiation, conduction, or other means. These products have the potential to cause interference to radio services operating in the radio frequency range of 9 kHz to 3000 GHz.

Almost all electronic-electrical devices are capable of emitting radio frequency energy. Most, but not all, of these products must be tested to demonstrate compliance to the FCC rules for each type of electrical function by the device. As a general rule, devices that, by design, contain circuitry that operates in the RF spectrum need to demonstrate compliance using the applicable FCC equipment authorization

procedure (i.e., Supplier's Declaration of Conformity or Certification), as specified in the FCC rules for each type of device. An RF device must be approved using the appropriate equipment authorization procedure before it can be marketed, imported, or used in the United States.

Radio spectrum allocation, regulatory responsibility for the radio spectrum is divided between the FCC (for non-Government uses) and the National Telecommunications and Information Administration (for Government agencies usage). At present, only frequency bands between 9 kHz and 275 GHz have been allocated for use by terrestrial or space radiocommunication services. FCC's Table of Frequency Allocations, which is a compilation of allocations, is codified at Section 2.106 of the Commission's Rules.

All RF devices used for the Project would comply with FCC regulations and would operate only in designed frequency bands. No interference with aviation communication frequency is expected. In the unlikely event of an unexpected radio frequency interference situation and notification by either FAA or DOT Airports Division, the Project's wireless communication system would be disabled and investigated to ensure it does not create a hazardous condition.

3.13 Natural Hazards

3.13.1 Affected Environment

Natural hazards that can affect Oʻahu include flooding, tsunami inundation, and wildfire. Potential flood hazards are identified by the Federal Emergency Management Agency (FEMA) National Flood Insurance Program and are mapped on the Flood Insurance Rate Maps (FIRM). The maps classify land into particular zones depending on the potential for flood inundation. The flood zone classification for the proposed project site was obtained from the Hawaiʻi National Flood Insurance Program (NFIP) Flood Hazard Assessment Tool (DNLR, 2016). Based on NFIP information, the Project area is located entirely within an area that has been designated as Flood Zone D, where analysis of flood hazards has not been conducted and flood hazards are undetermined (Figure 3-11). No portion of the Project area is within a special flood hazard zone.

A tsunami is a series of ocean waves generated by sudden displacements in the sea floor, landslides or volcanic activity, including those caused by disturbances around the Pacific Rim as well as earthquakes and landslides near Hawaiʻi. The hazard risk associated with tsunami inundation throughout Hawaiʻi are depicted on tsunami evacuation maps prepared by the City and County of Honolulu, in coordination with the Hawaiʻi Emergency Management Agency and UH (DEM, 2015). These maps define both the tsunami evacuation zone based on distant tsunami events that have previously impacted Hawaiʻi during the past 100 years, as well as the extreme tsunami evacuation zone for a tsunami that may exceed the historic distant events. As shown on Figure 3-12, the Project area is more than 4.5 miles inland from the tsunami evacuation zone, and more than 3.5 miles inland from the extreme tsunami evacuation zone.

Wildfire occurs on all of the major Hawaiian Islands, with human activity as the primary cause. Because Hawaiʻi's native ecosystems are not adaptive to wildfire, they can result in extinction of native species

and increased coverage of nonnative, invasive species. Other effects include soil erosion, increased runoff and decreased water quality (Pacific Disaster Center, 2010b).

3.13.2 Potential Impacts and Mitigation Measures

The Project would not affect geologic or natural processes and would not result in an increased risk of natural hazards in the project vicinity. As the Project area is not located within a flood hazard zone or a tsunami evacuation zone, it is extremely unlikely that conditions associated with flood or tsunami inundation would occur within the site, nor would the Project contribute to increased risk of flooding or inundation.

The Project would incorporate multiple layers of fire prevention and suppression measures. It is being designed in accordance with the National Fire Protection Association (NFPA) 1 and National Electric Code (NEC) requirements for fire prevention for large-scale solar, including installation of fire breaks throughout the Project area. Vegetation would be managed with livestock to control flammable materials, while still providing enough ground cover to prevent erosion. Dedicated operations and maintenance staff would proactively monitor the vegetation growth. All electrical wiring would be elevated or enclosed, thus preventing interaction between circuits and flammable materials. Battery systems would be fully contained within temperature-controlled, leak-proof containers; each container would be fully equipped with temperature/smoke/fire sensors and alarms, remote controlled disconnects and a clean agent fire suppression system. Remote monitoring staff would be alerted in the event of a system issue. The Honolulu Fire Department was initially consulted as part of the pre-assessment scoping process and consultation will continue during the design of the Project, with on-site training and orientation prior to commercial operation.

For these reasons, impacts associated with natural hazards are considered negligible over both the short and long term.

3.14 Public Facilities and Services

3.14.1 Police, Medical, and Fire Protection Service

3.14.1.1 Affected Environment

Fire protection services for O‘ahu are provided by the Honolulu Fire Department. Although the majority of their activity is associated with fire operations, the Honolulu Fire Department is also involved in other emergency response including emergency medical situations, hazardous material incidents, and natural disasters. The departments resources are divided into five battalions containing 44 fire stations. There are three fire stations in close proximity to the Project area – the Makakilo Fire Station (Station 35), East Kapolei Fire Station (Station 43), and the Waipahu Fire Station (Station 12).

Police services are provided by the Honolulu Police Department, with eight patrol districts serving the island of O‘ahu. The Project area is within District 8, which spans from ‘Ewa to Ka‘ena. The district station is located on Kamokila Boulevard in Kapolei, approximately 3 miles southwest of the Project

area. The Queen's Medical Center West Oʻahu, located on Fort Weaver Road approximately 3 miles east of the Project area, is the nearest hospital and provides emergency medical services.

3.14.1.2 Potential Impacts and Mitigation Measures

Consistent with requirements articulated by the Honolulu Fire Department, the existing access road as well as service roads within the Project area would be able to accommodate fire apparatus; it is anticipated that the Project does not need to provide water supply for fire flow as no occupied buildings would be constructed within the Project area. Furthermore, as discussed in Section 3.13.2, the Project would incorporate multiple layers of fire prevention and suppression measures. As such, the Project is not expected to increase the need for fire response or otherwise impact fire protection services; no mitigation is proposed.

Similarly, the Project is not expected to interrupt, increase the demand for, or otherwise affect police or emergency medical services. During construction, the Project area would be staffed with security personnel on an as-needed basis. During operations, the facilities would be adequately secured and are not expected to require additional security on a regular basis. As such, the Project is not expected to impact police services; no mitigation is proposed.

3.14.2 Educational Facilities

3.14.2.1 Affected Environment

The nearest school to the Project area is Mauka Lani Elementary School, which is approximately 1.25 miles to the southwest. Several other schools occur within a larger radius, primarily to the south and east of the Project area; these include Makakilo Elementary School, Seagull Schools, Kapolei Elementary School, ʻEwa Elementary School, Hale O Ulu, Waipahu Intermediate, and Honowai Elementary School. As previously described, the Project would be located on the UH West Oʻahu Mauka Lands property; the UH West Oʻahu campus is located approximately one mile to the south.

3.14.2.2 Potential Impacts and Mitigation Measures

The Project would not impact existing educational facilities, nor would it increase the need for educational facilities. Although located on the UH West Oʻahu Mauka Lands property, the Project would not impact the campus; furthermore, the Project would be consistent with their long-range land use plan for UH West Oʻahu. As such, no mitigation is proposed.

3.14.3 Recreational Facilities

3.14.3.1 Affected Environment

There are no existing recreational areas within or immediately surrounding the Project area. Kapolei Regional Park is located approximately 2.3 miles southwest of the Project area, and ʻEwa Mahiko District Park is located approximately 2.7 miles southeast of the Project area. Other park facilities in this region include Makakilo Community Park (approximately 1.2 miles southwest of the Project area), Maukalani Neighborhood Park (approximately 1.4 miles to the southwest), Kahiwelo Neighborhood Park

(approximately 1.8 miles to the southwest), Asing Community Park (approximately 2.8 miles to the southeast), and West Loch Shoreline Park (approximately 2.5 miles to the east). Other recreational facilities in this region include the West Loch and ‘Ewa Villages golf courses, which are 2 and 2.4 miles southeast of the Project area, respectively (DLNR, 2015). There are no known designated hiking trails in proximity to the Project area (DOFAW, 2019).

3.14.3.2 Potential Impacts and Mitigation Measures

The Project will not affect existing recreational facilities; therefore, no mitigation is proposed.

3.15 Utility Infrastructure

3.15.1Affected Environment

Utility infrastructure relates to services such as electric, gas, telephone, sanitary sewer, domestic water, and solid waste management. Utility services provided within the City and County of Honolulu include electricity, telecommunications, domestic water and wastewater, stormwater drainage facilities, and solid waste management.

3.15.1.1 Electricity and Telecommunications

As previously described, the existing Hawaiian Electric ‘Ewa Nui #42 46-kV sub-transmission line crosses the Project area. However, there are no distribution lines which deliver electricity to the Project area, nor are there any telecommunication services provided within the Project area.

3.15.1.2 Water and Wastewater

Domestic water is provided by the Board of Water Supply. O‘ahu’s wastewater system is managed by the City and County of Honolulu Department of Environmental Services. Neither the water nor wastewater systems currently service the Project area.

3.15.1.3 Stormwater Drainage

Stormwater is managed separately from wastewater, with stormwater facilities that ultimately drain to the ocean. The nearest stormwater drainage facilities are storm drain inlets located approximately 0.5 mile south of the Project area (City and County of Honolulu, 2019).

3.15.1.4 Solid Waste

Solid waste on O‘ahu is handled at one of two landfills – Waimanalo Gulch Sanitary Landfill, which is managed by the City and County of Honolulu Department of Environmental Services, and the PVT Landfill, which is privately owned. The Waimanalo Sanitary Landfill is the island’s only municipal solid waste landfill. The PVT Landfill is designated for construction and demolition waste only (ENV, 2019).

3.15.2 Potential Impacts and Mitigation Measures

3.15.2.1 Electricity and Telecommunications

As described in Section 2.1.4, the Project would interconnect with the existing Hawaiian Electric grid via the ‘Ewa Nui #42 46-kV sub-transmission line, which traverses the Project area. No new electrical lines or other work related to the electrical grid would occur outside of the Project area. Once operational, the Project would deliver up to 12.5 MW of solar energy, which is enough to provide electricity for approximately 4,600 homes based on average energy use (Hawaiian Electric, 2019a). The Project would also provide up to 50 MWh of battery storage, which would improve electric grid stability by enabling the solar energy to be dispatched on an as needed basis. Overall, the Project would provide a benefit by directly contributing to the state’s renewable energy goals, fulfilling approximately 0.5 percent of Hawaiian Electric’s RPS (Hawaiian Electric, 2019a).

The Project would require telecommunication circuits (via fiber optic cable or equivalent) to connect the Project with Hawaiian Electric’s existing ‘Ewa Nui substation.[23] The existing fiber optic lines and the closest connection point to the Project area are currently being studied by Hawaiian Telecom. Communications circuits would include primary and back-up lines for SCADA, primary and back-up lines for protective relaying and direct transfer trip (if applicable), primary and back-up lines for fault recording and power quality metering and an analog telephone line for metering. Coordination with Hawaiian Electric and Hawaiian Telecommunications will continue through design and construction.

3.15.2.2 Water and Wastewater

Water would be required during construction and operation for dust control, temporary irrigation of the landscaping and filling of the cattle water troughs. Total water consumption for both construction and operation of the Project would be minimal, likely using temporary water tanks (filled using water trucks). No connection to the domestic water system is expected to be required.

The Project facilities would not generate any sanitary wastewater. As operation of the facilities would not require full-time, on-site staff, no sanitary wastewater system would be needed. Portable sanitation units would be brought onsite during construction, as needed. As such, the Project is not expected to have any effect on either the domestic water system or the municipal wastewater system.

3.15.2.3 Stormwater Drainage

No stormwater drainage facilities are located within or surrounding the Project area. In general, stormwater flows across the site toward the natural drainage features. As detailed in Section 3.3.2.2, the Project would not significantly alter the existing drainage patterns within the Project area and would incorporate a range of stormwater BMPs both during construction and throughout operation. As the Project would not direct additional stormwater flows to the stormwater drainage system and would minimize the potential for increased discharge of sediment or other pollutants, significant impacts to the

[23] The specific telecommunications requirements to facilitate interaction between the Project and Hawaiian Electric are currently being reviewed by Hawaiian Telecom.

stormwater drainage system are not anticipated. Accordingly, it is expected that the Project would be in compliance with the City and County of Honolulu's Rules Relating to Water Quality and Storm Drain Standards.

3.15.2.4 Solid Waste

Construction of the Project is not anticipated to generate a significant amount of solid waste. During construction, all waste would be temporarily stored onsite and periodically transported and properly disposed of in a permitted landfill. Little to no waste would be generated during operation.

At the end of the operational period, the Project would be decommissioned, which would involve removal of all Project equipment from the Project area. As described in Section 2.4, decommissioning would be conducted in accordance with industry standards, with all equipment and materials treated according to the highest and best use. Equipment and materials would be salvaged or recycled to the extent feasible; the remaining materials would be disposed of at authorized sites on Oʻahu, in accordance with applicable laws. As only a small portion of the Project equipment would be disposed of as solid waste, impacts related to solid waste disposal are expected to be minor.

3.16 Economic Resources

3.16.1 Affected Environment

Hawaii's economy has transformed over time from a plantation economy to a modern economy with a mix of tourism, construction, retail, and professional businesses. Based on 2016 census data, the State of Hawaiʻi had a total of 32,350 business establishments with 528,415 paid employees and an annual payroll of approximately $23 million. Specifically within the City and County of Honolulu, a total of 21,404 business establishments, 359,766 paid employees and an annual payroll of approximately $16 million was reported (U.S. Department of Commerce, Census Bureau, 2016). In terms of jobs, the largest industries in the City and County of Honolulu are accommodation and food services, health care and social assistance, and retail trade. In 2016, accommodation and food services accounted for 63,225 jobs, health care and social assistance accounted for 55,010 jobs, and retail trade accounted for 47,049 jobs (U.S. Department of Commerce, Census Bureau, 2016). Unemployment in the State of Hawaiʻi has decreased in recent years, from approximately 7 percent in 2010 to a current rate of approximately 2.6 percent; in comparison, the nationwide unemployment rate is approximately 3.5 percent (U.S. Bureau of Labor Statistics, 2019; State of Hawaiʻi, 2020).

3.16.2 Potential Impacts and Mitigation Measures

Overall, Project implementation would contribute to Hawaiʻi's economy by providing jobs and other forms of economic activity, thus resulting in a positive impact. Jobs directly related to construction and operation of the solar facilities would be considered "green jobs," which are generally defined as jobs related to preserving or restoring the environment (U.S. Bureau of Labor Statistics, 2020). The economic activity associated with the Project was modeled using IMPLAN, a commercially available economic modeling package widely used to assess the economic impacts of renewable energy and many other

types of projects. Economic impacts were assessed in terms of employment, labor income, and economic output, with separate analyses presented for the construction and operation phases. The results of the analysis are summarized below, with additional detail provided in the Economic Impact Assessment Report contained in Appendix J.

It is estimated that construction of the Project would directly employ an average of 55 onsite workers, including technicians, laborers, foremen, equipment operators, and construction managers for the solar photovoltaic modules, battery energy storage system and other renewable energy equipment. It is anticipated that approximately 75 percent of these positions (or a total of approximately 41 jobs) would be filled by Hawaiʻi residents and would result in an estimated $6.6 million in related payroll (labor income). The remaining jobs are expected to require specialty trade and/or professional staff that would be brought to Hawaiʻi for the Project; in many cases, these staff would serve to train the local workforce and commission certain components per manufacturer requirements. Construction of the Project would also support employment, labor income, and economic output in other sectors of the state economy, with indirect impacts estimated to support approximately 38 jobs and induced impacts estimated to support a further 38 jobs.[24] As summarized in Table 3-9, it is estimated that construction of the Project would support a total of 118 jobs in the state of Hawaiʻi and approximately $11.3 million in labor income, with total economic output of approximately $20.2 million.

Once operational, the Project would continue to contribute to the state economy over its 25-year lifespan. AES expects to employ an in-state workforce of 5 employees to oversee operations and maintenance of their Hawaiʻi portfolio, including the Project. Operation and maintenance of the Project would also support employment, labor income, and economic output in other sectors of the state economy. As summarized in Table 3-9, it is estimated that the Project would support approximately 7.6 total (direct, indirect, and induced) jobs in Hawaiʻi and approximately $0.7 million in labor income, with total economic output of approximately $1.2 million. Estimated indirect and induced impact estimates include the impacts of Project-related payments to UH, which would potentially support employment at the university, as well as elsewhere in the statewide economy. In addition, the Project will support additional economic benefits associated with the compatible agricultural activities. These estimated annual impacts would be expected to occur each year that the Project operates.

Table 3-9. Estimated Economic Impacts

Type of Impact[1]	Employment (FTE)[2]	Labor Income ($000s)[3]	Economic Output ($000s)[3]
Construction – One-Time Impacts			
Direct Impacts	41.3	6,577	6,577
Indirect Impacts	37.9	2,520	6,460

[24] Indirect impacts relate to workers directly employed elsewhere in Hawaiʻi that would provide Project-related technical services, such as engineering design and permitting, and expenditures on goods and services by those suppliers. Induced impacts are generated by household spending associated either directly or indirectly with the proposed facility (e.g., use of income to purchase groceries and other household goods and services).

Type of Impact[1]	Employment (FTE)[2]	Labor Income ($000s)[3]	Economic Output ($000s)[3]
Induced Impacts	38.3	2,207	7,199
Total Impacts	**117.5**	**11,303**	**20,236**
Operation – Annual Impacts			
Direct Impacts	2.1	302	437
Indirect Impacts	3.2	251	373
Induced Impacts	2.3	134	437
Total Impacts	**7.6**	**687**	**1,247**

[1] Numbers may not sum due to rounding.

[2] Jobs are full-time equivalent (FTE) for a period of one year (1 FTE = 2,080 hours).

[3] Labor income and economic output are expressed in thousands of dollars in Year 2020 dollars.

Decommissioning of the Project would involve removing all facilities and returning the Project area to substantially the same condition as existed prior to Project development. The Project would directly employ workers from Hawaiʻi during decommissioning, as well as support additional secondary (indirect and induced) benefits elsewhere in the regional economy. In-state expenditures on equipment and material recycling/salvage and disposal, and per diem expenditures by workers on lodging and food, as well as spending on household goods and services by workers living in the area would all support additional economic activity elsewhere in the state economy. Economic impacts related to decommissioning are expected to be broadly similar to those anticipated during construction.

3.17 Indirect and Secondary Impacts

Indirect and secondary impacts are defined in HAR §11-200.1-2 as those which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Potential indirect effects of the Project are generally described throughout Section 3. The environmental resources that could be indirectly impacted by implementation of the Project include (1) water resources as a result of erosion and sedimentation, (2) air quality as a result of temporary construction activities, (3) noise as a result of temporary construction activities, and (4) traffic as a result of temporary construction activities. However, with implementation of avoidance and minimization measures (as described in the respective sections), these indirect impacts are all expected to be less than significant.

While the construction and operation expenditures associated with the Project would provide a direct economic benefit, the amounts are relatively too small to cause significant secondary effects in the local economy. The Project would not lead to secondary or indirect changes related to land use, development

or population growth in the ‘Ewa District, and thus would not cause associated adverse secondary effects on infrastructure, public facilities, and housing.

3.18 Cumulative Impacts

Cumulative impacts result from the incremental effects of a proposed project when added to other past, present, and reasonably foreseeable future projects, regardless of the person or agency that undertakes the other projects. The potential for cumulative impacts to the environment from the Project was evaluated with consideration given to other projects and activities in the region that could affect the same environmental resources within a similar timeframe. Actions that were considered include projects that were recently completed, are currently underway, or are expected to occur in the foreseeable future.

In general, portions of the ‘Ewa District have been and continue to be developed at a rapid pace. Based on the City and County of Honolulu’s General Plan and ‘Ewa Development Plan, this area was designated as a secondary urban center, thus directing future growth on O‘ahu to relieve developmental pressures in the urban fringe and rural areas. The City of Kapolei was subsequently identified as the urban center, as detailed in both the ‘Ewa Development Plan and the long-range master plan for this area (Group 70, 2007). Large scale development of the City of Kapolei started in the 1990s, with a wide range of commercial, residential, recreational and government facilities constructed and continuing to be installed.

Specific facilities that have been (or are being) constructed in proximity to the Project area include the UH West O‘ahu Campus, starting in 2010, and the Honolulu Rail Transit system, starting in 2011. New facilities continue to be constructed within the UH West O‘ahu campus to accommodate the growing student body, including the new Administration and Health Science Facility and the upcoming Creative Media Facility, with other future facilities also envisioned (UHWO, 2018). The Honolulu Rail Transit system, which is still in the process of being constructed, is an approximately 20-mile-long elevated rail guideway extending from East Kapolei to Ala Moana Center. In the vicinity of the Project area, the guideway will be located along Kualaka‘i Parkway and Farrington Highway; in addition, three stations (Kualaka‘i, Keone‘ae [UH West O‘ahu] and Ho‘opili) will be located within 2 miles of the Project area. Based on the planned route for the Honolulu Rail Transit system, the City & County of Honolulu has been planning for transit-oriented development (TOD), which promotes the development of housing, jobs and services within an approximately 0.5-mile radius of transit stations. The East Kapolei Neighborhood TOD Plan provides the framework for buildout of the Kualaka‘i, Keone‘ae and Ho‘opili stations. It is envisioned that these stations will provide access for both existing and future residential developments, including park-and-ride facilities and a bus transit center. The TOD Plan also identifies a range of other uses, including residential, shopping, employment and community services around these stations (City and County of Honolulu, 2015). Although many of the specific TOD developments have yet to be defined in detail, some transit-oriented projects are already underway. In particular, Ho‘opili is a 1,600-acre transit-oriented residential community that is located adjacent to the Keone‘ae and Ho‘opili transit stations. A portion has been built; at full buildout, it is expected that the Ho‘opili community will

include approximately 12,500 housing units plus a range of community amenities including community recreation centers, playgrounds, parks, bike paths and schools.

Although not related to the urbanization of the Kapolei region, other recently completed, underway or planned actions in the Project vicinity include development of the Honouliuli National Monument. The site was designated as a national monument in 2015 and archaeological, cultural and related planning activities are ongoing. It is anticipated that some type of support facilities will be installed and the site will be opened for public visitation in the relatively near future, but the exact nature of the development is not known (NPS, 2019).

Collectively, these projects have transformed Kapolei and the surrounding areas of the ‘Ewa District into a highly urbanized environment. In general, it is understood that these projects have been developed in a manner that is consistent with the ‘Ewa Development Plan and the Kapolei Area Long Term Master Plan; regardless, there have been a range of impacts associated with these various developments, which have been addressed through the respective environmental review and permitting processes. Considering the impacts of these projects, in combination with the probable impacts of the proposed solar and battery energy storage facility, it is anticipated that potential cumulative impacts would primarily relate to stormwater, noise, air quality, and traffic. However, as detailed throughout this document, BMPs would be implemented to avoid and minimize the impacts of the Project; it is expected that similar measures would be implemented for the other projects under consideration. As such, cumulative impacts associated with the Project are expected to be less than significant.

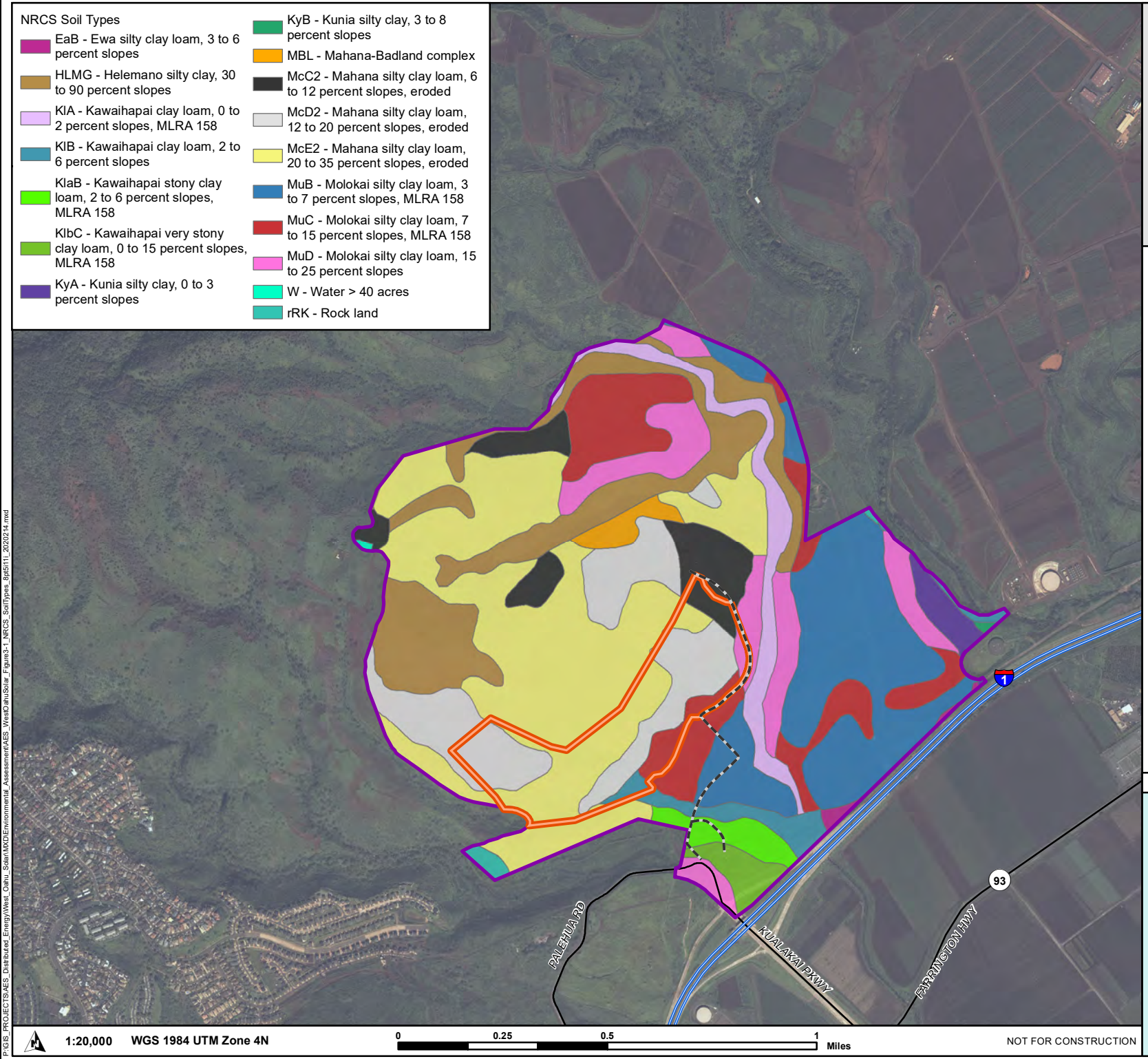


Figure 3-1

West Oahu Solar Plus Storage Project

AES Distributed Energy

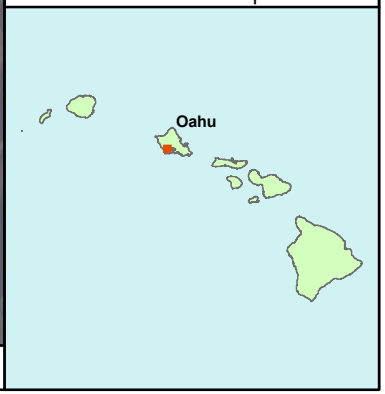
NRCS Soil Types

HONOLULU COUNTY, HI

Project Area
Property Boundary
Existing Access Road
Interstate Highway
Roadway

TETRA TECH

Reference Map



1:20,000 WGS 1984 UTM Zone 4N

0 0.25 0.5 1 Miles

NOT FOR CONSTRUCTION

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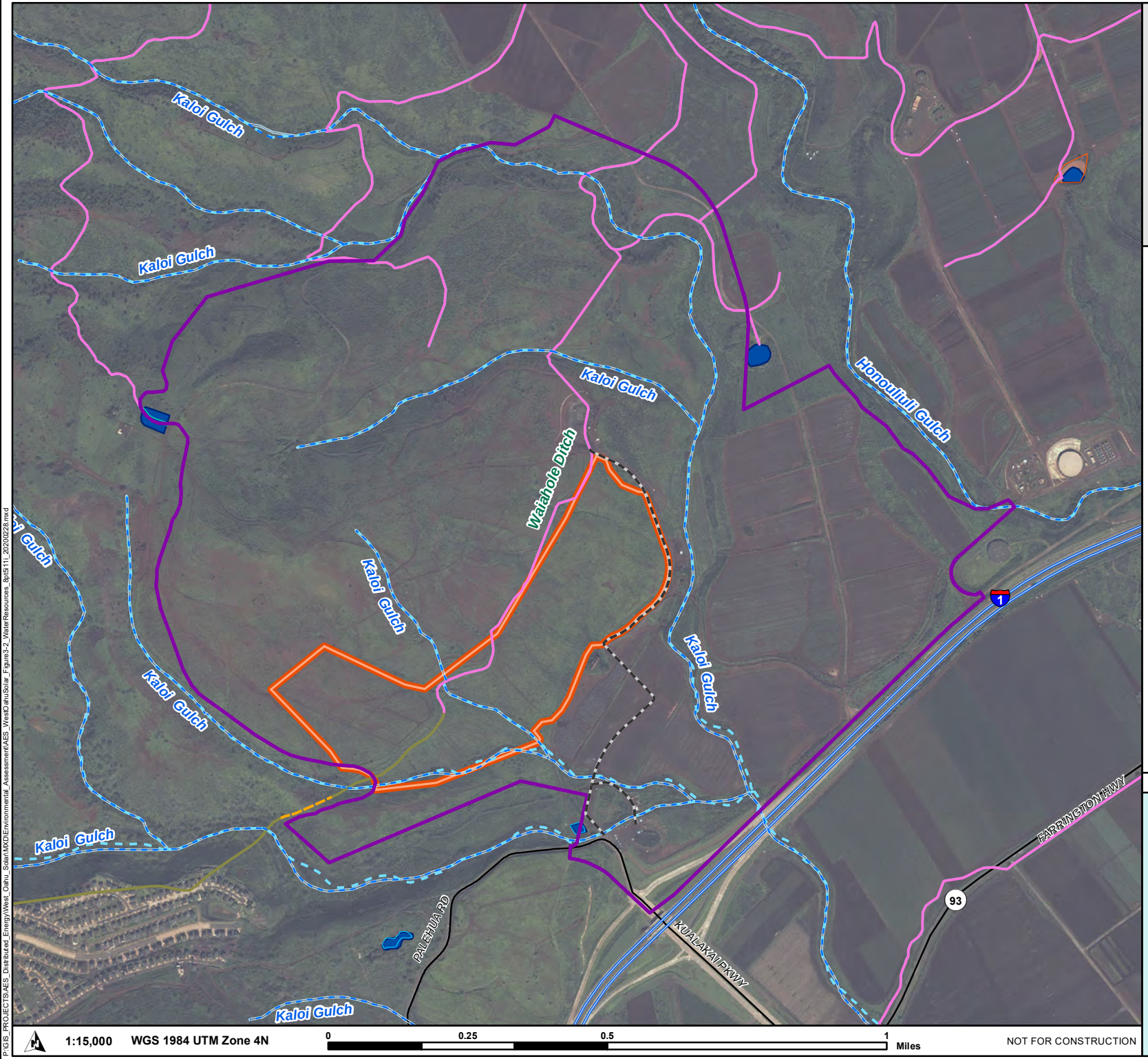


Figure 3-2

West Oahu Solar Plus Storage Project

AES Distributed Energy

Water Resources

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- Interstate Highway
- Roadway
- Non-Perennial Stream (State of Hawaii Division of Aquatic Resources)

National Wetland Inventory

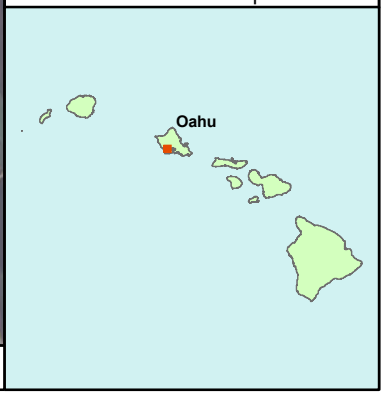
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Riverine

National Hydrography Dataset

- Waterbody
- Canal/Ditch
- Pipeline (Surface Aqueduct)
- Pipeline (Underground Aqueduct)
- Intermittent Stream

TETRA TECH

Reference Map



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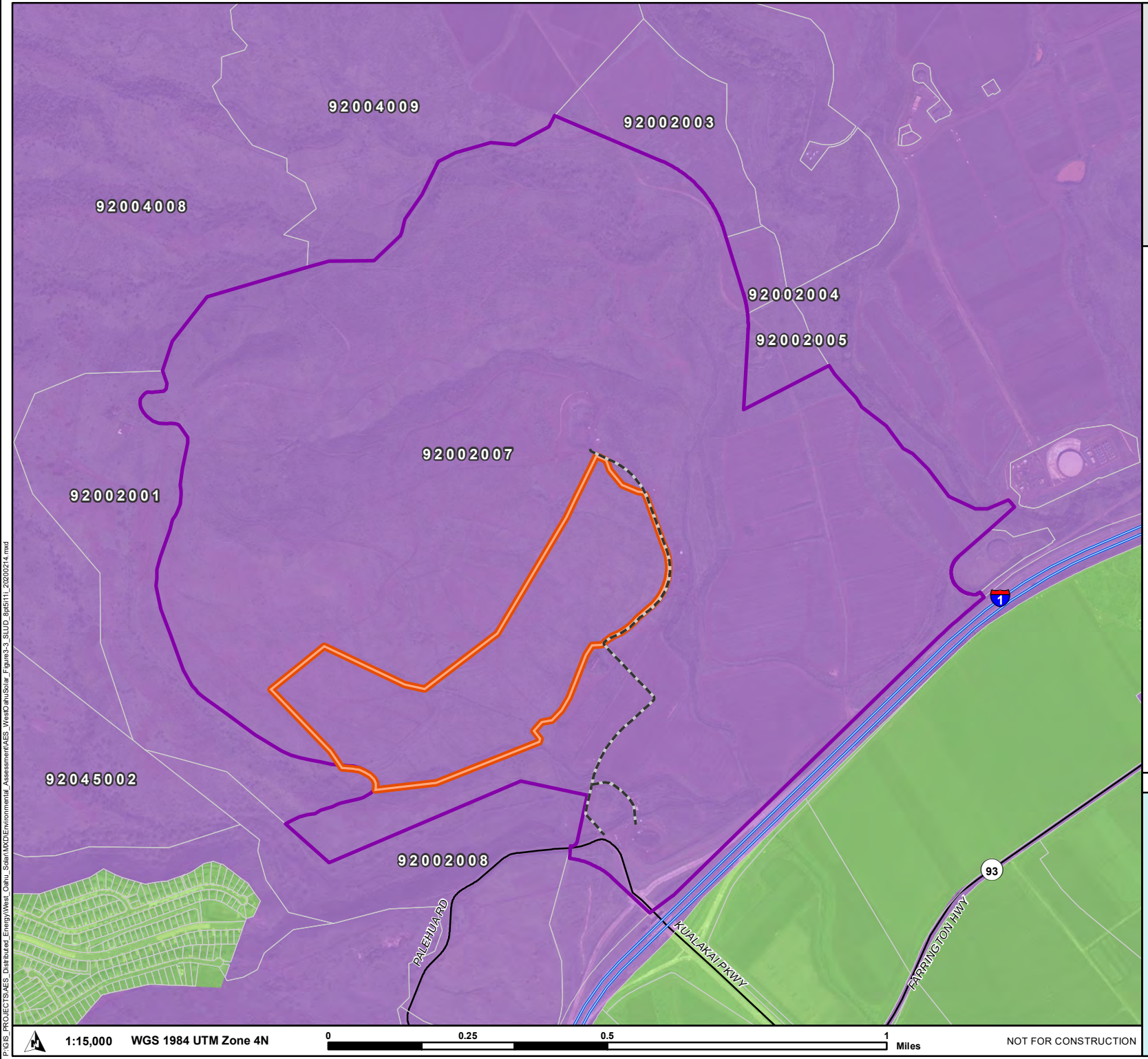


Figure 3-3

West Oahu Solar Plus Storage Project

AES Distributed Energy

State Land Use Districts

HONOLULU COUNTY, HI

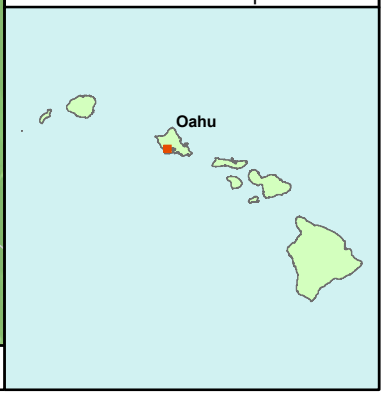
- Project Area
- Property Boundary
- Existing Access Road
- TMK Boundary
- Interstate Highway
- Roadway

State Land Use

- Agricultural Land Use District
- Urban Land Use District

TETRA TECH

Reference Map



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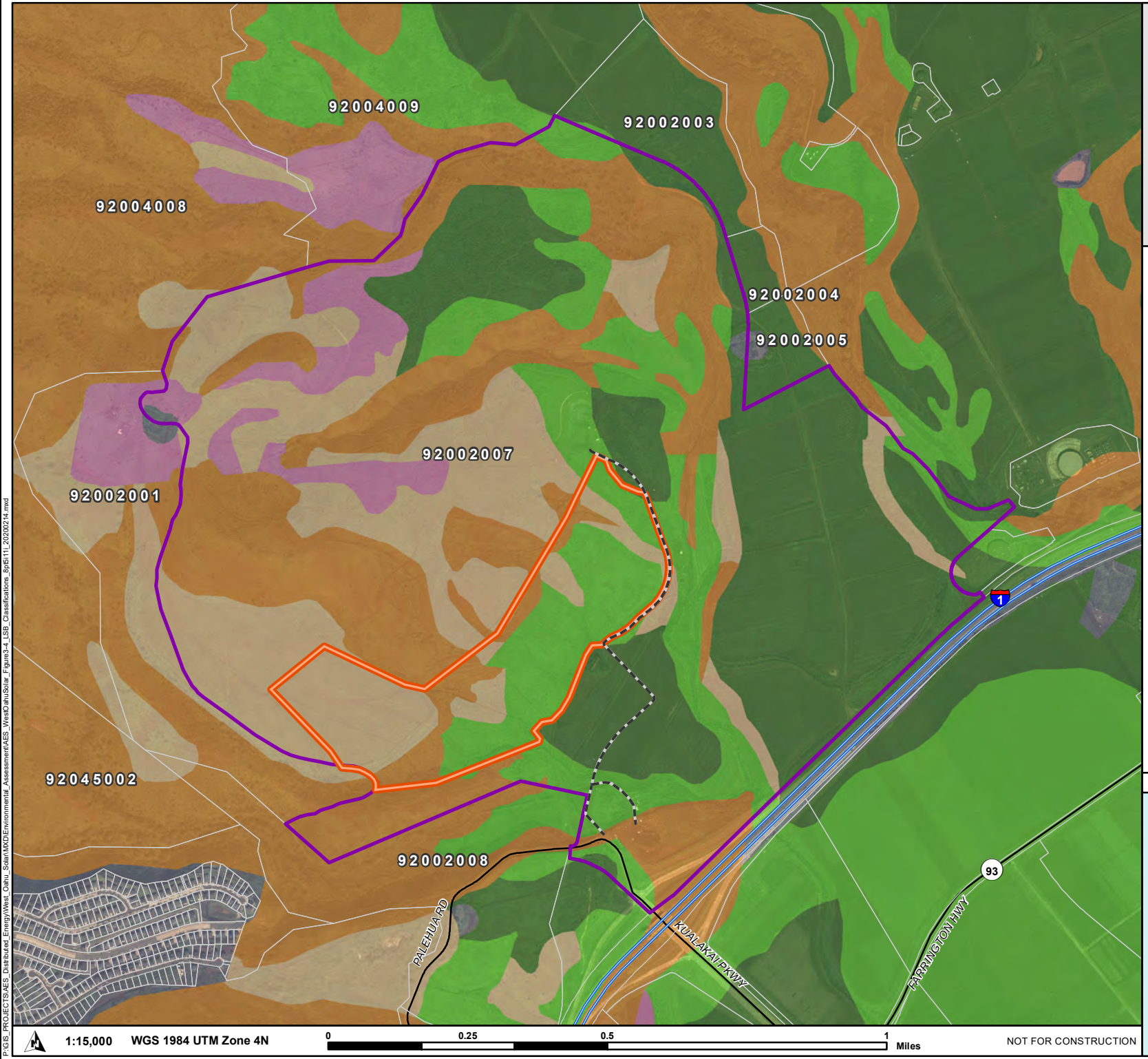


Figure 3-4

West Oahu Solar Plus Storage Project

AES Distributed Energy

Land Study Bureau Classification

HONOLULU COUNTY, HI

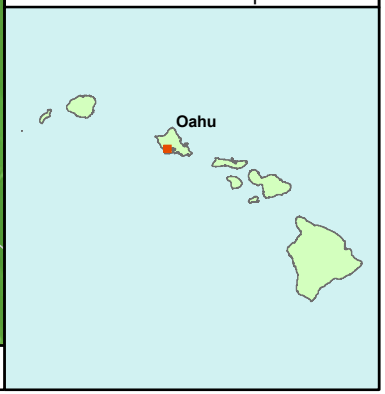
- Project Area
- Property Boundary
- Existing Access Road
- TMK Boundary
- Interstate Highway
- Roadway

Land Study Bureau Classes

- A
- B
- C
- D
- E

TETRA TECH

Reference Map



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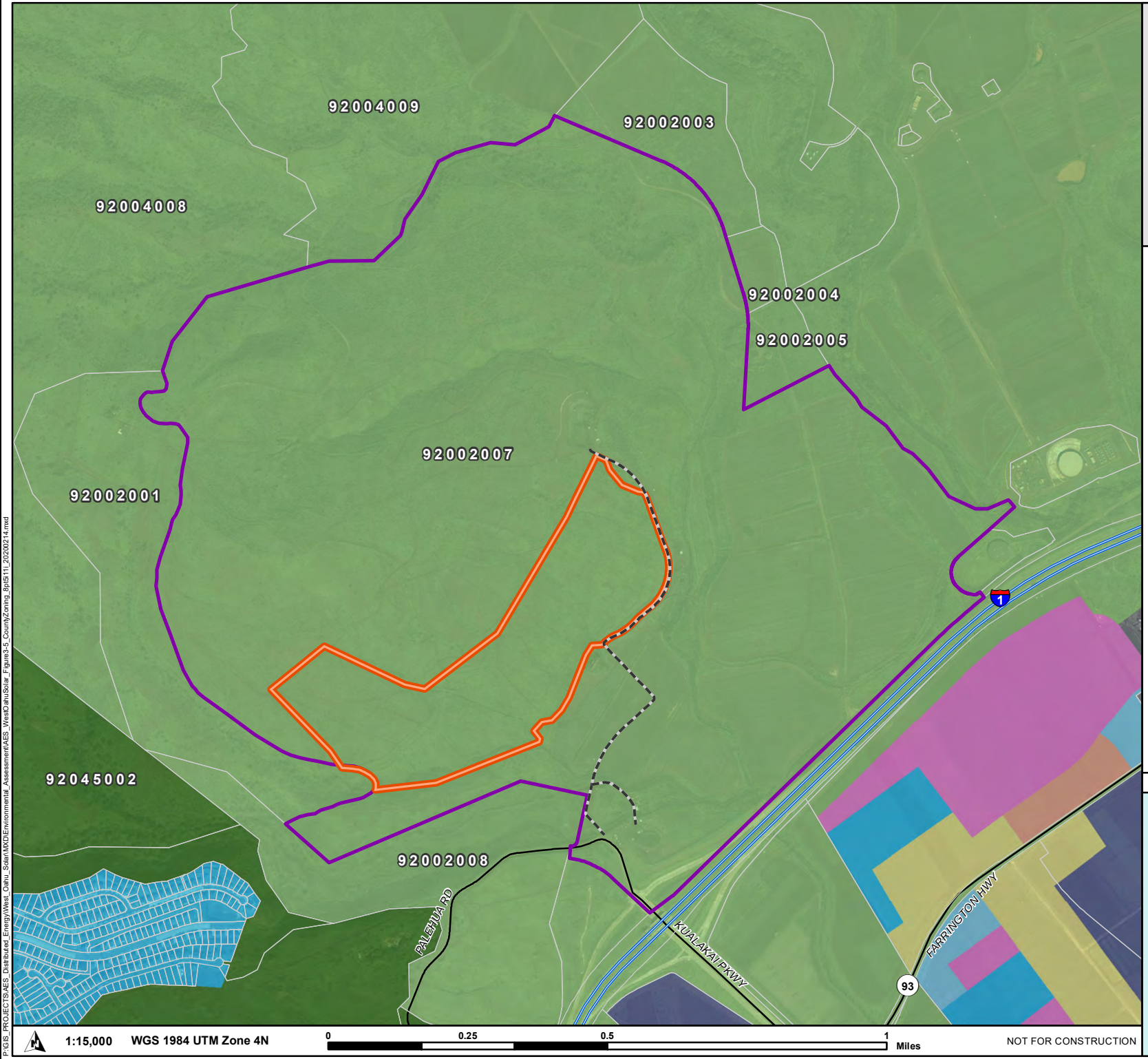

Figure 3-5

West Oahu Solar Plus Storage Project

AES Distributed Energy

County Zoning

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- TMK Boundary
- Interstate Highway
- Roadway

Zoning Classes

- Low- and Medium-Density Apartment District
- Restricted Agriculture District
- General Agriculture District
- Medium-density Apartment Mixed Use District
- Neighborhood Business District
- Community Business/ Community Business Mixed Use District
- General Preservation District
- Residential District

TETRA TECH

Reference Map

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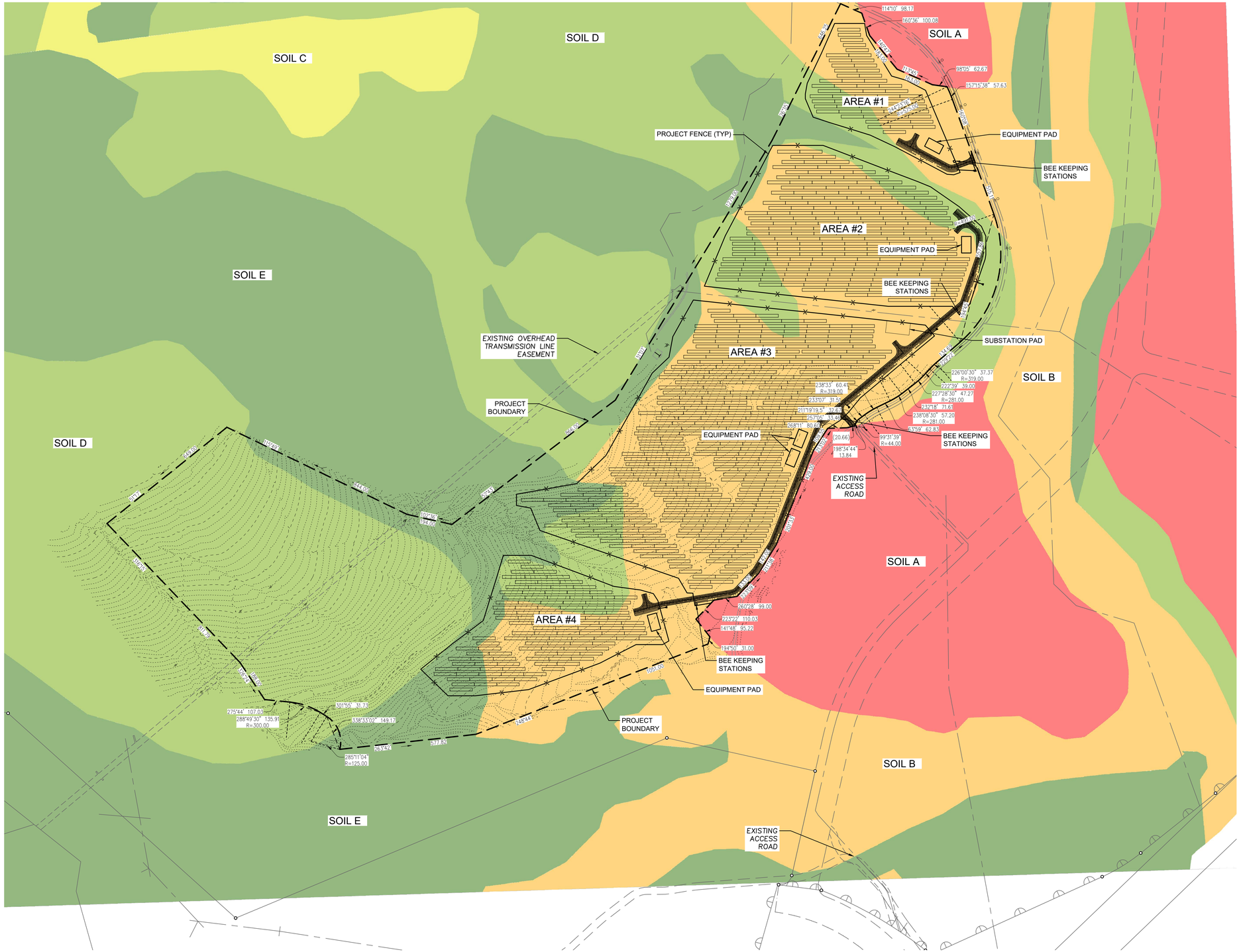

SOIL LEGEND

- LSB CLASS A
- LSB CLASS B
- LSB CLASS C
- LSB CLASS D
- LSB CLASS E

N
W E
S

SCALE: 1" = 200'
0 200 400 FT

AES
Distributed Energy

AES Distributed Energy
282 Century Pl. Suite 2000
Louisville, CO 80027 USA

HDR
3J CONSULTING
CIVIL ENGINEERING
WATER RESOURCES
COMMUNITY PLANNING
9600 SW NIMBUS AVE, SUITE 100; BEAVERTON, OR 97008

SYSTEM DESCRIPTION

REVISIONS

REV	BY	DATE	DESCRIPTION

PE STAMP

AES WEST OAHU SOLAR
OAHU, HI

PROJECT NUMBER 19537
PHASE ISSUED FOR REVIEW
MILESTONE 60% DESIGN

ELECTRICAL DESIGNER

STRUCTURAL DESIGNER

DATE 03-13-2020
SCALE 1"=200'

TITLE
LSB SOIL UNDERLAY

DRAWING
Figure 3-6

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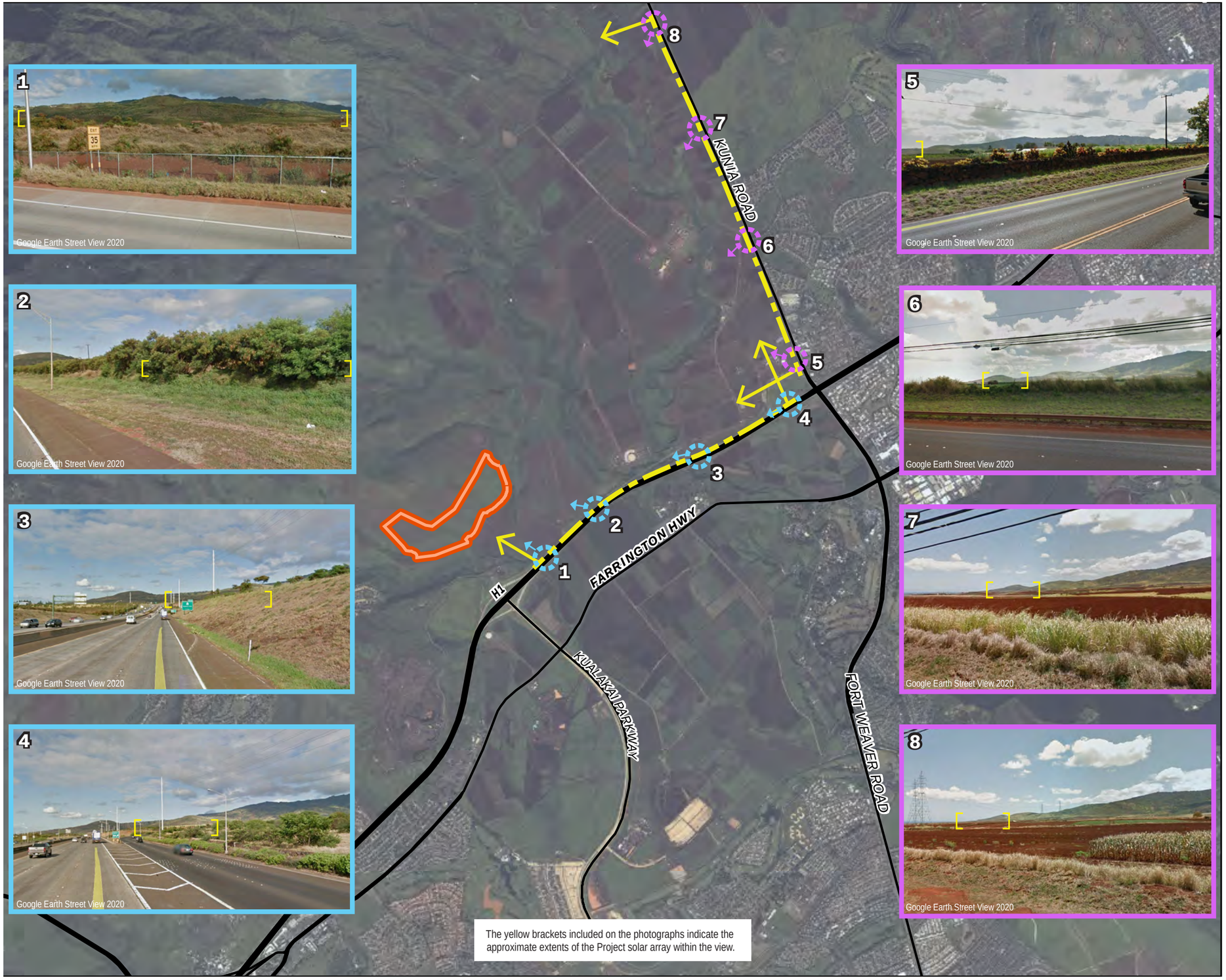

Figure 3-7

West Oahu Solar Plus Storage Project

AES Distributed Energy

Representative Views from Identified Viewplanes

HONOLULU COUNTY, HI

Project Area

Identified Viewplane in Ewa Development Plan

TETRA TECH

Reference Map

1:200,000 WGS 1984 UTM Zone 4N

0 0.5 1 2 3 4 Miles

NOT FOR CONSTRUCTION

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FIGURE 3-8

West O'ahu Solar Plus Storage Project

PHOTO SIMULATION

Representative Viewpoint 01

Farrington Highway

Existing Conditions

Simulated Conditions

VICINITY MAP

Photograph Information

Time of photograph: 8:40 a.m.
Date of photograph: 11/15/2019
Weather condition: Partly Cloudy
Viewing direction: Northwest
Latitude: 21.368050° N
Longitude: -158.050300° W
Photo Location: The photo was taken from along Farrington Highway approximately 4500 feet southeast of the Project.

AES

FIGURE 3-8

West O'ahu Solar Plus Storage Project

PHOTO SIMULATION

Representative Viewpoint 02

Kualakai Parkway

Mile Marker 1.5

Existing Conditions

Simulated Conditions

VICINITY MAP

Photograph Information

Time of photograph: 9:45 a.m.
Date of photograph: 11/15/2019
Weather condition: Partly Cloudy
Viewing direction: Northwest
Latitude: 21.355490° N
Longitude: -158.050200° W
Photo Location: The photo was taken from along Kualakai Parkway approximately 7250 feet southeast of the Project.

AES

FIGURE 3-8

West O'ahu Solar Plus Storage Project

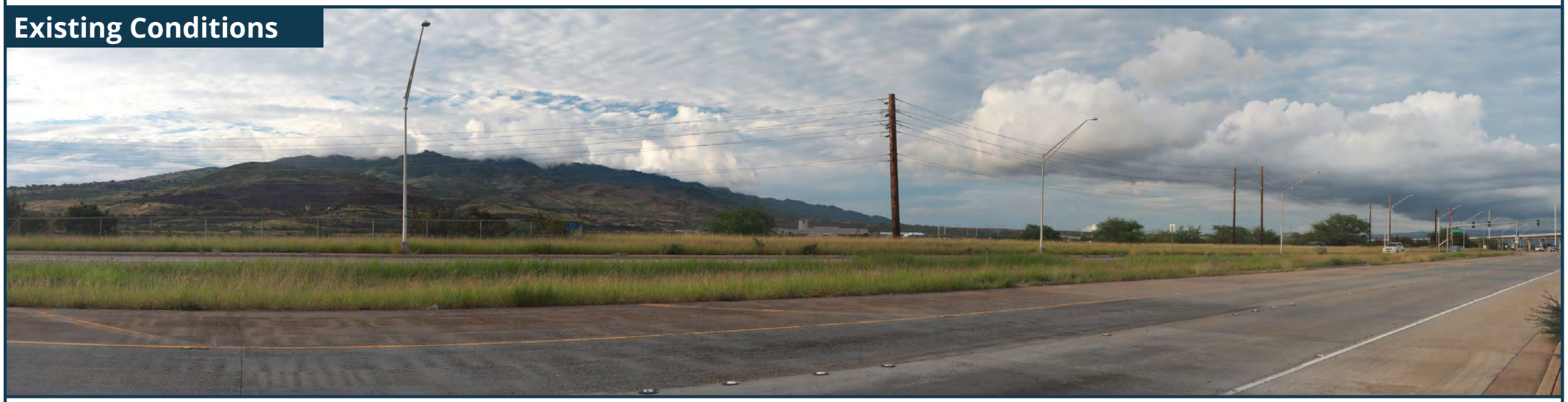
PHOTO SIMULATION

Representative Viewpoint 03

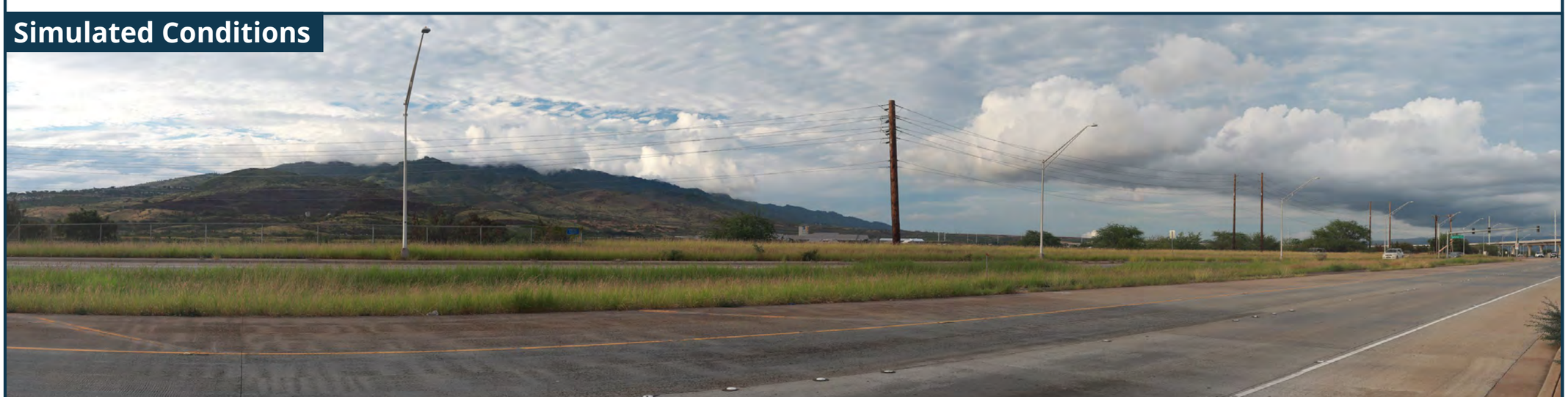
Kualakai Parkway

Mile Marker 0.5

Existing Conditions



Simulated Conditions



VICINITY MAP

Photograph Information

Time of photograph: 5:15 p.m.
Date of photograph: 11/15/2019
Weather condition: Mostly Cloudy
Viewing direction: North northeast
Latitude: 21.343980° N
Longitude: -158.052700° W
Photo Location: The photo was taken from along Kualakai Parkway approximately 2 miles southeast of the Project.

AES

FIGURE 3-8

West O'ahu Solar Plus Storage Project

PHOTO SIMULATION

Representative Viewpoint 04

Geiger Community Park

Existing Conditions

Simulated Conditions

VICINITY MAP

Photograph Information

Time of photograph: 11:00 a.m.
Date of photograph: 11/15/2019
Weather condition: Partly Cloudy
Viewing direction: Northwest
Latitude: 21.332410° N
Longitude: -158.026900° W
Photo Location: The photo was taken from Geiger Community Park approximately 3.5 miles southeast of the Project.

AES

FIGURE 3-8

West O'ahu Solar Plus Storage Project

PHOTO SIMULATION

Representative Viewpoint 05

Makakilo Neighborhood

Near Luawainui Street and Punawainui Street

Existing Conditions

Simulated Conditions

VICINITY MAP

Photograph Information

Time of photograph: 3:05 p.m.
Date of photograph: 11/15/2019
Weather condition: Partly Cloudy
Viewing direction: Northeast
Latitude: 21.367980° N
Longitude: -158.074300° W
Photo Location: The photo was taken from the Makakilo neighborhood approximately 2200 feet southwest of the Project.

AES

FIGURE 3-8

West O'ahu Solar Plus Storage Project

PHOTO SIMULATION

Representative Viewpoint 06

Makakilo Neighborhood

Near End of Punawainui Street

Existing Conditions

Simulated Conditions

VICINITY MAP

Photograph Information

Time of photograph: 3:15 p.m.
Date of photograph: 11/15/2019
Weather condition: Partly Cloudy
Viewing direction: Northeast
Latitude: 21.366740° N
Longitude: -158.071300° W
Photo Location: The photo was taken from the Makakilo neighborhood approximately 1600 feet southwest of the Project.

AES

FIGURE 3-8

West O'ahu Solar Plus Storage Project

PHOTO SIMULATION

Representative Viewpoint 07

Makakilo Neighborhood

Near End of Pueonani Street

Existing Conditions

Simulated Conditions

VICINITY MAP

Photograph Information

Time of photograph: 3:10 p.m.
Date of photograph: 11/15/2019
Weather condition: Partly Cloudy
Viewing direction: Northeast
Latitude: 21.365770° N
Longitude: -158.072000° W
Photo Location: The photo was taken from the Makakilo neighborhood approximately 2000 feet southwest of the Project.

AES

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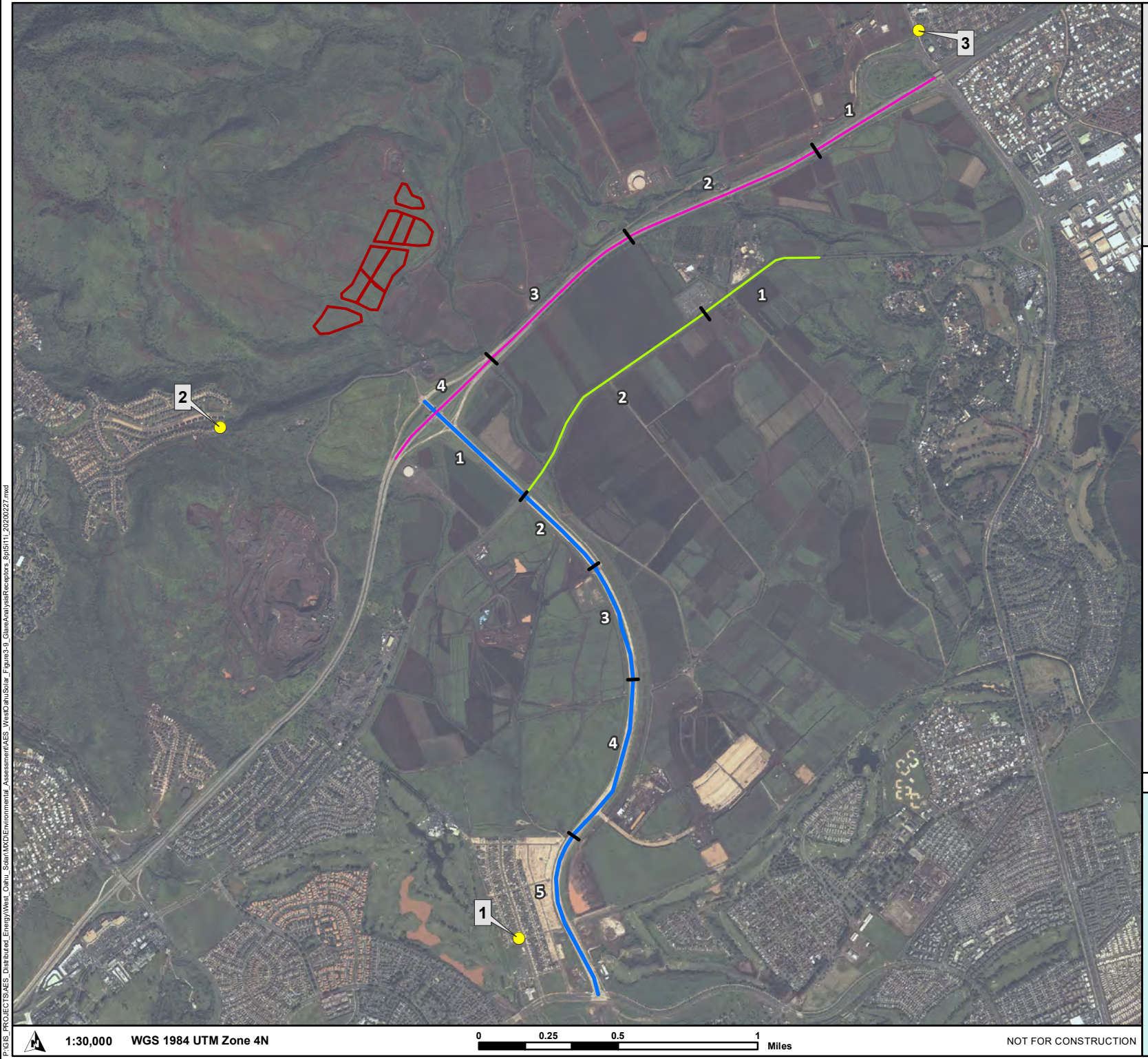

Figure 3-9

West Oahu Solar Plus Storage Project

AES Distributed Energy

Glare Analysis Receptors

HONOLULU COUNTY, HI

Project Layout (Solar Arrays)

Observation Point

Road Segments

Farrington Highway

H-1 Freeway

Kualakai Parkway

TETRA TECH

Reference Map

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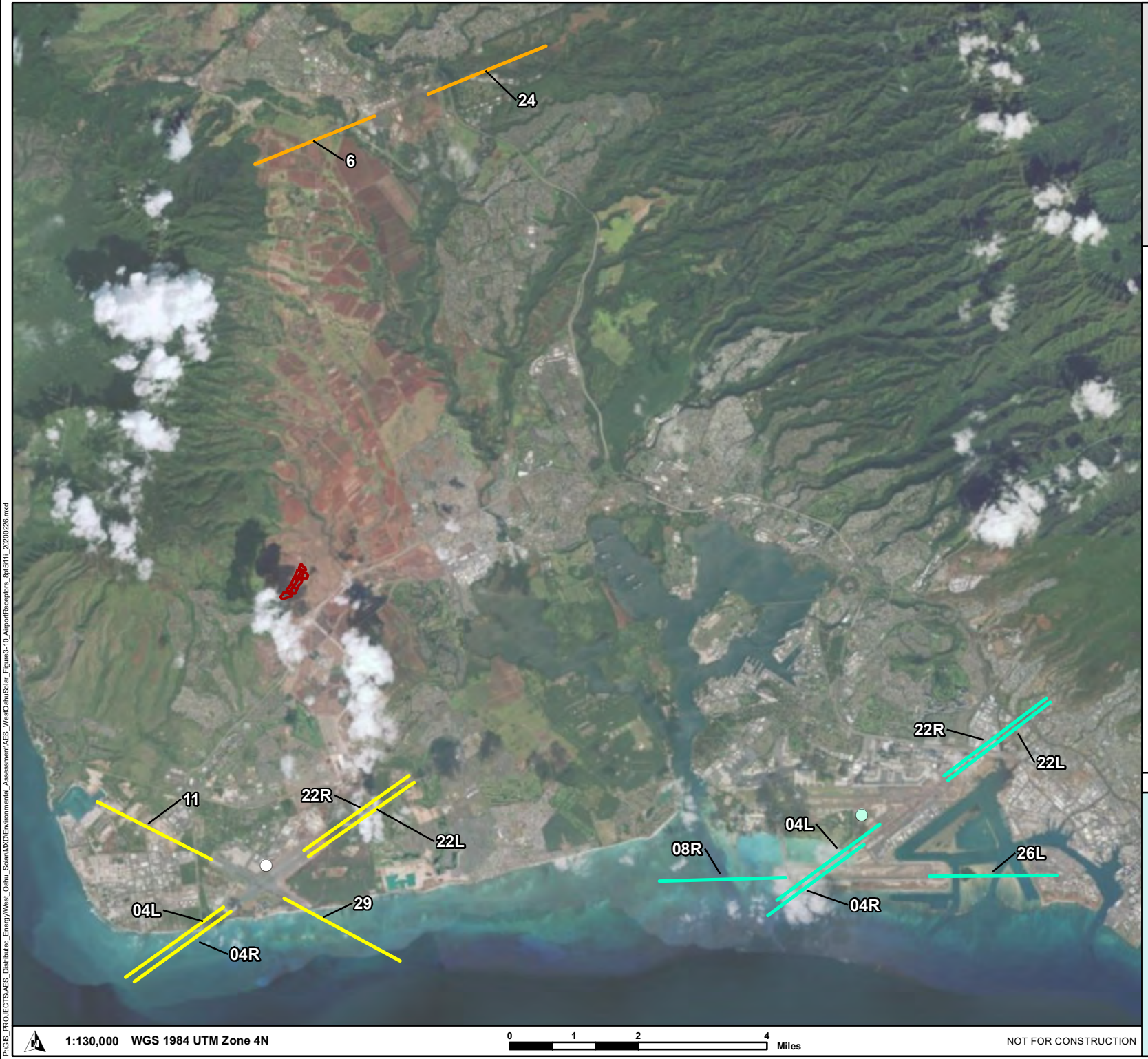

Figure 3-10

West Oahu Solar Plus Storage Project

AES Distributed Energy

Airport Receptors

HONOLULU COUNTY, HI

Project Layout (Solar Arrays)

Honolulu International Airport (HNL)

- Final Approach
- Air Traffic Control Tower

Kalaeloa Airport (JRF)

- Final Approach
- Air Traffic Control Tower

Wheeler Army Airfield

- Final Approach

TETRA TECH

Reference Map

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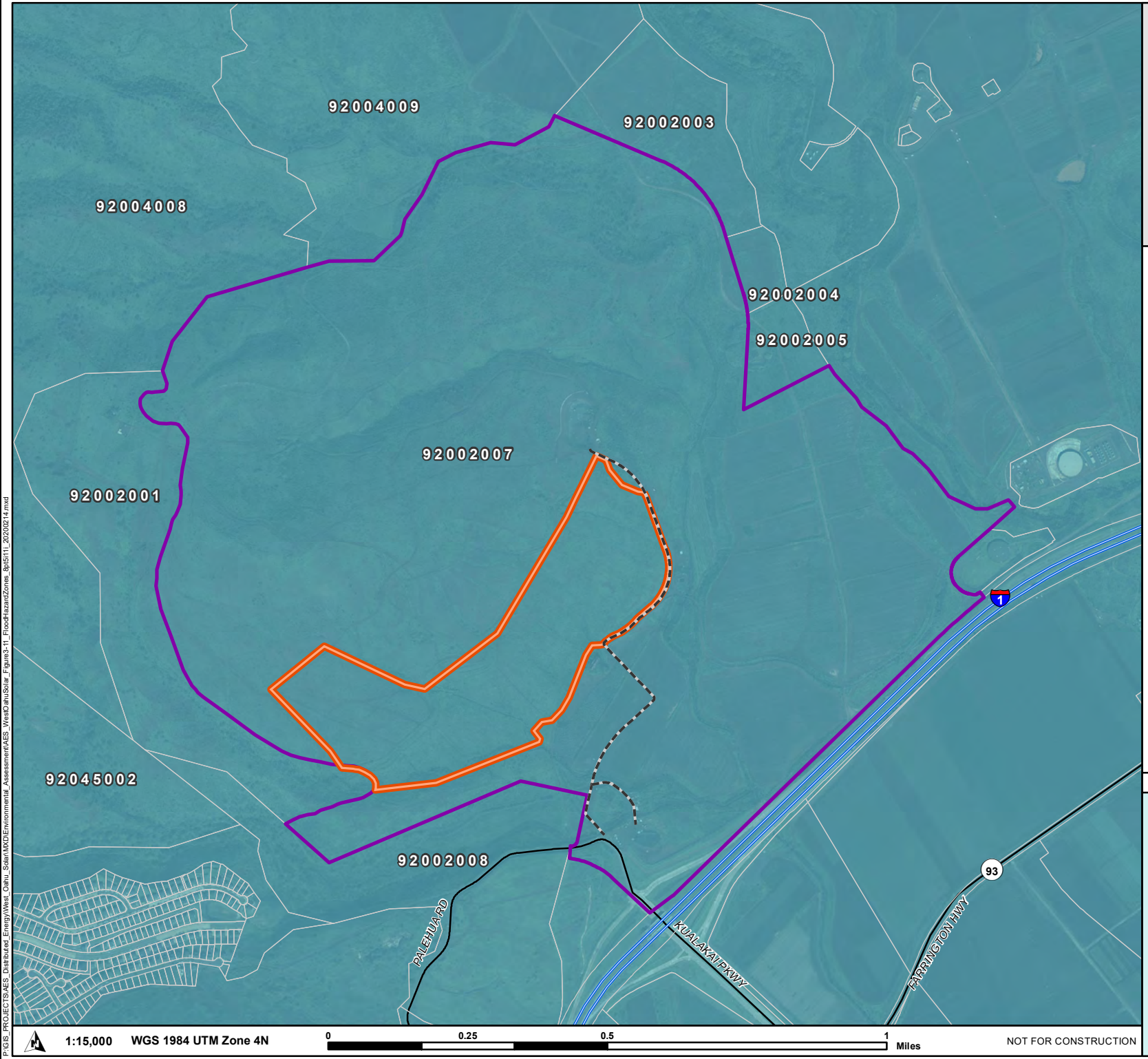


Figure 3-11

West Oahu Solar Plus Storage Project

AES Distributed Energy

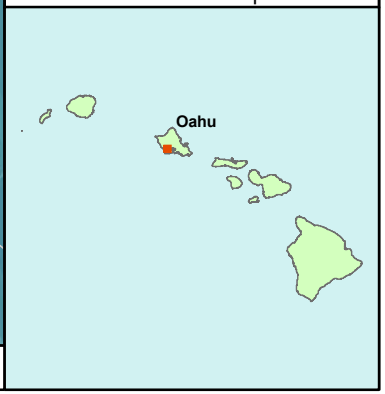
Flood Hazard Zones

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- TMK Boundary
- Interstate Highway
- Roadway
- Flood Hazard Zone D (FEMA)

TETRA TECH

Reference Map



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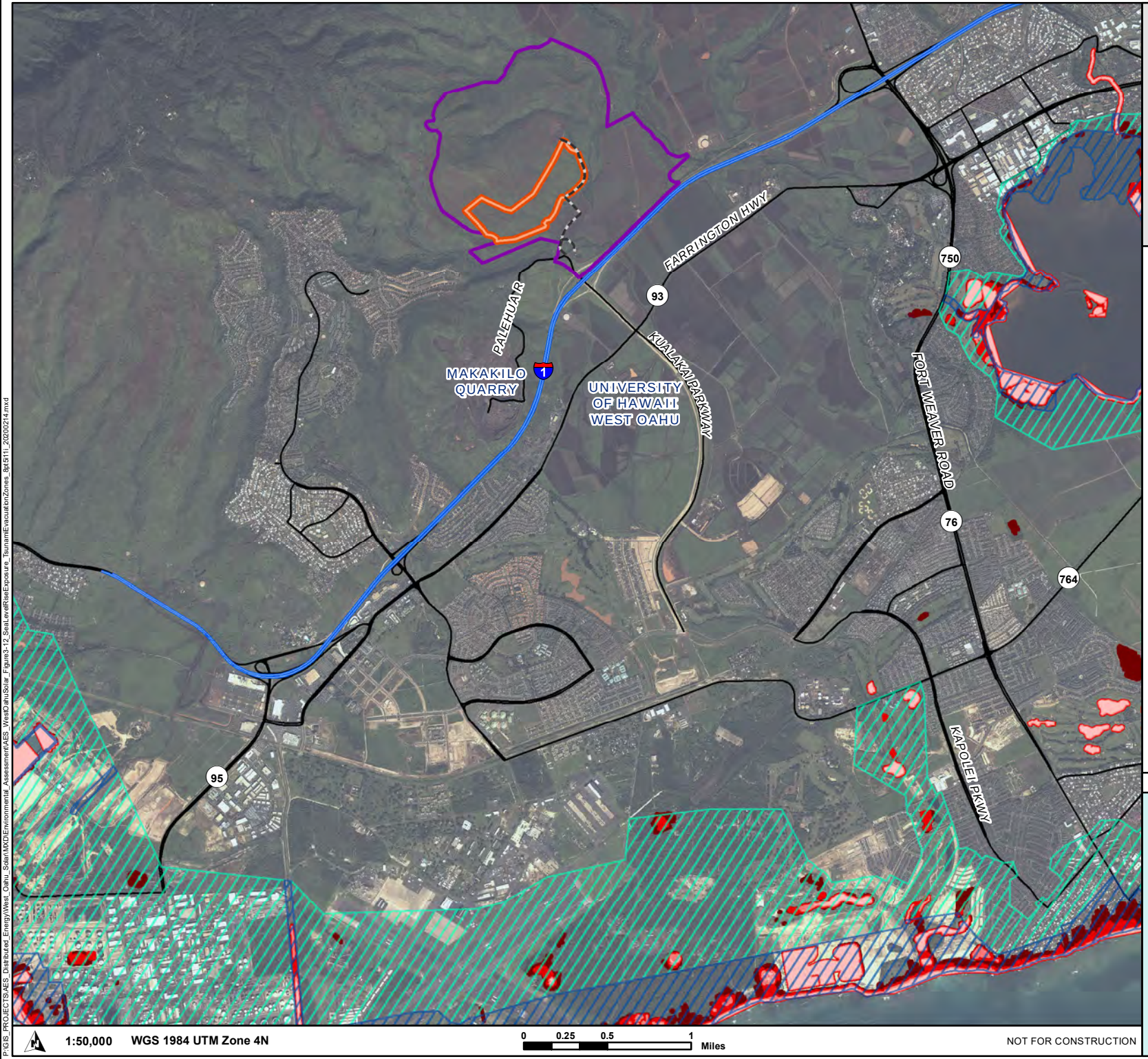

Figure 3-12

West Oahu Solar Plus Storage Project

AES Distributed Energy

Sea Level Rise Exposure and Tsunami Evacuation Zones

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- Interstate Highway
- Roadway
- Extreme Tsunami Evacuation Zone
- Tsunami Evacuation Zone

Sea Level Rise Exposure Areas

- 0.5 feet
- 1.1 feet
- 2.0 feet
- 3.2 feet

TETRA TECH

Reference Map

P:\GIS_PROJECTS\AES_Distributed_Energy\West_Oahu_Solar\MXD\Environmental_Assessment\AES_WestOahuSolar_Figure3-12_SeaLevelRiseExposure_TsunamiEvacuationZones_8p5x11_20200214.mxd

4 Alternatives to the Proposed Project

This section discusses alternatives to the proposed Project described in Section 2. The range of alternatives addressed include the following: (1) the No Action alternative, (2) use of alternative technologies, (3) alternative Project locations, and (4) alternative Project size. Each of these alternatives were eliminated from further consideration; a summary of the rationale for dismissing each alternative is provided in the discussion below.

4.1 No Action Alternative

The No Action alternative represents the probable future conditions that would occur should the Project not proceed and is the baseline against which other alternatives are measures. Under the No Action alternative, a solar photovoltaic and battery energy storage system would not be constructed at the UH West Oʻahu Mauka Lands property, nor would complimentary agricultural activities be pursued. Rather, the site would remain as former agricultural lands, intermittently used for cattle grazing. It is unknown if UH would pursue other potential uses at this site in the future.

In the absence of constructing the solar photovoltaic and battery energy storage facility, the No Action alternative would not result in the production of clean, renewable energy for the island of Oʻahu, and thus would not support the goals of the HCEI nor contribute to the state's RPS. The other benefits of the Project, including reducing greenhouse gases and other pollutants, minimizing long-term volatility in energy prices, increasing stability of the electric grid, and providing a revenue stream for UH, would not be realized. As such, the No Action alternative would not achieve the purpose and need.

4.2 Alternative Location

As described in Section 1.1, Hawaiian Electric issued an RFP in 2018, which established a competitive bidding process for projects to provide grid-scale renewable generation to their electrical system. AES submitted a proposal to Hawaiian Electric that detailed the development of a 12.5 MW solar photovoltaic and battery energy storage system on the UH West Oʻahu Mauka Lands property; the use of this property for the Project was based on development rights granted by UH West Oʻahu as part of a competitive solicitation, consistent with the UH – West Oʻahu Land Use Plan (UH, 2015). The proposal was subsequently selected by Hawaiian Electric to be one of several projects in the final award portfolio of renewable energy projects and the PPA for the Project was subsequently approved by the PUC in 2019. Based on selection of the Project by Hawaiian Electric, AES negotiated an agreement with UH West Oʻahu, which would allow AES to own and operate the Project with the university retaining ownership of the land.

As this is the only property on Oʻahu for which AES has development rights and an approved PPA based on Hawaiian Electric's Phase I RFP, alternative locations for development of a solar photovoltaic and battery energy storage system on Oʻahu (to the extent they exist and may be available) are not being considered at this time.

4.3 Alternative Energy Storage Technology

There are a number of different energy storage system technologies, all of which have different technical performance, operational, and cost characteristics. In order to select the optimal technology, the Project's technical requirements, safety aspects, site and environmental conditions and economic feasibility were evaluated based on the following requirements:

- High-energy output (necessary to achieve a minimum of four hours discharge)
- High-power output (high capacity necessary to supplement solar PV technology)
- Moderate charge/discharge frequency (at least one full cycle per day)
- High depth of discharge capability (important to minimize degradation and extend lifetime)
- Fast response times (needed to comply with utility dispatch requirements)
- Size constraints (to fit within project boundaries)
- Safe and reliable technology (to reduce potential risk to personnel and property)

Overall, these requirements all fall well within the range of capabilities of a battery energy storage system. The Project's capacity requirement of 12.5MW/50MWhr is too low for either a pumped hydro storage system or a typical compressed air energy storage system. Furthermore, pumped hydro storage systems involve substantial geological and environmental impacts, and would not be feasible in this location. For these reasons, a battery system is considered the best storage solution for this Project.

With regards to the different types of battery systems, the high depth of discharge requirement effectively eliminates lead-acid batteries and their new advanced derivatives. Other options include sodium-sulfur and various flow batteries. In this case, the lithium-ion batteries were selected due to their high-energy storage capability and relative maturity as a storage technology. Additionally, lithium-ion batteries have the ability to undergo a high depth of discharge without significant deterioration in operating life; as such, this is the most suitable battery technology for this Project. Table 4-1 summarizes the various technologies; as shown, lithium-ion battery technology most closely matches the Project requirements in terms of power and energy needs.

Table 4-1. Comparison of Energy Storage Technologies

Type	Technology	Description	Typical Power Range	Typical Energy Range
Electrochemical Energy Storage	Sodium-sulfur battery	A molten-salt battery made up of sodium and sulfur that operates at high temperature ranges and is primarily suitable for >4-hour duration applications.	Several kW to a few MW	100 Wh or higher
	Lithium-ion battery	A battery based on charge and discharge reactions from a lithiated metal oxide cathode and graphite anode. This battery technology is used in a wide variety of applications.	1 kW to 100 MW	<200 MWh
	Lead-acid battery	A battery made up of lead dioxide for the positive electrode and a spongy lead negative electrode. Vented and valve-regulated batteries make up two subtypes of this technology.	Up to a few MW	<10 MWh
	Sodium metal halide battery	A molten battery made up on nickel, sodium chloride, and sodium, which is kept at a temperature between 270°C and 350°C. Batteries using other materials are being developed to decrease cost and operation temperatures.	Several MV	4 kWh – several MWh
	Zinc-hybrid cathode battery	A high-energy density battery storage technology that uses inexpensive and widely available materials. Zine-hybrid cathode batteries use non-flammable, near-neutral pH aqueous electrolytes that are non-dendritic and do not absorb CO_2.	250 kW subsystem repeat unit up to 2 MW	1 MWh subsystem repeat unit up to 8 MWh
	Redox flow battery	A battery in which energy storage in the electrolyte tanks is separated from power generation in stacks. The stacks consist of positive and negative electrode compartments divided by a separator or an ion exchange membrane through which ions pass to complete the electrochemical reactions. Scalability due to modularity, ability to change energy and power independently, and long cycle and calendar life are attractive features of this technology.	Several kW – 30 MW	100 kW to 120 MWh
Mechanical Energy Storage	Compressed air energy storage	This energy storage system is based on using electricity to compress air and store it in underground caverns. The air is released when needed and passed through a turbine to generate electricity.	Up to 500 MW	1 GWh to 20 GWh
	Flywheels	A storage system that relies on kinetic energy from rotor spinning through a ”nearly frictionless enclosure” that can provide short-term power through inertia.	Up to 20 MW	Up to 5 MWh
	Pumped storage hydro	A technology that stores energy by pumping water from a lower to a higher reservoir and then releasing it back through the connection, passing through a turbine(s), which generates electricity. This technology is typically used for grid-scale storage.	Up to 3,600 MW	Up to 40 GWh

Type	Technology	Description	Typical Power Range	Typical Energy Range
Electrical Energy Storage	Ultracapacitor	Ultracapacitors store energy at the double layer of each electrode separated by a dielectric and can discharge energy instantaneously. Due to lack of chemical reaction, the cycle life is orders of magnitude higher than battery cycle life.	250 kW to 2 MW	2.5 kWh to 20 kWh
Non-storage Generation	Combustion turbine	A gas turbine coverts fuel such as natural gas to mechanical energy, which drives a generator to produce electricity.	10 kW – 100 MW	Not applicable
Source: DOE, 2019				

Of all the energy storage systems deployed internationally (excluding pumped storage hydro), lithium-ion batteries currently comprise approximately 48 percent of the total storage capacity (DOE, 2019). Lithium-ion batteries currently dominate the market, which further supports the development, testing and certification of this technology. The involvement of financial institutions is indispensable to provide the necessary financing and insurance for storage systems. Due to its development stage and deployment, lithium-ion batteries have become the acceptable industry standard for solar plus storage projects. Massive investments in lithium-ion batteries are driving down costs, while efforts are made to continuously improve safety. The project's lithium-ion batteries are supplied from industry leaders such as Samsung or LG Chem (or equivalent) which are reputable global organizations that meet and exceed the warranty and bankability requirements of investors. Figure 4-1 shows a cost comparison between different storage technologies, with lithium-ion batteries offering the most competitive rate compared to other battery technologies.

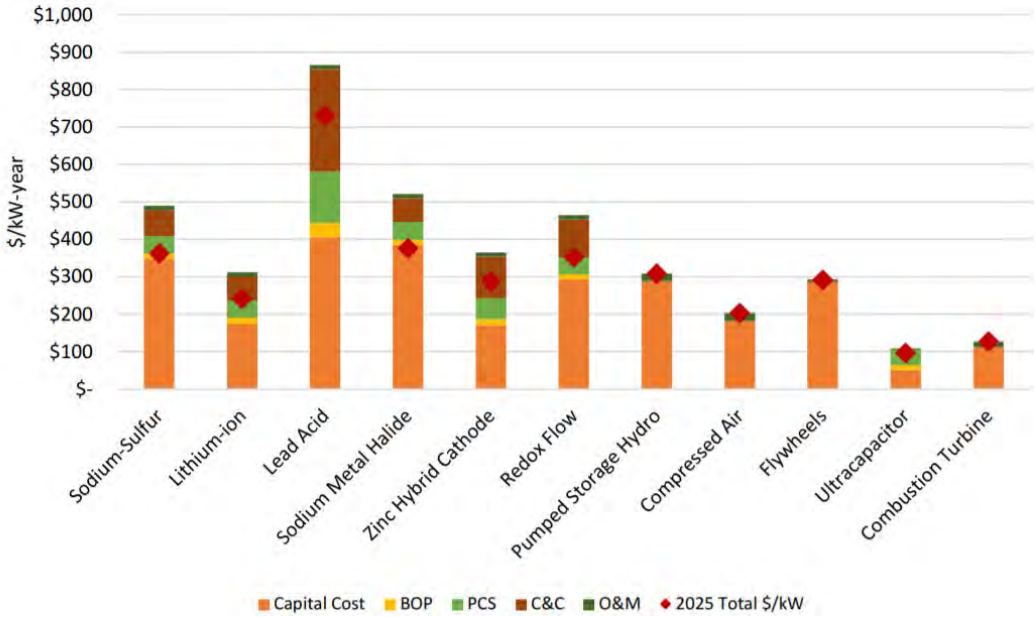

Figure 4-1. Annualized Cost of Various Energy Storage Technologies ($/kW) (DOE, 2019)

Based on this evaluation, lithium-ion batteries were determined to be the best option for an energy storage system for the Project in terms of safety, cost, performance, calendar and cycle life, and technology maturity. As such, other alternative energy storage technologies were eliminated from further consideration.

4.4 Delayed Implementation

As part of the RFP process, Hawaiian Electric required that all selected renewable energy projects for the island of Oʻahu commence commercial operation by December 31, 2022. The agreement with Hawaiian Electric as well as the PPA approved by the PUC establishes a commercial operation date no later than September 30, 2021, subject to the results of an Interconnection Requirements Study. As such, AES is not considering a delayed development schedule for the project.

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5 Consistency with Plans, Policies and Controls

5.1 State of Hawaiʻi

5.1.1 State Land Use Law (HRS Chapter 205)

The Hawaiʻi State Land Use Law (HRS Chapter 205) established the State Land Use Commission and granted the authority to classify all lands in the state into one of four land use districts: urban, rural, agricultural, and conservation. As shown in Figure 3-3, the Project is located on land that is classified within the agricultural district. HRS Chapter 205 specifies the uses that are permitted within the state agricultural district, with consideration given to the Land Study Bureau (LSB) classification system. The LSB system rates the productivity of soils throughout the state based on characteristics including texture, slope, salinity, erodibility, and rainfall, and designates areas in categories ranging from A to E (with Class A representing the most productive soils and Class E representing the least productive soils).

HRS Chapter 205-2(d) specifies that the agricultural district shall include:

> *(6) Solar energy facilities; provided that:*
>
> *(A) This paragraph shall apply only to land with soil classified by the land study bureau's detailed land classification as overall (master) productivity rating class B, C, D, or E; and*
>
> *(B) Solar energy facilities placed within land with soil classified as overall productivity rating class B or C shall not occupy more than ten per cent of the acreage of the parcel, or twenty acres of land, whichever is lesser, unless a special use permit is granted pursuant to section 205-6;*

HRS Chapter 205-4.5 further restricts uses for solar energy facilities on Class B or C soils to include the following:

> *(21) Solar energy facilities on lands with soil classified by the land study bureau's detailed land classification as overall (master) productivity rating B or C for which a special use permit is granted pursuant to section 205-6; provided that:*
>
> *(A) The area occupied by the solar energy facilities is also made available for compatible agricultural activities[3] at a lease rate that is at least fifty per cent below the fair market rent for comparable properties;*
>
> *(B) Proof of financial security to decommission the facility is provided to the satisfaction of the appropriate county planning commission prior to date of commencement of commercial generation; and*
>
> *(C) Solar energy facilities shall be decommissioned at the owner's expense according to the following requirements:*

(i) Removal of all equipment related to the solar energy facility within twelve months of the conclusion of operation or useful life; and

(ii) Restoration of the disturbed earth to substantially the same physical condition as existed prior to the development of the solar energy facility.

As shown in Figure 3-4, the proposed solar facilities would occupy areas with LSB Class B, D and E soils. Pursuant to HRS Chapter 205-4.5, the Project would be a permitted use with issuance of an SUP, assuming compliance with the provisions related to decommissioning, proof of financial security, and making the Project area available for compatible agricultural activities at a lease rate below fair market rent. AES will seek approval of an SUP prior to Project construction; discussion of the permit requirements and approval process is provided below.

As discussed in Section 3.7, no portion of the Project area has been designated as IAL. As such, the Project would be in compliance with HRS Chapter 205 (Part III).

5.1.1.1 Special Use Permit

Based on the requirements outlined above, an SUP will be required for the Project. As specified in HRS Chapter 205-6, an SUP may be granted for "certain unusual and reasonable uses within agricultural and rural districts other than those for which the district is classified." The County Planning Commission is the decision-making authority for all SUPs; if the proposed use involves more than 15 acres of land (such as for this Project) or involves IAL, the SUP also requires approval by the State Land Use Commission.

To apply for an SUP within the City and County of Honolulu, an application must be submitted to DPP for review and processing. For proposed uses that require compliance with HRS Chapter 343 (such as this Project), an SUP application cannot be accepted for processing until the requirements of HRS Chapter 343 have been met. Once the application has been accepted by DPP, the application is circulated for agency review and comment; a Director's Report and Recommendation is then provided by DPP to the Planning Commission for their consideration. A public hearing is held as part of the Planning Commission review process; the Planning Commission recommendation and a complete record of the proceedings are then transmitted to the Land Use Commission. The Land Use Commission review process also includes a public hearing, following which a decision to approve, approve with modification, or deny the application is rendered.

The Land Use Commission guidelines for determining "unusual and reasonable" uses for granting of an SUP are provided in HAR §15-15-95(b). These guidelines are bulleted below, with a preliminary discussion of the Project's compliance with each guideline; additional detail will be provided in the SUP application package.

(1) The use shall not be contrary to the objectives sought to be accomplished by HRS Chapters 205 and 205A and the rules of the commission

As described throughout this document, the Project would comply with the provisions of HRS Chapter 205-4.5. Along with the solar and storage facilities, the Project area would be made available for compatible agricultural activities, such as honey production and cattle grazing and production. Facilities

and equipment to support the agricultural activities, such as beekeeping stations, cattle trap areas and water troughs, would be installed as part of the Project.

Based on the approved PPA, the Project is expected to have an operational life of approximately 25 years (through 2046). At that point in time, the facility may be re-powered under a re-negotiated PPA (with subsequent permits/approvals) or decommissioned. Decommissioning would involve removal of all equipment associated with the Project and returning the Project area to substantially the same condition as existed prior to Project development. In accordance with the requirements of HRS Chapter 205-4.5(a)(21), financial assurance for decommissioning would be provided to the City & County of Honolulu Planning Commission prior to the commencement of commercial generation.

The Project would also be in compliance with the objectives and policies of HRS Chapter 205A, as further discussed in Section 5.1.2.

(2) The desired use would not adversely affect surrounding property

The Project area is located in the ʻEwa District, approximately 3 miles northeast of Kapolei. Based on its designation in the City and County of Honolulu's General Plan and ʻEwa Development Plan as the island's secondary urban center, much of the growth on Oʻahu has been focused in this region. Large scale development of the City of Kapolei started in the 1990s, and has included a wide range of commercial, residential, industrial and government facilities.

The Project would be located within the southwestern portion of the 991-acre UH West Oʻahu Mauka Lands property, which was historically part of an extensive agricultural plantation, but has been fallow and intermittently used for cattle grazing since the 1990s. The lands immediately surrounding the Project area, which are also part of the UH West Oʻahu Mauka Lands property, would continue to be used for cattle grazing and would not be affected by construction or operation of the solar and storage facilities. Other surrounding uses beyond the adjacent lands include the former Honouliuli Internment Camp site (approximately 1 mile to the northeast) and Makakilo Quarry (approximately 0.6 mile to the southwest); the residential community of Makakilo is located just north of the quarry, with the closest residential structure approximately 0.3 mile from the Project area. As discussed in Section 3.8.2, the Project would be visible to varying degrees from surrounding areas; however, it would not obstruct or impede views of the Waiʻanae Mountains, Pacific Ocean or other scenic resources. The Project facilities would introduce new visual elements within the landscape, but these would be seen in the context of other development including high-voltage transmission lines, commercial and residential structures, the rail transit system, Makakilo Quarry and other man-made features.

Construction of the solar and storage facilities would involve a variety of ground disturbing activities, such as site preparation and grading, equipment installation (e.g., driving support posts), and trenching for the underground collection lines. Use of heavy equipment and earthmoving operations conducted as part of these activities would generate noise, as well as temporary fugitive dust and internal combustion engine emissions, resulting in temporary and localized impacts to air quality. BMPs would be implemented to minimize the noise and emission levels, and in general, the impacts are expected to be temporary, intermittent, and localized in nature. Similarly, construction and operation of the Project

would require a variety of truck deliveries and other vehicle trips; however, these are not expected to measurably affect traffic levels; in addition, BMPs would be implemented to avoid, minimize and mitigate potential impacts based on Complete Streets principles. Overall, none of these impacts would be expected to alter the character of the surrounding areas in a manner that would result in significant adverse effects.

(3) The use would not unreasonably burden public agencies to provide roads and streets, sewers, water drainage and school improvements, and police and fire protection

The Project would not require improvements or otherwise burden public infrastructure, nor would it be expected to require police or fire protection services.

(4) Unusual conditions, trends, and needs have arisen since the district boundaries and rules were established

As discussed in Section 1.1, the State of Hawaiʻi has established an RPS, as codified in HRS Chapter 269-92, which specifies that electric utility companies in Hawaiʻi must use renewable energy for the equivalent of 30 percent of net electricity sales by 2020, 40 percent by 2030, seventy percent by 2040, and 100 percent by 2045. As of the third quarter of 2019, approximately 25 percent of Hawaiian Electric's electrical energy sales on Oʻahu were generated by renewable energy sources (Hawaiian Electric, 2019b).

The Project area is well suited for solar energy generation as it includes undeveloped land with relatively flat to moderate slopes that can accommodate the solar modules and battery storage facilities, an existing access road that can be traversed by construction equipment, and the ability to interconnect with the existing Hawaiian Electric grid onsite. It is recognized that these site attributes are also valuable for agricultural purposes, and it is understood that there is a need to balance agricultural and renewable energy production. By making the Project area available for compatible agricultural activities, the Project seeks to balance these uses.

(5) The land upon which the proposed use is sought is unsuited for the uses permitted within the district

As discussed in Section 2.1.7, agricultural activities in the Project area are highly constrained by site-specific factors, particularly the lack of infrastructure and uncertainty of water for irrigation. However, the Project area would be used in a manner that balances both agriculture and renewable energy needs. The Project is consistent with the underlying objectives of HRS Chapter 205, in that it would support and subsidize compatible agricultural activities (such as honey production and cattle grazing) and would implement specific decommissioning provisions in which the land would be returned to substantially the same condition as existed prior to Project development, thus allowing for the full range of future agricultural uses.

5.1.2 Coastal Zone Management Program (HRS Chapter 205A)

Under the authority of the federal Coastal Zone Management Act (16 U.S.C. 1451-1456), the Hawaiʻi CZM Program was enacted as HRS Chapter 205A and is administered by the State of Hawaiʻi Department

of Business, Economic Development and Tourism (DBEDT) Office of Planning. The purpose of the Hawai‘i CZM program is to provide for the effective management, beneficial use, protection, and development of the coastal zone. It is designed to integrate decisions made by state and county agencies to provide greater coordination and compliance with existing laws and rules. The CZM area encompasses the entire state. The objectives of the Hawai‘i CZM Program are listed in Table 5-1, with a brief statement regarding the consistency of the Project with each of the objectives and associated policies.

Table 5-1. Project Consistency with the Objective and Policies of the Hawai‘i CZM Program

Objectives and Policies	Assessment of Consistency
Recreational Resources: Provide coastal recreational opportunities accessible to the public.	The Project area does not support coastal nor any other type of recreational resources; the nearest coastal recreational areas are approximately 4 miles west and 5 miles south of the Project area. The Project would not impair access to the shoreline, degrade the quality of coastal waters, or otherwise affect coastal recreational opportunities.
Historic Resources: Protect, preserve, and where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.	An AIS was conducted for the Project, including detailed background research and a 100 percent pedestrian inspection of the Project area. The AIS identified two historic properties within the Project area, consisting of historic irrigation and plantation infrastructure and a remnant portion of the Waiahole Ditch. The Draft AIS Report has been submitted and is pending review by SHPD in compliance with HRS Chapter 6E and HAR §13-284. Implementation of the Project would affect portions of these historic properties within the Project area; however, based on the conclusions regarding the significance and documentation to date, the impacts are not expected to be significant. Pursuant to HAR §13-284-7 and subject to review and concurrence by SHPD, the effect determination for the Project is “no historic properties affected.”
Scenic and Open Space Resources: Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources.	Within the Project area, the solar photovoltaic and storage facilities would have a very small permanent footprint; the surrounding portions of the Project area would be maintained as open space. The Project would be visible to varying degrees from surrounding areas; however, it would not obstruct or impede views of the Wai‘anae Mountains, Pacific Ocean or other scenic resources. The Project facilities would introduce new visual elements within the landscape, but these would be seen in the context of other development including high-voltage transmission lines, commercial and residential structures, the rail transit system, Makakilo Quarry and other man-made features.
Coastal Ecosystems: Protect valuable coastal ecosystems, including reefs, from disruption and to minimize adverse impacts on all coastal ecosystems.	The Project would be located inland and would not involve work within or near coastal ecosystems. Ground disturbance during construction could temporarily increase the amount of sediment and other pollutants in stormwater runoff, which could affect water quality in receiving waters. However, BMPs would be implemented such that no adverse impacts to coastal ecosystems are anticipated.
Economic Uses: Provide public or private facilities and improvements important to the State’s economy in suitable locations.	The Project is not a coastal-dependent development. It would involve construction and operation of a solar energy generation facility in an inland location, within the State agricultural land use district. Based on the soil classification (LSB Class B, D and E), the Project is permitted within the State agricultural land use district use with issuance of an SUP, assuming compliance with the provisions related to decommissioning, proof of financial security, and making the Project area available for compatible agricultural activities at a lease rate below fair market rent. Activities that would be conducted pursuant to these requirements are described in Sections 2.1.7 and 2.4.

Objectives and Policies	Assessment of Consistency
Coastal Hazards: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.	The Project area is not within a tsunami or floodplain zone and is not subject to coastal hazards. The Project would be designed and constructed in compliance with all applicable Federal, State, and local environmental protection, design, and building standards and regulations, including the Federal Flood Insurance Program, and would not contribute to coastal flooding.
Managing Development: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.	As detailed in Section 7, outreach and consultation was initiated with Project stakeholders early in the Project development process. In parallel, this EA has been prepared to disclose the potential impacts of the Project; the environmental review process includes opportunities for public review and comment, pursuant to HRS Chapter 343 and HAR §11-200.1. The discretionary permitting process will also include opportunities for public participation.
Public Participation: Stimulate public awareness, education, and participation in coastal management.	The Project does not contain a public participation component for programmatic coastal management issues. Project-specific input has and will continue to be sought through the HRS Chapter 343 EA and permitting process.
Beach Protection: Protect beaches for public use and recreation.	The Project would be located inland and would not involve placement of any structures within the shoreline setback area or otherwise affect erosion or natural shoreline processes.
Marine Resources: Promote the protection, use, and development of marine and coastal resources to assure their sustainability.	The Project would not be located near the shoreline and would not directly or indirectly affect any marine resources.

Key components of the Hawaiʻi CZM Program include (1) regulation of development within the Special Management Area (SMA), a designated area extending inland from the shoreline, (2) restrictions within the shoreline setback area, which serves as a buffer against coastal hazards and erosion and to protect viewplanes, and (3) a Federal Consistency provision, which requires that federal activities, permits, and financial assistance be consistent with the enforceable policies of the Hawaiʻi CZM program, to the maximum extent practicable. The Project area is not within either the SMA or the shoreline setback area, nor would it involve a federal activity or permit requiring federal consistency review.

5.1.3 Hawaiʻi State Planning Act (HRS Chapter 226)

The Hawaiʻi State Planning Act (HRS Chapter 226) is a broad policy document relating to the statewide planning system, including all activities, programs and decisions made by local and state agencies. It is intended to "improve the planning process in this state, to increase the effectiveness of government and private actions, to improve coordination among different agencies and levels of government, to provide for wise use of Hawaiʻi's resources and to guide the future development of the state" (HRS Chapter 226-1). The State Plan serves as written guide for the long-range development of the state by describing the desired future for the residents of Hawaiʻi and providing a set of goals, objectives, and policies that are intended to shape the general direction of public and private development. Part I of the State Plan lists the state's long-range goals, objectives, policies and priorities. Part II establishes a statewide planning system to coordinate and implement the State Plan. Part III establishes priority guidelines to address areas of statewide concern.

The stated goals of the state plan relate to a strong viable economy, a desired physical environment, and individual and family well-being (HRS Chapter 226-4). Overall, the Project supports these goals; in particular, it would serve to provide a clean source of renewable energy that reduces the use of fossil fuels to meet the state's energy needs, while providing environmental and human health benefits. Consistency of the Project with the specific objectives and policies in the Hawaiʻi State Plan is summarized in Table 5-2. Consistency of the Project with the specific relevant priority guidelines in the Hawaiʻi State Plan is summarized in Table 5-3. Relevant state functional plans are discussed in the following subsection.

Table 5-2. Project Consistency with the Objective and Policies of the Hawaiʻi State Planning Act

Objectives	Assessment of Consistency
Population: It shall be the objective in planning for the State's population to guide population growth to be consistent with the achievement of physical, economic, and social objectives contained in this chapter.	The Project would not have any effect on population growth.
Economy - In General: Planning for the State's economy in general shall be directed toward achievement of the following objectives: (1) Increased and diversified employment opportunities to achieve full employment, increased income and job choice, and improved living standards for Hawaiʻi's people, while at the same time stimulating the development and expansion of economic activities capitalizing on defense, dual-use, and science and technology assets, particularly on the neighbor islands where employment opportunities may be limited. (2) A steadily growing and diversified economic base that is not overly dependent on a few industries and includes the development and expansion of industries on the neighbor islands.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (7) Expand existing markets and penetrate new markets for Hawaiʻi's products and services. (12) Encourage innovative activities that may not be labor-intensive, but may otherwise contribute to the economy of Hawaiʻi. The Project would contribute to Hawaiʻi's growing renewable energy market and would provide employment opportunities for Hawaiʻi residents in the innovative renewable energy field, particularly during construction; although operations would not include many labor-intensive activities, the Project would positively contribute to Hawaiʻi's economy.
Economy – Agriculture: Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives: (1) Viability of Hawaiʻi's sugar and pineapple industries. (2) Growth and development of diversified agriculture throughout the State. (3) An agriculture industry that continues to constitute a dynamic and essential component of Hawaiʻi's strategic, economic, and social well-being.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (2) Encourage agriculture by making the best use of natural resources. (12) In addition to the State's priority on food, expand Hawaiʻi's agricultural base by promoting growth and development of flowers, tropical fruits and plants, livestock, feed grains, forestry, food crops, aquaculture, and other potential enterprises. The Project would seek to balance agricultural and renewable energy needs. Specifically, it would support and subsidize compatible agricultural activities (such as honey production and cattle grazing) and would implement specific decommissioning provisions in which the land would be returned to substantially the same condition as existed prior to development of the solar facilities, thus allowing for a full range of future agricultural uses.
Economy – Visitor Industry: Planning for the State's economy with regard to the visitor industry shall be directed towards the achievement of the objective of a visitor industry that constitutes a major component of steady growth for Hawaiʻi's economy.	The Project would not have any effect on the economy as related to the visitor industry.

Objectives	Assessment of Consistency
Economy – Federal Expenditures: Planning for the State's economy with regard to federal expenditures shall be directed towards achievement of the objective of a stable federal investment base as an integral component of Hawai‘i’s economy.	The Project would not involve any federal expenditures.
Economy - Potential Growth and Innovative Activities: Planning for the State's economy with regard to potential growth and innovative activities shall be directed towards achievement of the objective of development and expansion of potential growth and innovative activities that serve to increase and diversify Hawai‘i’s economic base.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (1) Facilitate investment and employment growth in economic activities that have the potential to expand and diversify Hawai‘i’s economy, including but not limited to diversified agriculture, aquaculture, renewable energy development, creative media, health care, and science and technology-based sectors. (8) Accelerate research and development of new energy-related industries based on wind, solar, ocean, underground resources, and solid waste. The Project would contribute to and further diversify Hawai‘i’s economy through the growing renewable energy market.
Economy - Information Industry: Planning for the State's economy with regard to telecommunications and information technology shall be directed toward recognizing that broadband and wireless communication capability and infrastructure are foundations for an innovative economy and positioning Hawai‘i as a leader in broadband and wireless communications and applications in the Pacific Region.	The Project would not have any effect on the economy as related to telecommunication and information technology.
Physical Environment - Land-based, Shoreline, and Marine Resources: Planning for the State's physical environment with regard to land-based, shoreline, and marine resources shall be directed towards achievement of the following objectives: (1) Prudent use of Hawai‘i’s land-based, shoreline, and marine resources. (2) Effective protection of Hawai‘i’s unique and fragile environmental resources.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (3) Take into account the physical attributes of areas when planning and designing activities and facilities. (4) Manage natural resources and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage. (8) Pursue compatible relationships among activities, facilities, and natural resources. The Project area has been extensively modified by previous agricultural operations and is dominated by non-native species. Regardless, the Project has been designed to minimize ground disturbance and maintain ample, natural open space surrounding the Project facilities. Impacts to natural resources would be avoided and minimized to the extent possible through implementation of BMPs.
Physical Environment - Scenic, Natural Beauty, and Historic Resources: Planning for the State's physical environment shall be directed towards achievement of the objective of enhancement of Hawai‘i’s scenic assets, natural beauty, and multi-cultural/historical resources.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (1) Promote the preservation and restoration of significant natural and historic resources. (3) Promote the preservation of views and vistas to enhance the visual and aesthetic enjoyment of mountains, ocean, scenic landscapes, and other natural features. An AIS has been conducted for the Project and is currently in reviewed with SHPD. Historic properties identified within the Project area include plantation-era infrastructure and a

Objectives	Assessment of Consistency
	remnant section of the Waiahole Ditch; the Project would avoid these properties to the extent possible and would incorporate the recommended mitigation. The Project would be visible to varying degrees from surrounding areas; however, it would not obstruct or impede views of the Waiʻanae Mountains, Pacific Ocean or other scenic resources. The Project facilities would introduce new visual elements within the landscape, but these would be seen in the context of other development including high-voltage transmission lines, commercial and residential structures, the rail transit system, Makakilo Quarry and other man-made features.
Physical Environment - Land, Air, and Water Quality: Planning for the State's physical environment with regard to land, air, and water quality shall be directed towards achievement of the following objectives: (1) Maintenance and pursuit of improved quality in Hawaiʻi's land, air, and water resources. (2) Greater public awareness and appreciation of Hawaiʻi's environmental resources.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (3) Promote effective measures to achieve desired quality in Hawaiʻi's surface, ground, and coastal waters. (4) Encourage actions to maintain or improve aural and air quality levels to enhance the health and well-being of Hawaiʻi's people. BMPs would be implemented as part of the Project to avoid and minimize impacts to water quality and air quality. Once operational, the Project would provide a net benefit by replacing energy generated by burning fossil fuels with renewable energy, thereby reducing emissions of greenhouse gases.
Facility Systems – In General: Planning for the State's facility systems in general shall be directed towards achievement of the objective of water, transportation, waste disposal, and energy and telecommunication systems that support statewide social, economic, and physical objectives.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (2) Encourage flexibility in the design and development of facility systems to promote prudent use of resources and accommodate changing public demands and priorities. (3) Ensure that required facility systems can be supported within resource capacities and at reasonable cost to the user. The Project would help to meet the state's need for renewable energy by providing up to 12.5 MW of solar energy and 50 MWh of battery storage. Based on the 25-year fixed-price PPA, the energy produced by the Project would be sold at a price that is less than the current cost of fossil fuel power and would help to hedge long-term price volatility. The Project would also help to improve electric grid stability by enabling Hawaiian Electric to utilize stored solar energy to meet peak demand. The Project area would be made available for compatible agriculture activities such as honey production and cattle grazing/production, contributing to agricultural production while requiring minimal water resources.
Facility Systems – Solid and Liquid Wastes: Planning for the State's facility systems with regard to solid and liquid wastes shall be directed towards the achievement of the following objectives: (1) Maintenance of basic public health and sanitation standards relating to treatment and disposal of solid and liquid wastes.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (2) Promote reuse and recycling to reduce solid and liquid wastes and employ a conservation ethic. Construction and operation of the Project would generate very little waste. At the end of operations, the Project would be decommissioned, including removal of all Project equipment from the Project area. It is anticipated that most materials would be either salvaged or recycled. Only a small portion of

Objectives	Assessment of Consistency
(2) Provision of adequate sewerage facilities for physical and economic activities that alleviate problems in housing, employment, mobility, and other areas.	the Project equipment would be disposed of as solid waste; these materials would be disposed of at authorized sites in accordance with applicable laws.
Facility Systems – Water: Planning for the State's facility systems with regard to water shall be directed towards achievement of the objective of the provision of water to adequately accommodate domestic, agricultural, commercial, industrial, recreational, and other needs within resource capacities.	The Project would not have any effect on facility systems related to water.
Facility Systems – Transportation: Planning for the State's facility systems with regard to transportation shall be directed towards the achievement of the following objectives: (1) An integrated multi-modal transportation system that services statewide needs and promotes the efficient, economical, safe, and convenient movement of people and goods. (2) A statewide transportation system that is consistent with and will accommodate planned growth objectives throughout the State.	The Project would not have any effect on facility systems related to transportation.
Facility Systems – Energy: Planning for the State's facility systems with regard to energy shall be directed toward the achievement of the following objectives, giving due consideration to all: (1) Dependable, efficient, and economical statewide energy systems capable of supporting the needs of the people; (2) Increased energy security and self-sufficiency through the reduction and ultimate elimination of Hawai‘i’s dependence on imported fuels for electrical generation and ground transportation; (3) Greater diversification of energy generation in the face of threats to Hawai‘i’s energy supplies and systems; (4) Reduction, avoidance, or sequestration of greenhouse gas emissions from energy supply and (5) Utility models that make the social and financial interests of Hawai‘i’s utility customers a priority.	The Project would be consistent with the objectives and policies for this theme, particularly the following policies: (1) Support research and development as well as promote the use of renewable energy sources The Project would help to meet the state’s need for renewable energy by providing up to 12.5 MW of solar energy and 50 MWh of battery storage, which is enough electricity for approximately 4,600 homes on O‘ahu (based on average energy use). The Project is expected to offset the use of approximately 545,794 barrels of fuel and 64 tons of coal and would decrease greenhouse gas emissions by approximately 244,394 tons over its lifetime (Hawaiian Electric, 2019a).
Facility Systems – Telecommunications: Planning for the State's telecommunications facility systems shall be directed towards the achievement of dependable, efficient, and economical statewide telecommunications systems capable of supporting the needs of the people.	The Project would not have any effect on facility systems related to telecommunications.
Socio-Cultural Advancement - Housing: Planning for the State's socio-cultural advancement with regard to housing shall be directed toward the achievement of the following objectives: (1) Greater opportunities for Hawai‘i’s people to secure reasonably priced, safe, sanitary, and livable homes, located in suitable environments that satisfactorily accommodate the needs and desires of families and individuals, through collaboration and cooperation between government and nonprofit and for-profit developers to ensure that more rental and for sale affordable housing is made available to extremely low-, very low-, lower-, moderate-, and above moderate-income segments of Hawai‘i’s population.	The Project would not have any effect on housing.

Objectives	Assessment of Consistency
(2) The orderly development of residential areas sensitive to community needs and other land uses. (3) The development and provision of affordable rental housing by the State to meet the housing needs of Hawai‘i’s people.	
Socio-Cultural Advancement – Health: Planning for the State's socio-cultural advancement with regard to health shall be directed towards achievement of the following objectives: (1) Fulfillment of basic individual health needs of the general public. (2) Maintenance of sanitary and environmentally healthful conditions in Hawai‘i’s communities. (3) Elimination of health disparities by identifying and addressing social determinants of health.	The Project would not have any effect on health.
Socio-Cultural Advancement – Education: Planning for the State's socio-cultural advancement with regard to education shall be directed towards achievement of the objective of the provision of a variety of educational opportunities to enable individuals to fulfill their needs, responsibilities, and aspirations.	The Project would not have any effect on education.
Socio-Cultural Advancement – Social Services: Planning for the State's socio-cultural advancement with regard to social services shall be directed towards the achievement of the objective of improved public and private social services and activities that enable individuals, families, and groups to become more self-reliant and confident to improve their well-being.	The Project would not have any effect on social services.
Socio-Cultural Advancement – Leisure: Planning for the State's socio-cultural advancement with regard to leisure shall be directed towards the achievement of the objective of the adequate provision of resources to accommodate diverse cultural, artistic, and recreational needs for present and future generations.	The Project would not have any effect on leisure activities.
Socio-Cultural Advancement – Individual Rights and Personal Well-Being: Planning for the State's socio-cultural advancement with regard to individual rights and personal well-being shall be directed towards achievement of the objective of increased opportunities and protection of individual rights to enable individuals to fulfill their socio-economic needs and aspirations.	The Project would not have any effect on individuals' rights and personal well-being.
Socio-Cultural Advancement – Culture: Planning for the State's socio-cultural advancement with regard to culture shall be directed toward the achievement of the objective of enhancement of cultural identities, traditions, values, customs, and arts of Hawai‘i’s people.	The Project would not have any effect on culture.
Socio-Cultural Advancement – Public Safety: Planning for the State's socio-cultural advancement with regard to public safety shall be directed towards the achievement of the following objectives: (1) Assurance of public safety and adequate protection of life and property for all people. (2) Optimum organizational readiness and capability in all phases of emergency management to maintain the strength, resources, and social and economic well-being of the community	The Project would not have any effect on public safety.

Objectives	Assessment of Consistency
in the event of civil disruptions, wars, natural disasters, and other major disturbances. (3) Promotion of a sense of community responsibility for the welfare and safety of Hawai‘i’s people.	
Socio-Cultural Advancement – Government: Planning the State's socio-cultural advancement with regard to government shall be directed towards the achievement of the following objectives: (1) Efficient, effective, and responsive government services at all levels in the State. (2) Fiscal integrity, responsibility, and efficiency in the state government and county governments.	The Project would not have any effect on government.

Table 5-3. Project Consistency with the Priority Guidelines of the Hawai‘i State Planning Act

Priority Guidelines	Assessment of Consistency
Economic Priority Guidelines	
(a) To stimulate economic growth and encourage business expansion and development to provide needed jobs for Hawai‘i’s people and achieve a stable and diversified economy	The Project would be consistent with these guidelines, particularly the following: (1) Seek a variety of means to increase the availability of investment capital for new and expanding enterprises (A)(i) Encourage investments which reflect long-term commitments to the State (A)(iii) Diversify the economy The Project would be part of the growing renewable energy industry in Hawai‘i, helping to both diversify Hawai‘i’s economy and provide valuable job opportunities to residents. The power generated by the Project would be sold to Hawaiian Electric under a new 25-year PPA.
(b) To promote the economic health and quality of the visitor industry	The Project would not have any effect on the visitor industry.
(c) To promote the continued viability of the sugar and pineapple industries	The Project would not have any effect on the sugar and pineapple industries.
(d) To promote the growth and development of diversified agriculture and aquaculture	The Project would be consistent with these guidelines, particularly the following: (7) Encourage the development and expansion of agricultural and aquacultural activities which offer long-term economic growth potential and employment opportunities. The Project would support and subsidize agricultural activities that are compatible with the solar facilities (such as honey production and cattle grazing).
(e) Water use and development	The Project would not have any effect on water use and development.
(f) Energy use and development	The Project would be consistent with these guidelines, particularly the following: (1) Encourage the development, demonstration, and commercialization of renewable energy sources The Project would help to meet the state’s need for renewable energy by providing up to 12.5 MW of solar energy and 50 MWh of battery storage. It would also meet the needs of Hawaiian Electric’s system by allowing energy to be stored and dispatched at times of higher demand and offset night-time fossil fuel generation.

Priority Guidelines	Assessment of Consistency
(g) To promote the development of the information industry	The Project would not have any effect on the information industry.
Population Growth and Land Resources Priority Guidelines	
(a) To effect desired statewide growth and distribution	The Project would not have any effect on statewide growth and distribution.
(b) Regional growth distribution and land resource utilization	The Project would be consistent with these guidelines, particularly the following: (2) Make available marginal or nonessential agricultural lands for appropriate urban uses while maintaining agricultural lands of importance in the agricultural district. (9) Direct future urban development away from critical environmental areas or impose mitigating measures so that negative impacts on the environment would be minimized. The Project area has been extensively modified by past agricultural activities and is dominated by non-native species. Impacts to natural resources within or near the Project area would be avoided and minimized through the implementation of BMPs. Although the Project area is within the agricultural district, agricultural activities are highly constrained by site-specific factors, particularly the lack of available infrastructure and uncertainty of water for irrigation. Consistent with the requirements of HRS Chapter 205, the Project would support and subsidize compatible agricultural activities (such as honey production and cattle grazing) and would implement specific decommissioning provisions in which the land would be returned to substantially the same condition as existed prior to Project development, thus allowing for the full range of future agricultural uses.
Crime and Criminal Justice Priority Guidelines	
In the area of crime and criminal justice	The Project would not have any effect on crime and criminal justice.
Affordable Housing Priority Guidelines	
Provision of affordable housing	The Project would not have any effect on affordable housing.
Quality Education Priority Guidelines	
To promote quality education	The Project would not have any effect on quality education.
Sustainability Priority Guidelines	
To promote sustainability	The Project would be consistent with these guidelines, particularly the following: (1) Encouraging balanced economic, social, community, and environmental priorities (2) Encouraging planning that respects and promotes living within the natural resources and limits of the State (3) Promoting a diversified and dynamic economy (4) Encouraging respect for the host culture (5) Promoting decisions based on meeting the needs of the present without compromising the needs of future generations The Project would help to meet Hawai‘i’s economic, social, community and environmental priorities by providing clean, renewable solar energy with minimal adverse effects on the environment. In addition to helping meet the state’s renewable energy goals, the Project would also contribute to economic and social welfare by creating local employment opportunities, providing a source of revenue for the state, helping to hedge against long-term volatility in energy prices, and improving stability of the electric grid.

Priority Guidelines	Assessment of Consistency
Climate Change Adaptation Priority Guidelines	
To prepare the State to address the impacts of climate change, including impacts to the areas of agriculture; conservation lands; coastal and nearshore marine areas; natural and cultural resources; education; energy; higher education; health; historic preservation; water resources; the built environment, such as housing, recreation, transportation; and the economy	The Project would be consistent with these guidelines, particularly the following: (10) Encourage planning and management of the natural and built environments that effectively integrate climate change policy The Project would involve generation and storage of clean, renewable solar energy, thus contributing to Hawaiʻi's renewable energy goals. The solar energy from the Project would replace a portion of electricity that is currently generated by burning fossil fuels, thus reducing greenhouse gas emissions.

5.1.3.1 Functional Plans

In addition to establishing goals, objectives, and policies for the State of Hawaiʻi, HRS Chapter 226 also directs state agencies to prepare state functional plans for statewide priority issues. A total of 13 functional plans have been developed; these relate to agriculture, conservation lands, education, employment, energy, health, higher education, historic preservation, housing, human services, recreation, tourism and transportation. The plans that are most relevant to the Project are the agriculture and energy state plans; a brief discussion of the Project's consistency with each of these plans follows.

Agriculture Functional Plan. The agriculture functional plan describes the vision of agriculture in Hawaiʻi as having (a) growth and size of the sugar industry determined by optimal economic efficiency; (b) continued growth in pineapple production with more growth expected in production of fresh pineapple; and (c) greatest growth in diversified crops and products (DOA, 1991). The plan outlines actions directed at the factors and conditions that are key to achieving this vision; these relate to industry research and development, agricultural pests and the environment, land and water, and services and infrastructure. The plan identifies objectives, policies and priority actions relative to each of these issues. The majority of these relate to the broader agricultural industry and thus are not applicable to the Project; however, the Project would be consistent with the following:

- **Policy H(1):** Provide suitable public lands at a reasonable cost and with long-term tenure for commercial agricultural purposes
- **Action H(2)(c):** Administer land use district boundary amendments, permitted land uses, infrastructure standards, and other planning and regulatory functions on important agricultural lands and lands in agricultural use, so as to ensure the availability of agriculturally suitable lands and promote diversified agriculture.

The Project is located within the State agricultural land use district; no portion of the Project area has been designated as IAL. Pursuant to HRS Chapter 205-4.5, the Project is permitted within the State agricultural land use district use with approval of an SUP by the Land Use Commission, and compliance with the provisions related to decommissioning, proof of financial security, and making the Project area available for compatible agricultural activities at a lease rate below fair market rent. As described

throughout this document, the Project area would be made available for compatible agricultural activities, such as honey production and cattle grazing and production. The Project also incorporates specific decommissioning requirements in which the land would be returned to substantially the same condition as existed prior to Project development, thus allowing for the full range of future agricultural uses. As the solar facilities are a permitted land use in the agricultural district and the compatible agricultural activities would be supported and subsidized over the 25-year Project term, the Project is consistent with the agriculture functional plan.

Energy Functional Plan. The energy functional plan describes an overall objective of achieving dependable, efficient and economical statewide energy systems capable of supporting the needs of the people and increasing energy self-sufficiency. The plan specifically identifies the need to reduce dependence on imported fossil fuels such as oil and the state's vulnerability to supply disruptions (DBEDT, 1991). The plan establishes policies and actions to promote energy conservation and efficiency, displace fossil fuel consumption, support public education and legislation on energy, improve the development and management of energy, and assist with energy emergency preparedness. The following polices and actions are applicable to the Project:

- **Policy B(1):** Displace oil and fossil fuel consumption through the application of appropriate alternate and renewable energy resources and technologies.
- **Action B(1)(l):** Expand upon the existing 20 kW photovoltaic utility-scale application[25]

The Project would provide up to 12.5 MW of solar energy and 50 MWh of battery storage, which is enough electricity for approximately 4,600 homes on Oʻahu (based on average energy use), thus offsetting the use of approximately 545,794 barrels of fuel and 64 tons of coal (Hawaiian Electric, 2019a). It is directly responsive to the need for development of renewable energy sources and displacement of fossil fuel consumption; as such, the Project is consistent with the Energy State Functional Plan.

5.1.4 Hawaiʻi State Environmental Policy (HRS Chapter 344)

HRS Chapter 344 establishes a state policy to encourage productive and enjoyable harmony between people and their environment, promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, and enrich the understanding of ecological systems and natural resources important to the people of Hawaiʻi. Table 5-4 summarizes the Project's consistency with the specific guidelines identified in HRS Chapter 344.

[25] The application referred to in this action is a 20kW PVUSA system on Maui that was designed to demonstrate photovoltaics in a utility setting.

Table 5-4. Project Consistency with Hawaiʻi State Environmental Policy

Guideline	Assessment of Consistency
Population	
Recognize population impact as a major factor in environmental degradation and adopt guidelines to alleviate this impact and minimize future degradation;	The Project would not have any effect on population.
Recognize optimum population levels for counties and districts within the State, keeping in mind that these will change with technology and circumstance, and adopt guidelines to limit population to the levels determined.	
Land, Water, Mineral, Visual, Air, and Other Natural Resources	
Encourage management practices which conserve and fully utilize all natural resources;	The Project has been designed to minimize ground disturbance and maintain ample, natural open space surrounding the Project facilities. Impacts to natural resources would be avoided and minimized to the extent possible through implementation of BMPs.
Promote irrigation and waste water management practices which conserve and fully utilize vital water resources;	The Project is expected to only require temporary irrigation during plant establishment. Irrigation water would likely be provided via a temporary system and would only be used as needed.
Promote the recycling of waste water;	The Project would not generate any waste water.
Encourage management practices which conserve and protect watersheds and water sources, forest, and open space areas;	The Project has been designed to avoid surface water features to the maximum extent practicable. The only direct impacts to surface water features would be associated with construction of a single road crossing over a tributary to Kaloʻi Gulch to allow for access between the various solar arrays. The crossing would be designed to have as small of a footprint as possible and to maintain unobstructed flows following rain events.
Establish and maintain natural area preserves, wildlife preserves, forest reserves, marine preserves, and unique ecological preserves;	The Project would not involve any activities within a natural area preserve, wildlife preserve, forest reserve, marine preserve, or unique ecological preserve.
Maintain an integrated system of state land use planning which coordinates the state and county general plans;	The Project would be consistent with relevant state and county plans, as discussed in Section 5 of the EA.
Promote the optimal use of solid wastes through programs of waste prevention, energy resource recovery, and recycling so that all our wastes become utilized.	Construction and operation of the Project would generate very little waste. As part of Project decommissioning, all Project equipment would be removed; it is anticipated that most materials would be either salvaged or recycled. Only a small portion of the Project equipment would be disposed of as solid waste; disposal would be at authorized sites in accordance with applicable laws.
Flora and Fauna	
Protect endangered species of indigenous plants and animals and introduce new plants or animals only upon assurance of negligible ecological hazard	The Project area has been extensively modified by previous agricultural operations and is dominated by non-native species. No federally or state listed plants have been documented within the Project area. Although no federally and state listed wildlife species have been observed or documented within the Project area, several could occur within or traverse over the Project area. As detailed in Section 3.4.2.2, species-specific measures, as recommended by USFWS and DOFAW, would be implemented to avoid and minimize potential impacts.

Guideline	Assessment of Consistency
Foster the planting of native as well as other trees, shrubs, and flowering plants compatible to the enhancement of our environment	Landscaping would be installed to provide visual screening of Project equipment from adjacent areas to the extent practicable. It is anticipated that the landscaping would incorporate trees and shrubs in key locations, and would include native species that are ecologically and culturally appropriate for this location.
Parks, Recreation, and Open Space Guidelines	
Establish, preserve and maintain scenic, historic, cultural, park and recreation areas, including the shorelines, for public recreational, educational, and scientific uses	The Project area does not support coastal nor any other type of recreational resources, nor would it affect recreational opportunities. The Project is not located along the shoreline, nor would it affect shoreline structures or processes. Within the Project area, the solar photovoltaic and associated facilities would have a very small permanent footprint; the surrounding portions of the Project area would be maintained as open space. The Project would be visible to varying degrees from surrounding areas; however, it would not obstruct or impede views of the Waiʻanae Mountains, Pacific Ocean or other scenic resources. The Project facilities would introduce new visual elements within the landscape, but these would be seen in the context of other development including commercial and residential structures, the rail transit system, high-voltage transmission lines, Makakilo Quarry and other man-made features.
Protect the shorelines of the State from encroachment of artificial improvements, structures, and activities	
Promote open space in view of its natural beauty not only as a natural resource but as an ennobling, living environment for its people	
Economic Development Guidelines	
Encourage industries in Hawaiʻi which would be in harmony with our environment	The Project would contribute to the growing renewable energy industry in Hawaiʻi by providing solar energy for the island of Oʻahu, with minimal environmental impacts. It would be expected to positively impact the economy by creating local employment opportunities, as well as providing a source of revenue for the State. In addition to generating and storing renewable energy, the Project would incorporate compatible agricultural activities. It would not include any aquacultural activities, nor involve a visitor destination area.
Promote and foster the agricultural industry of the State; and preserve and conserve productive agricultural lands;	
Encourage federal activities in Hawaiʻi to protect the environment;	
Encourage all industries including the fishing, aquaculture, oceanography, recreation, and forest products industries to protect the environment;	
Establish visitor destination areas with planning controls which shall include but not be limited to the number of rooms;	
Promote and foster the aquaculture industry of the State; and preserve and conserve productive aquacultural lands.	
Transportation Guidelines	
Encourage transportation systems in harmony with the lifestyle of the people and environment of the State	Transportation system improvements are not included as part of the Project. As discussed in Section 3.12, the Project would not significantly contribute to traffic congestion. Recognizing that construction could result in minor, localized impacts to traffic and the roadway network, a TMP would be prepared prior to construction and would detail the measures that would be implemented to avoid, minimize and mitigate potential impacts based on Complete Streets principles.
Adopt guidelines to alleviate environmental degradation caused by motor vehicles	
Encourage public and private vehicles and transportation systems to conserve energy, reduce pollution emission, including noise, and provide safe and convenient accommodations for their users	

Guideline	Assessment of Consistency
Energy Guidelines	
Encourage the efficient use of energy resources	The Project would help to meet the state's need for renewable energy by providing up to 12.5 MW of solar energy and 50 MWh of battery storage. Further, the Project includes a battery storage system that would allow Hawaiian Electric to dispatch energy as needed to offset night-time customer demand, which is more beneficial to the Hawaiian Electric system than past projects that required instantaneous use of energy produced (PUC, 2019).
Community Life and Housing Guidelines	
Foster lifestyles compatible with the environment; preserve the variety of lifestyles traditional to Hawaiʻi through the design and maintenance of neighborhoods which reflect the culture and mores of the community	The Project would benefit community life by generating clean, renewable energy to replace a portion of electricity that is currently generated by burning fossil fuels, thus reducing greenhouse gas emissions and other forms of pollution that are detrimental to the environment and human health. The Project would represent Hawaii's commitment to achieving of 100 percent renewable energy sources by 2045.
Develop communities which provide a sense of identity and social satisfaction in harmony with the environment and provide internal opportunities for shopping, employment, education, and recreation	
Encourage the reduction of environmental pollution which may degrade a community	
Foster safe, sanitary, and decent homes	
Recognize community appearances as major economic and aesthetic assets of the counties and the State; encourage green belts, plantings, and landscape plans and designs in urban areas; and preserve and promote mountain-to-ocean vistas	
Education and Culture Guidelines	
Foster culture and the arts and promote their linkage to the enhancement of the environment	The Project would not affect existing or future educational or cultural programs.
Encourage both formal and informal environmental education to all age groups	
Citizen Participation Guidelines	
Encourage all individuals in the State to adopt a moral ethic to respect the natural environment; to reduce waste and excessive consumption; and to fulfill the responsibility as trustees of the environment for the present and succeeding generations	The HRS Chapter 343 environmental review process provides opportunity for public input at various stages, including pre-assessment consultation and public review of the Draft EA. In addition, the land use permitting process also includes opportunity for public input regarding the Project.
Provide for expanding citizen participation in the decision-making process so it continually embraces more citizens and more issues	

5.1.5 2050 Sustainability Plan

The Hawaiʻi 2050 sustainability plan serves as the State's climate and sustainability action plan to determine future actions guiding the coordination and implementation of Hawaiʻi's sustainability and climate adaptation goals, principles, and policies, and to define and implement state goals, objectives, policies, and priority guidelines based on the objectives and guidelines established in HRS Chapter 226.

The long-term strategy in the Hawaiʻi 2050 Sustainability Plan is based on the definition of sustainability as respect for culture, character, beauty, and history of the State's island communities; balance among economic, community, and environmental priorities; and an effort to meet the needs of the present without compromising the future generations to meet their own needs. The plan identifies five goals toward a sustainable Hawaiʻi accompanied by strategic actions for implementation and indicators to measure success or failure. The goals relate to way of life, the economy, environment and natural resources, community and social well-being, and Kanaka Maoli culture and island values. Strategic actions that are applicable to the Project include:

- Goal 2, Strategic Action 1: Develop a more diverse and resilient economy
    - Provide incentives that foster sustainability-related industries, which include, but aren't limited to renewable energy, innovation and science-based industries, and environmental technologies.
- Goal 3, Strategic Action 1: Reduce reliance on fossil (carbon-based) fuels
    - Expand renewable energy opportunities

The Project would help to meet the state's need for renewable energy by providing up to 12.5 MW of solar energy and 50 MWh of battery storage, which is enough electricity for approximately 4,600 homes on Oʻahu (based on average energy use). It is expected to offset the use of approximately 545,794 barrels of fuel and 64 tons of coal and would decrease greenhouse gas emissions by approximately 244,394 tons over its lifetime (Hawaiian Electric, 2019a). As such, the Project is directly responsive to the strategic actions identified in the 2050 Sustainability Plan.

5.2 City and County of Honolulu Plans, Polices and Regulations

5.2.1 Oʻahu General Plan

The Oʻahu General Plan is a policy guidance document that presents the long-range objectives for the island of Oʻahu. It is the foundation of a comprehensive planning process that addresses the physical, cultural, social, economic and environmental concerns, and is intended to provide direction for future growth on Oʻahu. It presents objectives regarding the desired conditions over a 20-year planning horizon, as well as broad policies to meet those objectives, and is intended to serve as a guide for all levels of government, private enterprise, neighborhood and citizen groups, organizations, and individual citizens.

The General Plan was adopted in 1977 and has been subsequently updated through a series of amendments. The most recent updates were completed in December 2017; the Proposed Revised Plan is currently in the process of being adopted (Resolution 18-093). The Proposed Revised General Plan continues to focus on critical issues such as regional population, economic health, and affordable housing, while also introducing additional topics such as climate change, sea level rise and sustainability. A total of 11 areas of concern are addressed in the plan: population, economy, natural environment and resource stewardship, housing and communities, transportation and utilities, energy, physical development and urban design; public safety and community resilience, health and education, cultural and recreation, and government operations and fiscal management (DPP, 2017).

Overall, the proposed Project is consistent with the various objectives and policies contained in the proposed revised General Plan. The proposed Project would not impact objectives and policies related to population, housing and communities, transportation and utilities, public safety and community resilience, health and education, and government operations and fiscal management. As a result, these objectives and policies are not discussed further. The proposed Project is consistent with the applicable objectives and policies of the City and County of Honolulu General Plan described below.

5.2.1.1 Economy

Objective A **To promote economic opportunities that enable all the people of O‘ahu to attain meaningful employment and a decent standard or living.**

Policy 1 Support a strong, diverse and dynamic economic base resilient to changes in global conditions.

Policy 3 Pursue opportunities to grow and strategically develop non-polluting industries such as trade, communications, media, medical, life sciences, and technology in appropriate locations that contribute to O‘ahu’s long-term environmental, economic, and social sustainability.

Objective C **To ensure the long-term viability and continued productivity of agriculture on O‘ahu.**

Policy 2 Support agricultural diversification to help strengthen the agricultural industry and to make more locally grown food available for local consumption.

Policy 6 Promote small-scale farming activities and other operations, such as truck farming, flower growing, aquaculture, livestock production, taro growing, and subsistence farms.

Policy 7 Encourage landowners to actively use agricultural lands for agricultural purposes.

Policy 12 Provide plans, incentives, and strategies to ensure the affordability of agricultural land for farmers.

Discussion: The Project would be part of the growing renewable energy industry in Hawai‘i, helping to both diversify Hawai‘i’s economy and provide valuable job opportunities to residents, particularly short-term jobs during construction. It would generate clean, renewable solar energy and would help to meet the state’s need for renewable energy by providing up to 12.5 MW of solar energy and 50 MWh of battery storage, which is enough electricity for approximately 4,600 homes on O‘ahu (based on average

energy use). The Project is expected to offset the use of approximately 545,794 barrels of fuel and 64 tons of coal and would decrease greenhouse gas emissions by approximately 244,394 tons over its lifetime (Hawaiian Electric, 2019a). Furthermore, the Project would seek to balance agricultural and renewable energy needs. Specifically, it would support and subsidize compatible agricultural activities (such as honey production and cattle grazing) and would implement specific decommissioning provisions in which the land would be returned to substantially the same condition as existed prior to development of the solar facilities, thus allowing for the full range of future agricultural uses.

5.2.1.2 Natural Environmental and Resource Stewardship

Objective A **To protect and preserve the natural environment.**

Policy 1 Protect Oʻahu's natural environment, especially the shoreline, valleys, ridges, and watersheds, from incompatible development.

Policy 4 Require development projects to give due consideration to natural features and hazards such as slope, inland and coastal erosion and flood hazards, water-recharge areas, and existing vegetation, as well as to plan for coastal hazards that threaten life and property.

Policy 6 Design and maintain surface drainage and flood-control systems in a manner which will help preserve natural and cultural resources.

Policy 7 Protect the natural environment form damaging levels of air, water, and noise pollution.

Policy 8 Protect plants, birds, and other animals that are unique to the State of Hawaiʻi and Oʻahu, and protect their habitats.

Policy 12 Plan and prepare for the impacts of climate change on the natural environment, including strategies of adaptation.

Objective B **To preserve and enhance natural landmarks and scenic views of Oʻahu for the benefit of both residents and visitors as well as future generations.**

Policy 1 Protect the Island's significant natural resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shorelines, fishponds, and bays; and reefs and offshore islands.

Policy 2 Protect Oʻahu's scenic views, especially those seen from highly developed and heavily traveled areas.

Policy 3 Locate and design public facilities, infrastructure, and utilities to minimize the obstruction of scenic views.

Discussion: The Project area has been extensively modified by previous agricultural operations and is dominated by non-native species. The Project has been designed to minimize ground disturbance and maintain ample, natural open space surrounding the facilities. Impacts to natural resources would be avoided and minimized to the extent possible through implementation of BMPs. LID design measures would be incorporated to maintain permeability throughout the Project area while also minimizing the potential for erosion; the Project would also incorporate stormwater retention BMPs during and post-construction to retain and treat stormwater within the Project area.

Although the Project components would be visible from surrounding areas, the Project would not obstruct views of the mountains, ocean or other scenic resources. Landscaping would be installed to provide visual screening of Project equipment from adjacent areas to the extent practicable. It is anticipated that the landscaping would incorporate trees and shrubs in key locations and would include native species that are ecologically and culturally appropriate for this location.

5.2.1.3 Energy

Objective A **To increase energy self-sufficiency and maintain an efficient, reliable, resilient, and cost-efficient energy system.**

Policy 1 Encourage the implementation of a comprehensive plan to guide and coordinate energy conservation and renewable energy development and utilization programs.

Policy 2 Support and encourage programs and projects, including economic incentives, regulatory measures, and educational efforts, which will reduce O‘ahu’s dependence on fossil fuels as its primary source of energy.

Policy 7 Manage our resources and the development of our communities in line with the long-term goals of net zero to net positive performance in areas of energy, carbon emissions, waste streams, all utilities, and food security.

Policy 9 Consider health, safety, environmental, cultural, and aesthetic impacts, as well as resource limitations, land use patterns, and relative costs in all major decisions on renewable energy.

Objective B **To conserve energy through the more efficient management of its use and through more energy-efficient technologies.**

Policy 5 Encourage the implementation of an adaptable and reliable electrical grid, energy transmission, energy storage, and energy generation technologies.

Objective C **To foster an ethic of energy conservation that inspires residents to engage in sustainable practices.**

Policy 4 Provide communities with timely, relevant, and accurate information concerning renewable energy facilities proposed in their area.

Discussion: The Project would help to meet the state’s goal of 100 percent renewable energy sources by 2045 by providing up to 12.5 MW of solar energy and 50 MWh of battery storage, which is enough electricity for approximately 4,600 homes on O‘ahu (based on average energy use). The Project is expected to offset the use of approximately 545,794 barrels of fuel and 64 tons of coal and would decrease greenhouse gas emissions by approximately 244,394 tons over its lifetime (Hawaiian Electric, 2019a). The EA review process would inform the public of the proposed renewable energy facility and provide opportunity for input at various stages, including the pre-assessment consultation process and the Draft EA 30-day public comment period. Additional opportunities for input would occur during the subsequent discretionary permitting process.

5.2.1.4 Physical Development and Urban Design

Objective A **To coordinate changes in the physical environment of O'ahu to ensure that all new developments are timely, well-designed, and appropriate for the areas in which they will be located.**

Policy 10 Discourage uses which are major sources of noise, air, and light pollution.

Policy 11 Encourage siting and design solutions that seek to reduce exposure to natural hazards, including those related to climate change and sea level rise.

Policy 13 Promote opportunities for the community to participate meaningfully in planning and development processes, including new forms of communication and social media.

Discussion: The Project would be designed to minimize impacts related to noise, air, and light pollution during construction and operation, and is not anticipated to be a major source of these pollutants. As detailed in Sections 3.1 and 3.13 and as shown in Figures 3-11 and 3-12, the Project would not be located in a sea-level rise exposure area, flood hazard zone, or tsunami evacuation zone, and would not be expected to increase exposure to natural hazards. Once constructed, the Project would generate clean renewable energy which would replace the burning of fossil fuel for the production of electricity, thus offsetting greenhouse gas emissions and providing a beneficial impact relative to climate change. As noted above, the EA and discretionary permitting processes include opportunities for meaningful community input.

5.2.1.5 Culture and Recreation

Objective B **To protect, preserve, and enhance O'ahu's cultural, historic, architectural, and archaeological resources.**

Policy 2 Identify and, to the extent possible, preserve and restore buildings, sites, and areas of social, cultural, historic, architectural, and archaeological significance.

Discussion: An AIS was conducted for the Project, including detailed background research and a 100 percent pedestrian inspection of the Project area. The AIS identified two historic properties within the Project area, consisting of historic irrigation and plantation infrastructure and a remnant portion of the Waiahole Ditch. The Draft AIS Report has been submitted and is pending review by SHPD in compliance with HRS Chapter 6E and HAR §13-284. Implementation of the Project would affect portions of these historic properties within the Project area; however, based on the conclusions regarding the significance and documentation to date, pursuant to HAR §13-284-7 and subject to review and concurrence by SHPD, the effect determination for the Project is "no historic properties affected" with a recommendation for no further historic preservation work.

5.2.2 'Ewa Development Plan

The General Plan for the City and County of Honolulu requires that community development plans be adopted by the City Council for each judicial district. These development plans are intended to provide detail for the elements presented in the General Plan and emphasize those elements most relevant to

the issues and conditions of the specific area plan in order to guide public policy, infrastructure investment and land use decision making over the next 25 years. The ‘Ewa Development Plan was originally adopted by the City Council in 1997 and was most recently revised in 2013 (Ordinance 13-26). The revised plan maintains the vision for protecting agricultural land, open space and natural, historic, and cultural resources; developing a secondary urban center around the City of Kapolei; building master planned residential communities that support walking, biking, and transit use; and providing adequate infrastructure to serve both existing and planned development (DPP, 2013).

The key elements of the vision for development of ‘Ewa include (1) community growth boundary; (2) retention of agricultural lands; (3) open space and greenways; (4) Kalaeloa Regional Park; (5) secondary urban center; (6) master planned residential communities; (7) communities designed to support non-automotive travel; (8) conservation of natural resources; (9) preservation and enhancement of historic and cultural resources; and (10) phased development. The community growth boundary is intended to give long-range protection from urbanization for prime agricultural land and for preservation of open space while providing adequate land for urban development. The proposed Project is located outside the community growth boundary and as a non-urban land use, it would be consistent with this demarcation. Specific policies and guidelines that are applicable to the Project include the following:

3.1 Open Space Preservation and Development

3.1.1 General Policies

- Use open space to:
  - Provide long-range protection for diversified agriculture on lands outside the Community Growth Boundary
  - Protect scenic views and natural, cultural, and historic resources
  - Preserve natural gulches and ravines as drainageways and stormwater retention areas

3.1.3 Guidelines

3.1.3.2 Natural Gulches and Drainageways

- Where practical, retain drainageways as natural or man-made vegetated channels rather than concrete channels.

Discussion: As defined in the Open Space Map for the ‘Ewa Development Plan, the Project would be located in an area that is generally identified as a combination of Preservation and Agricultural Areas, interspersed with natural drainageways/gulches. The plan defines Agricultural Areas as “land with agricultural value by virtue of current agricultural use or high value for future agricultural use.” Preservation Areas are defined as “lands with natural, cultural or scenic resource value.” Examples of Preservation Areas include lands necessary for protecting watersheds, water resources and water supplies; lands necessary for the conservation, preservation and enhancement of sites with scenic, historic, archaeological or ecological significance; and lands with topography, soils, climate or other related environmental factors that may not be normally adaptable or presently needed for urban, rural or agricultural use.

Although historically used for cultivation of sugar cane, the Project area has been fallow for an extended period of time with intermittent cattle grazing. Its current use for agricultural purposes is constrained by the site conditions, lack of infrastructure, and uncertainty of water availability for irrigation. In addition to providing clean, renewable energy, the Project area would also be made available for compatible agricultural uses at a lease price well below market value and would provide support facilities for compatible activities, such as beekeeping and cattle grazing, thus contributing to diversified agriculture in the ʻEwa District. As part of the decommissioning plan, the site would be restored to existing conditions at the end of the Project, such that the full range of potential agricultural uses would be preserved for future generations.

The Project would be visible to varying degrees from surrounding areas; however, it would not obstruct or impede views of the Waiʻanae Mountains, Pacific Ocean or other scenic resources. The Project facilities would introduce new visual elements within the landscape, but these would be seen in the context of other development including high-voltage transmission lines, commercial and residential structures, the rail transit system, Makakilo Quarry and other man-made features. Significant views and vistas that are identified in the ʻEwa Development Table (Table 3.2) include views of the Waiʻanae Range from H-1 Freeway between Kunia Road and Kaloʻi Gulch and from Kunia Road, as well as general mauka and makai views. As discussed in Section 3.8, the Project area is located on the lower slopes of the Waiʻanae Range and views of the Project area from the H-1 Freeway and Kunia Road would be at least partially blocked by existing topography, vegetation and intervening structures located along the roadway corridors; views of the broader Waiʻanae Range would not be affected, such that the identified viewplanes would not be substantially degraded.

The Project area includes tributaries to Kaloʻi Gulch, which run along the southern boundary and through the central portion of the Project area. These features are typically dry and only carry water during and immediately following rain events. The Project has been designed to avoid these features to the maximum extent practicable. The only direct impacts would be associated with construction of a road crossing to allow for access between the various solar arrays. The crossing would be designed to have as small of a footprint as possible and to maintain unobstructed flows following rain events. As such, the Project would not significantly affect the form or function of the tributaries to Kaloʻi Gulch.

As the Project would balance renewable energy and agricultural needs, while also maintaining elements of open space and natural drainageways within the Project area, it is expected to be consistent with the relevant designations in the ʻEwa Development Plan.

3.4 Historic and Cultural Resources

3.4.1 General Policies

- Preserve significant historic features from the plantation era and earlier periods.
- Vary the treatment of sites according to their characteristics and potential value.
- Retain significant vistas whenever possible.

3.4.2 Guidelines

3.4.2.5 Native Hawaiian Cultural and Archaeological Sites

- Require preservation in situ for those features that the State Historic Preservation Officer has recommended for such treatment.

Discussion: An AIS was conducted for the Project, including detailed background research and a 100 percent pedestrian inspection of the Project area. The AIS identified two historic properties within the Project area, consisting of historic irrigation and plantation infrastructure and a remnant portion of the Waiahole Ditch. The Draft AIS Report has been submitted and is pending review by SHPD in compliance with HRS Chapter 6E and HAR §13-284. Implementation of the Project would affect portions of these historic properties within the Project area; however, based on the conclusions regarding the significance and documentation to date, pursuant to HAR §13-284-7 and subject to review and concurrence by SHPD, the effect determination for the Project is "no historic properties affected" with a recommendation for no further historic preservation work.

As discussed above, the Project would be visible to varying degrees from surrounding areas and would introduce new visual elements within the landscape, but would be seen in the context of other development including commercial and residential structures, the rail transit system, high-voltage transmission lines, Makakilo Quarry and other man-made features. The Project would not obstruct or impede views of the Waiʻanae Mountains, Pacific Ocean or other scenic resources.

3.5 Natural Resources

3.5.1 General Policies

- Require surveys for proposed new development areas to identify endangered species habitat, and require appropriate mitigations for adverse impacts on endangered species due to new development.
- Reduce light pollution's adverse impact on wildlife and human health and its unnecessary consumption of energy by using, where sensible, fully shielded lighting fixtures using lower wattage.

Discussion: A biological resources surveys was conducted for the Project area to characterize the existing habitat and assess the potential for state or federally listed threatened, endangered, or otherwise rare plants or animals to occur within the Project area. In general, the biological resources in the Project area have been extensively modified by previous agricultural use and the introduction of invasive species, which has resulted in a reduction of the number and abundance of native species and habitats suitable for native species. No federally or state listed plants were documented within the Project area. Although no federally and state listed wildlife species have been observed or documented within the Project area, several could occur within or traverse over the Project area. As detailed in Section 3.4.2.2, species-specific measures, as recommended by USFWS and DOFAW, would be implemented to avoid and minimize potential impacts. As discussed in Section 3.4.2.2, these measures would include the requirement for lighting to be shielded or directed downward and fitted with non-white lights to minimize the attractiveness to seabirds.

5.2.3 Land Use Ordinance

The City & County of Honolulu's LUO (Revised Ordinances of Honolulu Chapter 21) regulates land use by identifying the uses that are considered appropriate in each zoning district and the minimum standards and conditions that must be met if those uses are to be permitted. The purpose of the LUO is to regulate land use in a manner that will encourage orderly development in accordance with adopted land use policies, including the Oʻahu General Plan and community development plans.

The Project area is located within the AG-1 (Restricted Agriculture) zoning district (see Figure 3-5). The purpose of the AG-1 Restricted Agricultural zoning district is to conserve and protect important agricultural lands for agricultural functions. Agricultural districts are specifically addressed in Section 21-3.50-4 of the LUO, which refers to Table 21-3 (Master Use Table) for permitted uses and structures. Based on DPP's *Solar Farm Guidelines*, the Project is expected to be considered a "Type B utility installation" (DPP, 2019).[26] According to the Master Use Table, Type B utility installations are permitted with issuance of a CUP minor permit in the AG-1 zoning district. A CUP minor would be requested from DPP for the proposed Project.

5.2.3.1 Conditional Use Permit

To obtain a CUP minor, the Project would be subject to compliance with the specific development standards, district development standards and general development standards outlined in the LUO. As summarized in the following subsections, the development standards that would apply to the Project include maximum building area (lot coverage), yard setbacks, and maximum height limits, as well as preparation of a landscaping plan. It is anticipated that the Project would conform to these standards. In the event that the Project would not be in conformance with the applicable standards, a zoning waiver may also be required; if needed, the waiver request would be incorporated into the CUP application.

Specific Development Standards

Article 5 of the LUO identified the specific use development standards for particular conditions use categories. Relative to the proposed Project, it is expected that the development standards for Type B utility installations as provided in Section 21-5.650 will apply to the solar facilities. These standards are listed in Table 5-5.

[26] These guidelines identify eight criteria that are used to differentiate between a "Type A utility installation" and a "Type B utility installation." These criteria relate to proximity to adjoining residential, apartment or apartment mixed use zoning districts; rooftop facilities; adequate access; other solar farms on the subject zoning lot or abutting zoning lots; the need for a State SUP; the SMA; and use of a historic site. As the Project will require a State SUP, it is understood that it would be considered a "Type B utility installation."

Table 5-5. Development Standards for Type B Utility Installations

LUO Standard	LUO Provision	Project Consistency
Landscape Plan (Section 21-5.650(a)(1))	All requests for Type B utility installations shall be accompanied by a landscape plan which shall be approved by the director. Special emphasis shall be placed on visual buffering for the installation from adjacent streets and highways.	Landscaping would be installed to provide visual screening of Project equipment from adjacent areas to the extent practicable. It is anticipated that the landscaping would incorporate trees and shrubs in key locations and would include native species that are ecologically and culturally appropriate for this location. A landscaping plan would be included in the CUP minor application.
Utility Installations for Telecommunications (Section 21-5.650(a)(2))	Type B utility installations for telecommunications shall provide fencing or other barriers to restrict public access within the area exposed to a power density of 0.1 milliwatt/cm2 for all associated antennas involving radio frequency (RF)or microwave transmissions.	The Project is not a telecommunication project; however, a chain-link fence would be installed around the perimeter of the Project as well as additional fencing around the substation to maintain site security.
Antenna Heights (Section 21-5.650(a)(3))	In residential districts where utility lines are predominantly located underground, antennas shall not exceed the governing height limit.	The Project area is not within a residential district.

District Development Standards

Article 3 of the LUO identifies the district development standards for the various zoning districts. Section 21-3.50-4 addresses the development standards for the agricultural district (with specific standards listed in Table 21-3.1 of the LUO). As listed in Table 5-6, the Project is expected to comply with the development standards for the restricted agricultural (AG-1) zoning district; compliance with the maximum height requirements is discussed below as part of the general development standards.

Table 5-6. Development Standards for the Restricted Agricultural (AG-1) District

LUO Standard		LUO Provision (AG-1 District)	Project Area
Minimum lot area		5 acres	Approximately 861 acres
Minimum lot width/depth		150 feet	>150 feet
Yards:	Front Side and rear	15 feet 10 feet	>15 feet >10 feet
Maximum building area (percent of zoning lot)		For non-agricultural structures, 10 percent of zoning lot	Approximately 4.5 percent
Maximum height		15 - 25 feet; see note below	See discussion for general development standards

[1] The LUO defines "building area" as the total area of a zoning lot covered by structures and covered open areas. It is assumed that the total area of the Project is equivalent to the total area, as calculated in Table 2-1.

[2] Per Section 21-3.50-4(c), the maximum height may be increased from 15 to 25 feet if height setbacks are provided. Any portion of a structure exceeding 15 feet shall be set back from every side and read buildable area boundary line one feet for each two feet of additional height above 15 feet.

General Development Standards

Article 4 of the LUO identifies the general development standards that must be met for any use or site, irrespective of the zoning district in which it is located. The general development standards that are expected to apply to the Project are those related to height (Section 21-4.60), and landscaping, screening and buffering (Sections 21-4.70 and 4.71); these are discussed below. There are no non-conforming lots or structures.

- **Heights:** Section 21-4.60 specifies that all structures shall fall within a building height envelope at a height specified by the LUO or as specified on the zoning maps. As discussed above, Section 21-3.50-4 specifies that the maximum height in the AG-1 zoning district is 25 feet, provided that the portion of the structure that exceeds 15 feet has a setback of one foot for every two feet of additional height. The solar photovoltaic and battery energy storage equipment would not exceed the standards related to maximum height and height setbacks.

  Pursuant to Section 21-4.60(c)(4), utility poles and antennas are exempted from zoning district height limits; it is specified that utility poles shall not exceed 500 feet from existing grade, and antennas associated with utility installations shall not exceed 10 feet above the governing height limit. It is anticipated that the electrical equipment associated with the substation and interconnection facilities would qualify as utility poles, and pursuant to Section 21-4.60(c)(4)(A) are subject to a height limit of 500 feet from existing grade. This equipment would range in height up to approximately 40-60 feet, and therefore is expected to be in compliance with the height standards.

- **Landscaping, Screening and Buffering:** The development standards for a Type B Utility Installation require the development of a landscape plan, which emphasizes visual buffering from adjacent streets and highways. As described above, the Project would incorporate landscaping in key locations, with a landscape plan included in the CUP minor application. Relative to the landscaping requirements, general development standards are identified for landscaping and screening of parking lots, automobile service stations, service and loading spaces, trash enclosures, utility substations and rooftop machinery in zoning districts as specified in Section 21-4.70; other requirements for screening and buffering are listed in Section 21-4.70-1. These requirements would be included as part of the landscape plan, as applicable.

- **Outdoor Lighting:** Section 21-4.100 requires that for any commercial, industrial, or outdoor recreational development, lighting is shielded with full cut-off fixtures to eliminate direct illumination to any adjacent country, residential, apartment, apartment mixed use, or resort zoning district. If it is determined that lighting is needed at the substation, all fixtures would be fully shielded and directed downward, and fitted with non-white light bulbs.

Off-Street Parking and Loading Requirements

Article 6 of the LUO identifies the off-street parking and loading requirements, which are intended to minimize street congestion and traffic hazards, and to provide safe and convenient access to residences,

businesses, public services and places of public assembly. Table 21-6.1 specifies that the off-street parking requirements for utility installations (Type A or B) shall be determined by the director.

Normal operation of the Project would not require onsite staff; as such, the facility would not be manned. Period maintenance and inspection of the facilities would occur and would require employees to drive to various locations throughout the Project area. As such, no centralized parking facilities are planned.

5.3 Required Permits and Approvals

Table 5-7 presents the permits and approvals that are expected to be required for construction and operation of the Project, along with the current status of each item. A discussion of the approval process for the major discretionary permits (i.e. State SUP and County CUP minor) is provided in Sections 5.1.1 and 5.2.3, respectively.

Table 5-7. Anticipated Permits and Approvals Required for Project

Permit/Approval	Regulatory Agency	Status
HRS Chapter 343 Compliance	DPP (approving agency)	In progress; Draft EA published for public review
SUP	DPP, City & County of Honolulu Planning Commission, and Land Use Commission	Application to be submitted following HRS Chapter 343 EA process
CUP minor	DPP	Application to be submitted following approval of State SUP
HRS Chapter 6E Compliance (Historic Preservation Review)	State Historic Preservation Division (SHPD)	In progress; Draft AIS submitted to SHPD for review on February 6, 2020
NPDES Permit	Department of Health (DOH), Clean Water Branch	To be obtained prior to construction
Community Noise Permit	DOH, Indoor and Radiological Health Branch	To be obtained prior to construction
Building Permit	DPP	To be obtained prior to construction
Grading and Grubbing Permit	DPP	To be obtained prior to construction
Notice of Proposed Construction or Alteration (Form 7460-1)	Federal Aviation Administration (FAA)	To be submitted prior to construction

6 Summary of Findings and Anticipated Determination

6.1 Significance Criteria

The potential impacts of the Project have been thoroughly evaluated and discussed in this Draft EA. As detailed throughout the document, the Project would incorporate a variety of mitigation measures such that no significant impacts are anticipated for the identified environmental resources.

The HRS Chapter 343 environmental review process requires that the sum of the effects of a proposed action on the quality of the environment be considered as part of the determination of significance. Specific significant criteria are identified in HAR §11-200.1-13 for consideration in determining whether the action may have a significant effect on the environment. These significance criteria are listed below, with an assessment of the Project relative to each criterion.

(1) Irrevocably commit a natural, cultural, or historic resource

The Project would be located in an area that has been extensively modified by previous agricultural use and is dominated by non-native habitat. It would involve construction and operation of solar and storage facilities for the duration of the 25-year PPA; the Project would be decommissioned at the end of its' useful life, with all Project-related equipment removed and the Project area returned to substantially the same condition as existed prior to development. As detailed in Section 3.4.2, measures, which include recommendations provided by USFWS and DOFAW, would be implemented throughout construction and operation of the Project to avoid and minimize impacts to natural resources. With respect to historic resources, an AIS was conducted within the Project area; historic properties that were identified include remnants of irrigation and other plantation-era infrastructure. Implementation of the Project would affect portions of these historic properties within the Project area; however, based on the conclusions regarding the significance and documentation to date, pursuant to HAR §13-284-7 and subject to review and concurrence by SHPD, the effect determination for the Project is "no historic properties affected" with a recommendation for no further historic preservation work. As detailed in Section 3.6, the CIA did not identify any cultural resources, practices, or beliefs as currently existing within the Project area. Based on this analysis, implementation of the Project would not be expected to result in an irrevocable commitment to loss or destruction of important natural or cultural resources.

(2) Curtail the range of beneficial uses of the environment

The range of beneficial uses of the environment is determined by the physical setting and the land use controls that define its use. The Project area is characterized by former agricultural fields that are have been fallow for more than 20 years; portions of the site are intermittently used for cattle grazing. This area is within the State agricultural district and City and County of Honolulu's Restricted Agricultural (AG-1) zone. In addition to solar photovoltaic and battery energy storage facilities, the Project area

would be made available for compatible agricultural activities, such that it would be consistent with applicable State and County land use regulations. Furthermore, the Project would be decommissioned at the end of the operational phase, with Project-related equipment removed and the Project area returned to substantially the same condition as existed prior to development, thus preserving the full range of potential future land uses. As the Project would provide clean renewable energy while allowing for ongoing agricultural activities and would not preclude any future land use following decommissioning, it would not be expected to curtail the range of beneficial uses of the environment.

(3) Conflict with the State's environmental policies or long-term environmental goals established by law

The Project would not conflict with the State's environmental policies or long-term environmental goals, which are specified in HRS Chapter 344. A detailed discussion of the Project's consistency with these policies and goals is provided in Section 5.1.4.

(4) Have a substantial adverse effect on the economic welfare, social welfare, or cultural practices of the community and State

As discussed in Section 3.16, the Project would be expected to positively impact the economic and social welfare of the community by creating local employment opportunities, as well as providing a source of revenue for the State. In addition, the energy produced by the Project would be sold over the 25-year PPA term at a fixed price that is less than the current cost of fossil fuel power, thus helping to hedge against long-term price volatility. It would also help to improve electric grid stability by enabling Hawaiian Electric to utilize stored solar energy to meet peak demand. Based on information gathered from the cultural and historical background, as well as community consultation conducted as part of the CIA, no cultural resources, practices, or beliefs have been identified as existing within the Project area, nor is there any indication that traditional or customary Native Hawaiian rights are currently being exercised within any portion of the Project area. The Project would not be expected to affect or impair traditional and customary Native Hawaiian rights that are currently being exercised elsewhere within Honouliuli Ahupuaʻa. As such, Project implementation would not result in a substantial adverse effect on the economic welfare, social welfare, or cultural practices of the community and State.

(5) Have a substantial adverse effect on public health

The Project would be consistent with existing land uses and would not be expected to directly affect public health. Project implementation would result in short-term impacts related to air quality as a result of dust emissions and noise from construction vehicles and equipment; these impacts would be minimized through BMPs in compliance with State and County requirements. Over the long term, operation of the Project would generate clean renewable energy that would replace a portion of electricity that is currently generated by burning fossil fuels, thus reducing greenhouse gas emissions and other forms of pollution that are detrimental to human health.

(6) Involve adverse secondary impacts, such as population changes or effects on public facilities

While the construction and operation expenditures associated with the Project may provide a direct benefit to the local economy, the amounts are relatively too small to cause significant secondary effects in the local economy. The Project would not induce changes in land use, development or population size in the ‘Ewa District. Public facilities would not be adversely affected, nor would additional use of public facilities occur as a result of Project implementation.

(7) Involve a substantial degradation of environmental quality

The Project would not involve substantial degradation of environmental quality. The Project area has been extensively modified by previous agricultural use and is dominated by non-native habitat. Noise levels and airborne dust would likely increase as a result of Project construction and decommissioning, but these effects would be avoided and minimized through implementation of BMPs such that impacts would be minimal. BMPs would also be implemented to minimize the potential discharge of pollutants associated with stormwater runoff during both construction and throughout operations, as well as during decommissioning. Following decommissioning, the Project area would be returned to substantially the same condition as existed prior to development. All aspects of Project implementation would comply with applicable federal, state and local environmental regulations.

(8) Be individually limited but cumulatively have substantial adverse effect upon the environment or involves a commitment for larger actions

The proposed project does not involve a commitment to a larger action; although it would provide electricity for the island of O‘ahu, it would replace energy that is currently generated by fossil fuels and would not be a precursor for other future projects. When considered in combination with other actions, the Project could potentially contribute to cumulative impacts, including those related to stormwater, noise, air quality and traffic. However, avoidance and minimization measures would be implemented, such that cumulative impacts would be insignificant.

(9) Have a substantial adverse effect on a rare, threatened, or endangered species, or its habitat

Several wiliwili trees, which are relatively rare, occur within the Project area; these trees occur within the gulch along the southern boundary and would not be impacted by the Project. No federally and state listed plant or wildlife species have been observed or documented within the Project area. However, several federally and state listed wildlife species could potentially occur within or traverse over the Project area; these include the Hawaiian hoary bat, pueo and Hawaiian seabird species. Consistent with recommendations provided by USFWS and DOFAW, the Project would incorporate measures specifically intended to avoid and minimize impacts to these species. With implementation of these measures, the Project would not be expected to have a substantial adverse effect on these listed species or their habitat.

(10) Have a substantial adverse effect on air or water quality or ambient noise levels

Project implementation would result in minimal, short-term impacts related to air and water quality, as well as ambient noise levels; mitigation measures would be implemented to minimize these impacts. The Project would also include permanent BMPs to provide long-term retention and biofiltration of

stormwater within the Project area. No substantial adverse water quality or air quality impacts are anticipated over the long-term. Operation of the Project would generate some noise, primarily associated with the inverters and transformers within the solar arrays and substation; however, operational noise is expected to fall below the maximum permissible sound levels and is not expected to significantly impact any noise sensitive receptors, especially in the context of the industrial and agricultural activities in the Project vicinity.

(11) Have a substantial adverse effect on or be likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, sea level rise exposure area, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters

As shown in Figures 3-11 and 3-12, the Project area is outside the defined flood hazard zone, tsunami zone and sea level rise exposure area. Implementation of the Project would not affect any environmentally sensitive area, nor would the Project be affected by environmental hazards associated with any such area.

(12) Have a substantial adverse effect on scenic vistas and viewplanes, during day or night, identified in county or state plans or studies

The Project would be visible to varying degrees from surrounding areas; however, it would not obstruct or impede views of the Waiʻanae Mountains, Pacific Ocean or other scenic resources. The Project facilities would introduce new visual elements within the landscape, but these would be seen in the context of other development including high-voltage transmission lines, commercial and residential structures, the rail transit system, Makakilo Quarry and other man-made features. Significant views and vistas that are identified in the ʻEwa Development Table include views of the Waiʻanae Range from H-1 Freeway between Kunia Road and Kaloʻi Gulch and from Kunia Road, as well as general mauka and makai views. As discussed in Section 3.8, the Project area is located on the lower slopes of the Waiʻanae Range and views of the Project area from the H-1 Freeway and Kunia Road would be at least partially blocked by existing topography, vegetation and intervening structures located along the roadway corridors; views of the broader Waiʻanae Range would not be affected, such that the identified viewplanes would not be substantially degraded.

(13) Require substantial energy consumption or emit substantial greenhouse gases

Construction of the Project would use some energy for site preparation and equipment installation. However, once installed, the Project would function to generate clean renewable energy, thus providing a net increase in energy and reducing emissions of greenhouse gases by replacing a portion of the electricity that is currently generated by burning fossil fuels.

6.2 Anticipated Determination

Based upon the preliminary analysis and findings presented in this document, implementation of the Project is not expected to result in a significant adverse direct, indirect, or cumulative impact on the quality of the environment. As such, a FONSI is anticipated in accordance with HRS Chapter 343. This

assessment is based on an evaluation of the project impacts in relation to the significance criteria specified in HAR §11-200.1-13, as detailed above.

The anticipated determination is based on the preliminary analysis and findings of the environmental review process to date, as presented herein. Additional information and input obtained through the Draft EA public review process will be considered in finalizing the EA. A final determination will be made based on the analysis in the Final EA and published accordingly. If a FONSI is issued, AES will proceed with obtaining the required permits, then implementing the Project. If it is determined that the Project would result in significant impacts, either an Environmental Impact Statement Preparation Notice (EISPN) would be published in the OEQC *Environmental Notice*, or AES would not proceed with the Project.

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7 Coordination and Consultation

7.1 Community Outreach and Agency Coordination

Subsequent to the Project being selected for development through the Hawaiian Electric RFP process, AES initiated early consultation with key community leaders and elected officials to introduce the Project and to seek preliminary input. This initial outreach also included notification regarding a community meeting; the purpose of the meeting was to provide an overview of the Project and to solicit feedback from the broader community. In addition to strategic community outreach, a community meeting notice was mailed to approximately 2,264 addresses in the adjacent Makakilo neighborhood.

The community meeting was held on February 26, 2019 from 5:30 p.m. to 7:30 p.m. at Kapolei High School; a total of 19 individuals attended the meeting. The meeting included a presentation regarding the Project by AES representatives, followed by a question and answer session; questions related to vandalism and site safety, impacts to agricultural land, traffic and site access, and decommissioning. Additional detail regarding the community meeting is provided in the Community Meeting and Outreach Summary Report (contained in Appendix K).

AES has continued to conduct outreach and consultation through follow-up meetings and written correspondence with a range of community leaders, neighborhood associations, adjacent landowners, and other interested individuals. The Project team has also been in contact and coordinated with various agricultural operators to explore and further pursue opportunities for compatible agricultural activities within the Project area. In addition, consultation has been conducted with State and County agencies with jurisdiction related to the Project, including DPP and the Land Use Commission. The list of parties consulted to date is summarized in Table 7-1. These outreach and consultation efforts are anticipated to continue through the Project development and approval process.

Table 7-1. Summary of Agency Consultation and Community Outreach

Name / Entity	Date	Description
City Council Member Kymberly Pine, District 1	January 29, 2019	Meeting to discuss Project and request input; Provide community meeting notice
State Senator Mike Gabbard, District 20	February 11, 2019 February 21, 2019	Meeting to discuss Project and request input; Provide community meeting notice
State Representative Ty Cullen, District 39	February 19, 2019 Oct 8, 2019	Meeting(s) to discuss Project and request input; Provide community meeting notice
State Representative Sharon Har, District 42	February 21, 2019	Meeting to discuss Project and request input; Provide community meeting notice
Neighborhood Board members	February 11, 2019 August 26, 2019	Meeting to discuss Project and request input;
Representative community members[1]	February 22-26, 2019 May 31, 2019 July 20, 2019 August 26, 2019	Meeting to discuss Project and request input; Provide community meeting notice

Name / Entity	Date	Description
Villages of Kapolei Association	February 11, 2019 July 16, 2019 August 26, 2019	Outreach to discuss Project and request input; Provide community meeting notice
Pālehua Community Association	February 11, 2019 August 26, 2019	Meeting to discuss Project and request input
Wai Kalo'i Community Association	August 26, 2019 September 9, 2019	Meeting to discuss Project and request input
City and County of Honolulu Department of Planning and Permitting staff	April 2, 2019	Meeting to discuss Project and request input
State of Hawai'i Land Use Commission staff	September 9, 2019	Meeting to discuss Project and request input
Malama Learning Center	July 11, 2019	Discuss potential for compatible agricultural activities
Sheep Rancher	July 20, 2019	Discuss potential for compatible agricultural activities
Hui Ku Maoli Ola	July – August 2019	Discuss potential for compatible agricultural activities
Aloha Bee, LLC	July - December 2019	Discuss and develop plans for compatible agricultural activities
Rocker G Livestock	October 24, 2019 July 11, 2019 January 16, 2020	Discuss and develop plans for compatible agricultural activities
City and County of Honolulu Fire Department	November 14, 2019	Discuss requirements with Fire Prevention Bureau
Grace Pacific	August – December 2019	Discuss traffic and access, water resources, other community and land use issues
[1.] A listing of specific community members that have been engaged in the public outreach effort is provided in the Community Meeting and Outreach Summary Report (contained in Appendix K).		

7.2 HRS Chapter 343 Scoping and Public Review Process

In addition to the general community outreach and agency coordination described above, additional consultation has been conducted specifically for the HRS Chapter 343 environmental review process. These efforts have included consultation with DPP as the approving agency for the EA, as well as pre-assessment scoping and distribution of the Draft EA for public comment, in accordance with the requirements of HRS Chapter 343 and HAR §11-200.1. The various agencies, elected officials, community organizations and interested individuals contacted as part of the pre-assessment scoping and Draft EA public review process are listed in Table 7-2. Additional detail regarding the pre-assessment scoping and the Draft EA review process, including the comments received, is provided the following sections.

Table 7-2. Agencies, Organizations and Individuals Involved in HRS Chapter 343 Scoping and Public Review Process

Stakeholder	Pre-Assessment Scoping Letter		Draft EA		Final EA
	Letter Sent[1]	Comment Received[1]	Notice of Availability	Comment Received	Notice of Availability
Federal Agencies					
U.S. Geological Survey	●		●		
U.S. Fish and Wildlife Service	●		●		
National Marine Fisheries Service	●		●		
National Parks Service	●		●		
National Resources Conservation Service	●		●		
U.S. Army Corps of Engineers	●		●		
Department of the Navy	●		●		
Federal Aviation Administration	●		●		
Federal Transit Administration	●		●		
Federal Highways Administration	●		●		
U.S. Coast Guard	●		●		
Environmental Protection Agency	●		●		
State Agencies					
Department of Agriculture	●		●		
Dept. of Accounting and General Services (DAGS)	●	●	●		
DAGS Archives Division	●		●		
Dept. of Business, Economic Development and Tourism (DBEDT)	●		●		
DBEDT Research Division Library	●		●		
DBEDT Strategic Industries Division	●		●		
DBEDT Office of Planning	●	●	●		
Land Use Commission	●	●	●		
Hawai‘i Emergency Management Agency	●		●		
Department of Education	●	●	●		
Hawai‘i State Energy Office	●		●		
Department of Hawaiian Homelands	●	●	●		
DOH Environmental Health Administration	●		●		
Department of Land and Natural Resources	●	●[2]	●		
State Historic Preservation Division	●		●		
Department of Transportation	●	●	●		
Dept. of Transportation, Airports Division	●		●		
UH Office of Capital Improvement	●		●		
UH Water Resources Research Center	●		●		

Stakeholder	Pre-Assessment Scoping Letter		Draft EA		Final EA
	Letter Sent[1]	Comment Received[1]	Notice of Availability	Comment Received	Notice of Availability
UH Environmental Center	●		●		
Office of Hawaiian Affairs	●		●		
City & County of Honolulu Agencies					
Board of Water Supply	●	●	●		
Department of Customer Services Municipal Library	●		●		
Department of Design and Construction	●	●	●		
Department of Environmental Services	●		●		
Department of Facilities Maintenance	●	●	●		
Honolulu Fire Department	●	●	●		
Department of Community Services	●		●		
Department of Planning and Permitting	●	●	●		
Department of Parks and Recreation	●	●	[3]		
Honolulu Police Department	●		●		
Department of Transportation Services	●	●	●		
Office of Climate Change, Sustainability and Resiliency	●		●		
Utilities					
Hawaiian Electric Company, Inc.			●		
Hawaiian Telcom			●		
Elected Officials					
U.S. Senator Brian Schatz	●		●		
U.S. Senator Mazie Hirono	●		●		
U.S. Representative Ed Case	●		●		
State Senator Mike Gabbard	●		●		
State Representative Ty Cullen	●		●		
State Representative Sharon Har	●		●		
Mayor Kirk Caldwell	●		●		
Councilmember Kymberly Pine	●		●		
Jack Legal, Makakilo/Kapolei/Honokai Hale Neighborhood Board Chair	●		●		
Organizations and Interested Individuals					
Grace Pacific Corporation	●		●		
Kapolei Chamber of Commerce	●		●		
Shad Kane	●		●		
Maeda Timson	●		●		
Kioni Dudley	●		●		

Stakeholder	Pre-Assessment Scoping Letter		Draft EA		Final EA
	Letter Sent[1]	Comment Received[1]	Notice of Availability	Comment Received	Notice of Availability
Christian Kaimanu Yee			●		
Lynette Paglinawan			●		
Tom Berg			●		
Villages of Kapolei Community Association	●		●		
Makakilo Community Assoc. (Hawaiiana Management)	●		●		
Wai Kalo‘i Community Assoc. (Hawaiiana Management)	●		●		
Kānehili Hawaiian Homestead			●		
Kaupe‘a Homestead Association			●		
Malu‘ohai Residents Association (Malu‘ohai and Ho‘olimalima Homesteads)			●		
Kapolei Community Development Corporation (Kapolei and Ka‘uluokaha‘i Homesteads)			●		
Libraries					
Hawai‘i State Library, Hawai‘i Documents Center			●		
Kapolei Public Library			●		
University of Hawai‘i (UH) Thomas H. Hamilton Library			●		
UH West O‘ahu James & Abigail Campbell Library			●		
UH Hilo, Edwin H. Mo‘okini Library			●		
UH Maui College Library			●		
Kauai Community College Library			●		
Legislative Reference Bureau Library			●		
News Media					
Honolulu Star Advertiser			●		
Hawai‘i Tribune Herald			●		
West Hawai‘i Today			●		
The Garden Island			●		
Maui News			●		
Molokai Dispatch			●		
Honolulu Civil Beat			●		

[1] Copies of the pre-assessment scoping letter and comments received are provided in Appendices L and M.

[2] Comment letters were received from four divisions within the Department of Land and Natural Resources.

[3] The City and County of Honolulu Department of Parks and Recreation requested to be removed from the distribution list for the remainder of the Project.

7.2.1 Pre-Assessment Scoping

HAR §11-200.1-18 requires early consultation seeking the advice and input of the county agency responsible for implementing the county's general plan and other agencies having jurisdiction or expertise, as well as those citizen groups and individuals that may be affected by the proposed action. Pursuant to these requirements, as part of the scoping process for the Draft EA, the governmental agencies, elected officials, organizations and individuals that may have a specific interest or could otherwise be affected by the Project were identified. These parties, which are listed in Table 7-2, were sent a scoping letter containing preliminary Project information and were asked to provide comments and related information for consideration in preparing the Draft EA. A copy of the pre-assessment scoping letter is provided in Appendix L.

A total of 17 comment letters were received in response to the pre-assessment scoping request. The comments are summarized in Table 7-3, with copies of the comment letters and the responses in Appendix M In accordance with the intent of HAR §11-200.1, the information and input received through the pre-assessment process was considered in the preparation of the Draft EA.

Table 7-3. Summary of Comments Received in Response to Scoping Request

Commenting Party	Date of Comment	Summary of Comments
City and County of Honolulu Dept. of Parks & Recreation	Letter dated August 29, 2019	States the Project will not impact any of the Department's programs or facilities; requests to be removed as a consulted party.
City and County of Honolulu Dept. of Facility Maintenance	Letter dated September 5, 2019	No comment at this time; no facilities or easements on property. Notes that H-1 Freeway is under the jurisdiction of the State Department of Transportation and Pālehua Road is a private road.
Land Use Commission	Letter dated September 5, 2019	1. Notes that Project will need to comply with OEQC's updated rules 2. Requests that Draft EA discuss LSB classifications and limitations to solar development on those lands per HRS Chapters 205 3. Request that Draft EA discuss the State Special Permit process 4. States that Draft EA should discuss drainage issues and proposed mitigation measures 5. States that Project is within 5 miles of an airport and Draft EA should discuss compliance with applicable FAA requirements such as a glint and glare analysis
State of Hawai'i Dept. of Accounting and General Services	Letter dated September 9, 2019	No comment at this time; property does not appear to directly impact any of the Department's managed facilities (but notes intention to continue monitoring the project as it develops)
City and County of Honolulu Dept. of Design and Construction	Letter dated September 10, 2019	No comment at this time
State of Hawai'i Department of Hawaiian Home Lands	Letter dated September 11, 2019	1. Requests that Draft EA describe the proposed safety controls, contingency plans, and end-of-lifecycle treatment for battery storage system, as well as review other energy storage options 2. Requests that Draft EA include details regarding the proposed mixed-use of the Project area for agricultural purposes

Commenting Party	Date of Comment	Summary of Comments
		3. Notes that the Project is proximate to six Hawaiian Homestead communities and recommends considering these communities when short and/or long-term job opportunities arise 4. States that the Project has the potential to impact DHHL's beneficiaries in ʻEwa Moku and encourages consultation with Hawaiian Homestead community associations and other Native Hawaiian organizations to assess potential impacts to cultural and natural resources, access and other rights
Honolulu Fire Department	Letter dated September 12, 2019	Summarizes requirements for fire department access roads, water supply to provide fire flow, fire apparatus access roads, and fire code requirements for photovoltaic and battery storage systems; requests submittal of civil drawings for review by Honolulu Fire Department
State of Hawaiʻi Dept. of Education	Letter dated September 12, 2019	States that Project will not impact any Department of Education schools or facilities
Board of Water Supply	Letter dated September 23, 2019	1. States that existing water system is adequate to accommodate proposed solar facility; notes final decision on availability of water will occur as part of building permit review 2. States that proposed water connection designs for solar facility should be submitted for BWS review/approval; notes that the construction schedule should be coordinated with BWS 3. States that if water is made available, applicant will be required to pay Water System Facilities Charges 4. States that BWS cannot determine water availability adequacy for agricultural activities without further information regarding domestic and irrigation demands 5. Notes that developer should investigate feasibility of using non-potable water for agricultural activities; if non-potable water is unavailable or infeasible, a report of the investigation should be submitted to BWS 6. States that onsite fire protection requirements should be coordinated with the Honolulu Fire Department
City and County of Honolulu Department of Transportation Services	Letter dated September 23, 2019	1. States that a Traffic Management Plan (TMP) should be prepared that is jointly reviewed and approved by DTS and DPP 2. States that if there are any roadway, sidewalk or crosswalk closures, alternate routes should be provided for vehicles, pedestrians, and bicyclists that are safe and clearly marked 3. States that any existing pedestrian, bicycle and vehicle access/crossing should be maintained with the highest safety measures during construction 4. States that BMP controls should be included at the construction site to prevent trailing of dirt/debris onto adjacent roadways 5. Any damage to existing roadways/sidewalks should be repaired to current City standards and meet Americans with Disabilities Act requirements 6. States that the area representatives, neighborhood board, and area residents, businesses, emergency personnel, Oʻahu Transit Services Inc., etc. should be kept apprised of the project status and impacts that may occur to adjoining local street network 7. Notes that a street usage permit from DTS should be obtained for any construction-related work that may require the temporary closure of any traffic lane on a City street

Commenting Party	Date of Comment	Summary of Comments
DOT	Letter dated September 25, 2019	1. Notes that Project is approximately 3.64 miles from Kalaeloa Airport; all projects within five miles of Hawai'i State airports are advised to read Technical Assistance Memorandum (TAM) 2. Recommends submittal of FAA Form 7460-1 Notice of Proposed Construction or Alteration 3. Notes that a glint and glare analysis must be included with submittal of FAA Form 7460-1 4. States that if glint or glare from the PV array creates hazardous condition for pilots, the owner shall immediately mitigate the hazards upon notification by DOT and/or FAA 5. States that owner must ensure that PV installation will not create any radio frequency interference (RFI); if Project creates an RFI situation, the owner shall immediately mitigate the hazards upon notification by DOT and/or FAA 6. Requests that Draft EA include a traffic impact assessment that addresses (a) trip generation during construction and operations; (b) additional site access points that may be used during construction; and (c) potential construction impacts to nearby DOT roadways and intersections, and proposed mitigation measures 7. Requests that Draft EA include a discussion of existing and proposed linear utility alignments (e.g., powerlines) and the potential for new alignments to impact DOT roadways
DLNR Engineering Division	Letter dated September 27, 2019	Provides information regarding regulations that apply to projects within special flood hazard zones; states that the owner of the project property and/or their representative is responsible to research the Flood Hazard Zone designation for the project
DLNR Division of Forestry and Wildlife	Letter dated September 27, 2019	1. Recommends twilight pre-construction pueo surveys prior to clearing vegetation; if pueo nests are present, a buffer zone should be established in which no clearing occurs until nesting ceases, and DOFAW staff should be notified 2. Recommends measures to minimize impacts to seabirds: (1) all lights be fully shielded and directed to avoid reflecting off the panels; (2) monitoring during moon phases to assess potential impacts; and (3) nighttime work that requires outdoor lighting should be avoided during the fledging season 3. Recommends implementation of avian mortality avoidance measures during design and surveys/ monitoring during operation
CWRM	Letter dated September 27, 2019	1. Recommends use of best management practices (BMPs) for stormwater management to minimize the impact to existing hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events 2. Recommends adopting landscape irrigation conservation BMPs endorsed by the Landscape Industry Council of Hawai'i 3. Notes the potential for ground or surface water degradation/ contamination and recommends that project approvals be conditioned upon DOH review and the developer's acceptance of any resulting requirements related to water quality
DLNR Land Division	Letter dated September 27, 2019	No comments at this time

State of Hawaiʻi Office of Planning	Letter dated October 1, 2019	1. States that Draft EA should address the special permit guidelines relative to determining the "unusual and reasonable" use of lands for the proposed solar facility; also notes that the State Land Use Commission would be issuing the final decision on the Special Permit for the proposed facility. 2. States that Draft EA should include a discussion of consistency with all three parts of HRS Chapter 226; notes that proposed solar farm and storage facility is consistent with the principles of sustainability as a renewable energy production facility 3. States that Draft EA should include analysis on the project's consistency with the objectives and supporting policies of the Hawaiʻi CZM Program, as listed in HRS Chapter 205A-2 4. States that Draft EA should evaluate the effects of stormwater runoff from the project area; the evaluation on stormwater runoff, erosion control, and water quality benefits should involve steps taken during the construction phase, as well as during the operational life of the facility. Issues that may be examined include, but are not limited to, project site characteristics in relation to flood and erosion prone areas, potential vulnerability of water resources, soil absorption characteristics of the area, and examining the amount of permeable versus impervious surfaces in the area; mitigation measures for the protection for surface water resources and the coastal ecosystem should take this into account
City and County of Honolulu Department of Planning and Permitting	Letter dated October 10, 2019	1. A metes and bounds survey of the Project area overlaid on a LSB map is necessary to determine compliance with HRS Chapter 205-4.5(21); the site plan should include the Project area, the layout of the Project components, roadways and any related support uses and structures 2. Once compliance with HRS Sections 205-4.5(20) and 205-4.5(21) is verified, you may apply for an SUP; as the Project involves more than 15 acres, it is subject to approval by the Land Use Commission 3. Draft EA should address how the Project conforms to the vision, policies, and guidelines of the ʻEwa Development Plan, as well as the objectives and policies of the Oʻahu General Plan 4. Draft EA should include information to determine the use of the site as either a Type A or Type B Utility Installation. If it is considered a Type B Utility Installation, then a Minor Conditional Use Permit will be necessary. If the Project does not comply with the development standards for the AG-1 District, then a Zoning Waiver will be necessary 5. Draft EA should include an analysis of the visual impacts associated with the Project 6. Draft EA should include a narrative describing how the Project's post-construction stormwater quality strategic plan complies with the Rules Relating to Water Quality. The strategic plan should include a written description of the Project, expected activities and pollutants that will be generated, low impact development site design strategies that will be used to comply with the Rules, and an anticipated development schedule. The Draft EA should also disclose how the Project will comply with the City and County's prevailing Storm Drainage Standards 7. Recommends consultation with FAA and DOT-Airports, as the Project will be within five miles of the Kalaeloa Airport; refers to the Technical Assistance Memorandum (TAM-2016-1) for guidance 8. The Draft EA should list all required federal, state, and city permits

7.2.2 Public Review of Draft EA

HAR §11-200.1 requires publication of a Draft EA in the OEQC's bimonthly bulletin, *The Environmental Notice*, followed by a 30-day public review period. In accordance with these requirements, the Draft EA was published in *The Environmental Notice* on April 8, 2020, with the 30-day public review period running from the publication date through May 8, 2020. Notice of the Draft EA publication and public review period, including instructions for submitting comments was sent to the entities listed in Table 7-2. Comments received on the Draft EA (postmarked on or before May 8, 2020) will be considered and incorporated into the Final EA, as appropriate.

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Appendix A
Decommissioning Plan

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Decommissioning Plan

AES Distributed Energy

West Oahu Solar Project

March 2020

Prepared for:
AES Distributed Energy
282 Century Pl, Suite 2000
Louisville, CO 80027

Contents

1 Introduction

AES Distributed Energy (AES) engaged HDR Engineering, Inc. (HDR) to provide a physical plan to complete decommissioning of the West Oahu Solar project (Project). The Project consists of a solar photovoltaic (PV) system plus battery energy storage system (BESS) and project substation. The decommissioning plan (Plan) describes the general measures and procedures that should be developed and implemented to decommission and restore the site, and safely dispose of or recycle project materials.

1.1 Decommissioning Requirements

This Plan outlines a typical program for decommissioning the Project at the end of the project life cycle that satisfies Hawaii state law requiring decommissioning per the "Permissible uses within the agricultural districts" as part of the Special Use Permit requirements, specifically the following requirements per Section 205-4.5, Item 21[1]:

> *"(B) Proof of financial security to decommission the facility is provided to the satisfaction of the appropriate county planning commission prior to date of commencement of commercial generation; and*
> *(C) Solar energy facilities shall be decommissioned at the owner's expense according to the following requirements:*
> *(i) Removal of all equipment related to the solar energy facility within twelve months of the conclusion of operation or useful life; and*
> *(ii) Restoration of the disturbed earth to substantially the same physical condition as existed prior to the development of the solar energy facility."*

Prior to commencing decommissioning, the Owner would need to verify with the local, state or federal agencies any additional requirements and submit a revised plan as required.

1.2 Project Description

The Project is located on the Hawaiian island of Oahu, North of the intersection of Interstate H1 and Kualakai Parkway (see Figure 1) on approximately 80 acres of agricultural zoned property. The undeveloped site consists primarily of shrub brush on Land Study Bureau (LSB) Soil Classification B, D and E. The Project consists of 17.4 MWdc (12.5 MWac at POI) of fixed tilt solar PV with 20 DC-coupled 650 kW BESS containers. The project will interconnect via a new project substation to an existing overhead 46 kV transmission line owned by Hawaii Electric Company (HECO) that bisects the site.

[1] Hawaii State Legislature, §205-4.5 Permissible uses within the agricultural districts, https://www.capitol.hawaii.gov/hrscurrent/Vol04_Ch0201-0257/HRS0205/HRS_0205-0004_0005.htm

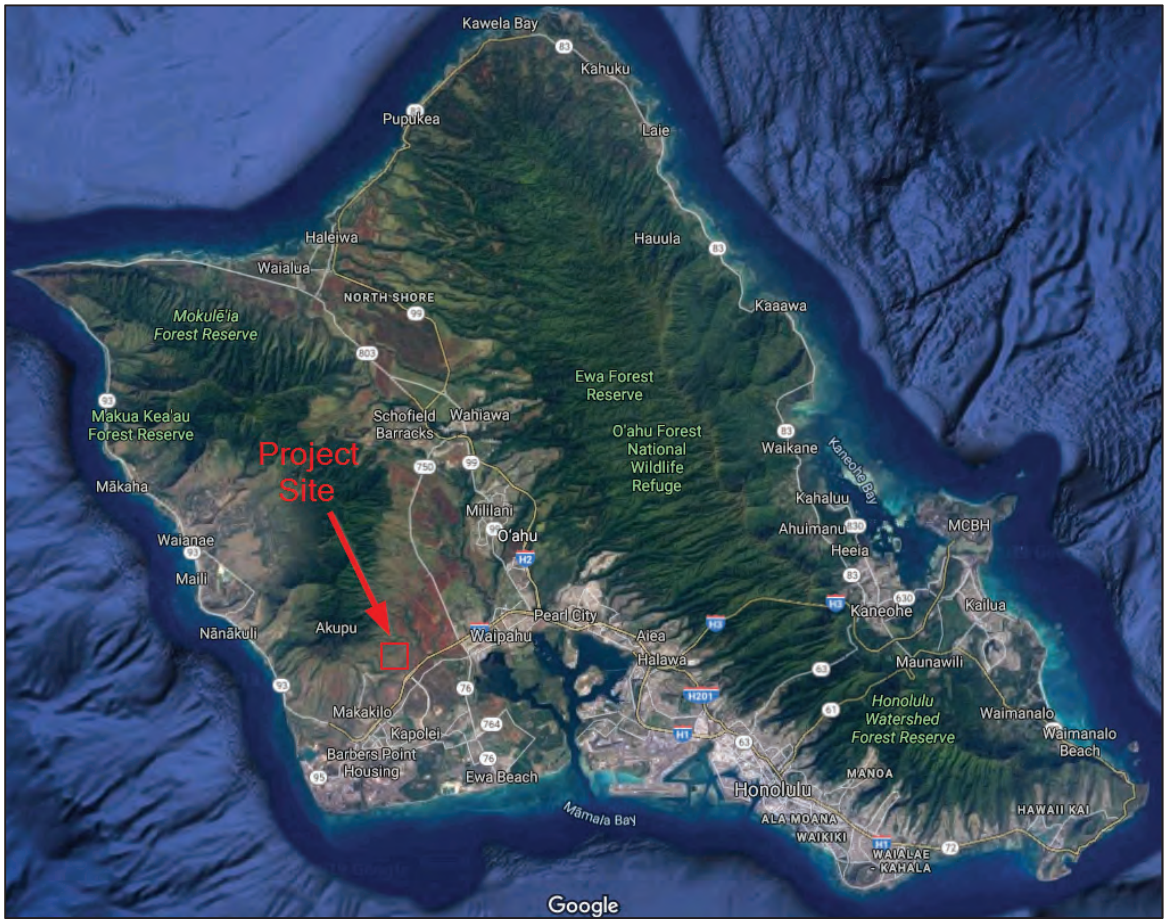

Figure 1 – Project Site Location (Source: Google Earth)

For preliminary site layout, see Appendix A. Major features of the Project are outlined below:

- 405 Watt (nominal) output, Monocrystalline, bifacial PV panels
- Fixed axis steel racks in a double portrait layout to support the PV panels
- Steel pile foundation to support panels/racks and miscellaneous equipment
- Five (5) 2.8 MWac central inverters on pads along with five (5) 3000 kVA medium voltage step up transformers, and associated data collection equipment for metering and monitoring.
- Twenty (20) 650 kWdc BESS storage containers co-located on electrical equipment pads
- On-site 100 ft by 200 ft project substation with GSU transformer
- 20 ft wide gravel site access roads
- Perimeter security fencing
- Bee hives and cattle grazing throughout the project area

1.3 Decommissioning Plan Description

This Plan has been developed to outline typical procedures and considerations for decommissioning the Project. Decommissioning may occur because the project has fulfilled its intended purpose and term, or because it has been abandoned.

2 Decommissioning Procedures

2.1 Overview

After project end of life or conclusion of operation, the site would be restored within 6-12 months to substantially the same physical condition as existed prior to the development of the Project. This decommissioning includes removal of project equipment and all site restoration activities noted below. All site activities described below will commence after the site has been de-energized and secured. Because decommissioning activities are not expected to occur for many years, and regulatory requirements may change, any applicable permitting or regulatory requirements would be reviewed with appropriate local and state agencies prior to decommissioning activities to ensure compliance.

2.2 General Environmental Protections

During decommissioning activities, general environmental protection measures would be implemented as required. Many activities during decommissioning would be comparable to the construction phase, including the use of heavy equipment on site, preparing staging areas, dust and erosion control procedures, and restoring disturbed areas around all project infrastructure. The project decommissioning activities shall meet all environmental, stormwater, dust control, erosion control and permitting requirements per local, state and federal regulations.

2.3 Pre-decommissioning Activities

Prior to engaging in decommissioning activities, the Owner would update this decommissioning plan in accordance with appropriate requirements at the time of decommissioning. Decommissioning and restoration activities will be performed in accordance with all relevant ordinances and requirements in place at the time of decommissioning and in accordance with the Project’s other environmental permits. At the end of the Project's useful life, it will first be de-energized and isolated from all external electrical lines prior to initiating dismantling or ground-disturbing decommissioning work. This includes coordination and advanced communication with the interconnection utility (HECO).

2.4 Decommissioning and Restoration Activities

The major components of the Project are PV modules, steel racking and support piles, electrical cabling, inverters, transformers, BESS containers, and project substation equipment. All electrical equipment, both above ground and underground (where practicable and as noted herein), will be removed from the project property upon decommissioning.

PV Module and Racking Removal

All modules will be disconnected, removed from the racking, packaged and transported to a designated location for recycling or resale. Recycling will be done in accordance with applicable laws and requirements. Whether recycling or disposal occurs on the island or off the island may depend on current regulations at the time. The connecting cables and the combiner boxes will be de-energized, disconnected, and removed. The steel racking system supporting the PV modules will be unbolted and disassembled by laborers using standard hand tools, possibly assisted by small portable crane. All steel support structures will be completely removed and transported off site for salvage or reuse. Any demolition debris that is not salvageable will be transported to an approved disposal area. Other salvageable equipment and/or material will be removed for the site for resale, scrap value or disposal.

The modules and racking systems will likely be supported via driven steel piles or screws. Other miscellaneous equipment may be supported via steel piles. All piles will be removed and salvaged.

Electrical Equipment Removal

All decommissioning of electrical devices, equipment, and wiring/cabling will be in accordance with local, state and federal laws. Any electrical decommissioning will include obtaining required permits, and following applicable safety procedures before de-energizing, isolating, and disconnecting electrical devices, equipment and cabling. Decommissioning will require dismantling and removal of the electrical equipment, including inverters, transformers and underground/aboveground cables. All electrical equipment will be removed from the project property upon decommissioning. The equipment will be disconnected and transported off site.

Any concrete foundations and support pads will be broken up by mechanical equipment (e.g. backhoe-hydraulic hammer/shovel, jackhammer), loaded in to dump trucks and removed from the site. All concrete foundations will be removed, including any deep pier foundations (if required). Smaller pre-cast concrete support pads will be removed intact by cranes and loaded onto trucks for reuse, or will be broken up and hauled away by dump trucks. Prior to removal of any transformers, any oil will be pumped out into a separate industry approved disposal container and sealed to prevent any spillage during storage and/or transportation. Salvaged oil from transformers will be transported to the nearest oil recycling or disposal center. Equipment and material may be salvaged for resale or scrap value depending on the market conditions.

BESS Removal

The BESS containers will be co-located with project inverters and electrical equipment. They will be comprised of containerized modules consisting of lithium-ion batteries and an air conditioning / HVAC system to provide cooling and heating. Lithium-ion batteries will require routine continuous maintenance and care in their use and handling. Batteries reaching end of life will be recycled and disposed of in accordance with the relevant local, state or federal regulations. Replacements will be made with new or appropriately refurbished batteries. This periodic replacement would have no effect on decommissioning processes.

The following steps are required for BESS removal:

- Disconnect BESS from sectionalizing equipment, inverters, transformers and auxiliary power

- Remove battery racks for recycling as well as other easily non-secured components. Containers to be removed and remaining components disassembled at appropriate recycling facilities.
- Remove foundation pad and/or pile supports as previously noted.
- Re-grade surfaces, add topsoil and seed according to “Site Restoration” below.

Project Substation Removal

All project substation equipment and buildings shall be removed, including the underground cabling, grounding grid, and foundations. The Project does not anticipate a gen-tie line to connect to the utility transmission line outside of the single connecting overhead span, but regardless all equipment, structures and foundations required for removal shall be done according to this Plan. Decommissioning activities would require coordination with the local utility on the interconnecting transmission line including the assets at the point of interconnection. Owner shall not be responsible for decommissioning anything on the utility transmission line unless otherwise agreed upon.

The following steps are required for Project substation removal:

- De-energize transformers and other energized equipment and disconnect from the project substation
- Disconnect and remove medium voltage switchgear
- Disconnect and remove sectionalizing equipment and transformers
- Disconnect and remove electrical and communications equipment in the control building
- Demolish control building and remove foundation
- Remove equipment foundation pads and pile supports for remaining equipment
- Remove grounding grid, fence and cables
- Remove and recycle aggregate surfaces
- Re-grade surfaces, add topsoil and seed according to “Site Restoration” below

Road Rehabilitation

At the time of decommissioning, the Owner will coordinate with the property owners and easement holders (if applicable) to determine if any site access roads should remain. If any of the other roads serve no future purpose, they will be decommissioned and restored to preconstruction conditions. The decommissioning will involve the removal of the aggregate and filling the remaining voids with on-site surface materials by grading. Removed materials will be taken to an appropriate recycling area (possibly on site) where the gravel or aggregate materials can be processed for salvage value or future use. Remaining ground surfaces will be rough graded to merge with the surrounding elevations and returned to near preconstruction conditions by means of grading and disking, using a tractor and disc attachment to restore the soil structure and to aerate the soil.

Site Restoration

Following decommissioning, the Project site will be stabilized to ensure that there are no ongoing adverse environmental effects. The site will be restored to a clean, safe and environmentally stable state, and substantially to preconstruction conditions according to state regulations. Site restoration activities in the various project areas will immediately follow the removal of above ground and below ground structures to ensure there are no adverse environmental impacts due to rain events. Site restoration will consist of re-seeding of disturbed areas with native grass mixture as required.

Fences and Gates

The security fence will be dismantled, removed and recycled offsite only after all other ground-disturbing decommissioning and site restoration work has been completed. The fencing protecting the perimeter of the site typically consists of steel fence attached to line posts. Posts will typically extend to depths of 4 ft to 6 ft below grade and will either be encased in concrete footings or directly embedded. All posts shall be removed intact. The Project will be accessed through manually operated swing gates located at multiple permanent access points and personnel gates. It is anticipated that the fence, gates, wire and hardware would be removed and recycled at decommissioning.

2.5 Waste Management Procedures

During decommissioning, debris and waste generated will be recycled to the extent feasible and as required by local, state and federal regulations. The contractor will facilitate recycling of all construction waste through coordination with licensed sub-contractors, local waste haulers, and/or other facilities that recycle construction/demolition wastes. The contractor will also be responsible for ensuring that wastes requiring special disposal (e.g., transformers) are handled according to regulations that are in effect at the time of disposal. Although hazardous waste is not anticipated on the site, any hazardous waste would be removed and disposed of in accordance with applicable laws and regulations.

2.6 Emergency Response and Communications Plans

During decommissioning, the Owner and Contractor will coordinate with local authorities, the public, and others as required to provide information about the ongoing activities. Besides regular direct/indirect communication, signs will be posted at the Project facility to inform the local public and visitors. The Owner and Contractor’s project representatives contact information (e.g. telephone number) will be made public for those seeking more information about the decommissioning activities and/or for reporting emergencies and complaints. All inquiries will be directed to the project representatives.

In the event of an emergency, the Owner will mobilize its resources to the site to respond to the event. Personnel involved in decommissioning will be trained in the emergency response and communications procedures. Emergency response procedures will be prepared prior to decommissioning.

3 Material and Salvage Plan

This section identifies major material and equipment quantities on the Project based off of preliminary designs. Any bids from decommissioning contractors will be responsible for verification of quantities (per final drawings), construction costs and salvage rates.

Salvage value of recyclable material is derived from the makeup of the materials of the racking system, piles, inverters, transformers, cabling, aggregate, BESS and potentially PV panels (see bullets below) removed from the project at end of life.

The following may be assumed for salvage recovery rates and values:

- Depending on the component, equipment, and anticipated decommissioning activity, various material recovery percentages ranging from 75% to 100% are assumed. Salvage rate accounts for inefficiencies in removal of salvageable material, damage during removal or transport, and inability to cost effectively separate components to recoverable materials. To be on the conservative side, a salvage rate less than 100% is typical to thereby reduce the salvage value recovered.
- The future market is not clear on the usability or value of recently deployed solar panels after the approximate component lifecycle of 25 years. Panels are recyclable (the majority of components) and disposing of panels in a landfill should be avoided.
    - Panels may be recycled by a panel recycler at a cost of $25 per panel (about $0.50/lb) as reported by Recycle PV Solar, LLC[2]. This can be impacted by transportation costs for the recycler.
    - Alternatively, the panels could also be offered to a panel refurbishment company at no cost to the project or possibly at a salvage rate. The Owner would dismantle, package and turn over the panels at no cost; therefore, no panel recycling fee.
    - Panel salvage/reuse is likely to remain dynamic; alternatives should be evaluated for and reassessed periodically.
- All excess material that is not salvageable is anticipated to be removed off-site and transported to approved disposal facilities.

3.1 Major Equipment Quantities

Major equipment quantities on the Project are listed in the table below based off preliminary design documents. Quantities listed below may not reflect final installed quantities and should be updated to reflect final designs.

Major Equipment Quantity Summary				
Item	**Description/Details**	**Unit**	**Quantity**	**Notes**
PV Modules	Jinko Eagle Bifacial HC 72M G2	Each	42,980	
ISU Transformers	3000 kVA	Each	5	GE Prolec
Inverters	2.8 MW Central Inverters	Each	5	GPTECH Inverters
BESS	650 kW BESS	Each	20	40 x 8 Containerized. Manufacturer not identified at this stage

[2] Recycle PV Solar. www.recyclepv.solar; accessed November 5, 2019.

Major Equipment Quantity Summary				
Item	**Description/Details**	**Unit**	**Quantity**	**Notes**
GSU Substation Transformer	10/13.3/16.6 MVA, 46kV-12.47kV Transformer	Each	1	Siemens
Substation Steel Structures	TBD	Lbs	TBD	
Breaker	46 kV Breaker	Each	1	TBD
15 kV Switchgear	Switchgear with (3) breakers and communication section	Each	1	TBD
Racking	Steel PV Racking Structure	Lbs	TBD	RBI Solar
Fence	PV Perimeter Fence	LF	TBD	
Roads	20 ft Gravel Access Roads	LF	TBD	Confirm Road Details

Appendix A:
Preliminary Site Layout

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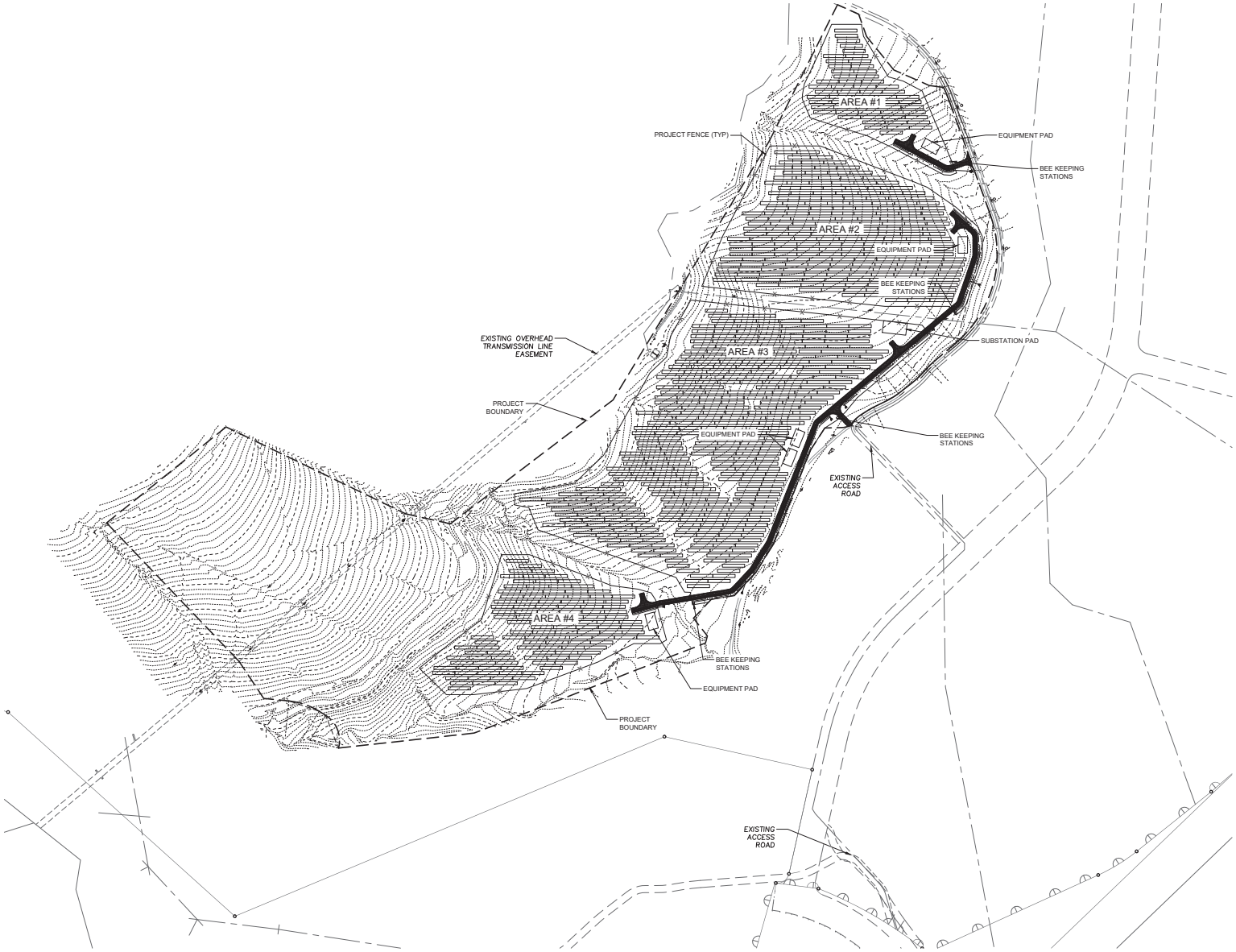

AES Distributed Energy
282 Century Pl. Suite 2000
Louisville, CO 80027 USA

SYSTEM DESCRIPTION

REVISIONS

REV	BY	DATE	DESCRIPTION

PE STAMP

AES WEST OAHU SOLAR

OAHU, HI

PROJECT NUMBER
19537

PHASE
ISSUED FOR REVIEW

MILESTONE
60% DESIGN

ELECTRICAL DESIGNER

STRUCTURAL DESIGNER

DATE
03-13-2020

SCALE
1"=200'

TITLE
OVERALL SITE PLAN

DRAWING
FIGURE 1

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Appendix B
Delineation of Wetlands and Waters of the U.S. Report and Jurisdictional Determination

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

September 04, 2019

SUBJECT: Determination of No Permit Required, West Oahu Solar Project, Ewa District, Oahu, Department of the Army File No. POH-2019-00164

AES Distributed Energy
c/o Mr. Nick Molinari
4875 Pearl East Circle, Suite 200
Boulder, CO 80301

Dear Mr. Molinari:

The Honolulu District, U.S. Army Corps of Engineers (Corps), Regulatory Branch has received your request for a jurisdictional determination and clarification whether a Department of the Army (DA) permit is required for grading within the 80-acre West Oahu Solar project site for construction of a 12.5-megawatt (MW) ground-mounted solar photovoltaic system with a 50-MW-hour batter energy storage system, a substation, a connection to the existing 40-kilovolt transmission line that transverses the project area, and other related interconnection and ancillary facilities and to conduct road improvements along existing unnamed roads located southeast of the West Oahu Solar Project site, located at 21.372006, -158.065250, on TMK 9-2-002:007, north of the intersection of Pueonani Street and Queen Liliuokalani Freeway (H1), in Kapolei, Island of Oahu, Hawaii. Your request has been assigned DA file number POH-2019-00164. Please reference this number in all future correspondence with our office relating to this action.

Based on our review of the information you provided and the enclosed approved jurisdictional determination (AJD), dated September 4, 2019, the area identified as the Corps Area of Review (AOR) (Enclosure 1) does not contain waters of the U.S., including wetlands or navigable waters of the U.S., as defined by 33 CFR Parts 328 and 329, respectively. Therefore, a DA permit under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act of 1899 is not required. The basis for our jurisdictional determination is on the enclosed AJD Form (Enclosure 2).

This letter contains an AJD for the aforementioned review area. If you wish to submit new information regarding this jurisdictional determination, please do so within 60 days. We will consider any new information submitted and respond within 60 days by either revising the prior determination, if appropriate, or reissuing the prior determination. If you object to this determination, you may request an administrative appeal under 33 CFR Part 331. We have enclosed a Notification of Appeal Process and Request for Appeal (NAP/RFA) form (Enclosure 3). If you wish to appeal this

determination, you must submit a completed RFA form within 60 days of the date on the NAP to the Corps' Pacific Ocean Division office at the following address:

Kate Bliss
Civil Works and Regulatory Program Manager
U.S. Army Corps of Engineers
Pacific Ocean Division, ATTN: CEPOD-PDC
Building 525
Fort Shafter, Hawaii 96858-5440

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR Part 331.5, and that it has been received by the Pacific Ocean Division office by October 28, 2019.

While a DA permit is not required for your proposed project, you are responsible for obtaining all other applicable Federal, state, or local authorizations required by law.

Thank you for your cooperation with the Honolulu District Regulatory Program. If you have any questions related to this determination, please contact me at 808-835-4310 or via e-mail at Vera.B.Koskelo@usace.army.mil. You are encouraged to provide comments on your experience with the Honolulu District Regulatory Branch by accessing our web-based customer survey form at http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey. For additional information about our Regulatory Program, please visit our web site at http://www.poh.usace.army.mil/Missions/Regulatory.aspx.

Sincerely,

KOSKELO.VERA.B.1370139110 Digitally signed by KOSKELO.VERA.B.1370139110 Date: 2019.09.04 17:44:01 -10'00'

Vera B. Koskelo
Regulatory Project Manager

Enclosures

West O‘ahu Solar Project

Delineation of Wetlands and Other Waters of the U.S.

Prepared for:

AES Distributed Energy

July 2019

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WATERS OF THE U.S. DELINEATION SUMMARY

Project Name	West Oʻahu Solar Project
Site Location	ʻEwa District, Oʻahu Island, Hawaiʻi 21.371939°N, -158.065087°W Tax map key parcel: 9-2-002:007
Applicant	AES Distributed Energy
Landowner	University of Hawaiʻi
Survey Dates	May 9, 10, and 22, 2019
Project Staff	Tiffany Bovino Agostini, Senior Biologist/Project Manager Jacob Dutton, Biologist

SUMMARY

AES Distributed Energy (AES) is proposing the West Oʻahu Solar Project (Project) on the southwest side of Oʻahu, approximately 3 miles northeast of Kapolei. The 12-megawatt facility would be located on roughly 80 acres within tax map key (TMK) 9-2-002:007. AES contracted Tetra Tech, Inc. (Tetra Tech) to complete a delineation of potential Waters of the United States (WoUS) governed by the Clean Water Act. This report summarizes the findings of the WoUS delineation conducted in the West Oʻahu Solar Study Area (Study Area) on May 9, 10, and 22, 2019.

Tetra Tech delineated a total of approximately 0.61 acre of the intermittent Kaloʻi Gulch within the Study Area including a main channel and two short branches. Although Kaloʻi Gulch has a defined bed and bank and ordinary high water mark in the Study Area, there is no evidence that Kaloʻi Gulch directly or indirectly contributes flow to the Pacific Ocean, a traditional navigable water of the United States. Furthermore, previous jurisdictional determinations for downstream portions of Kaloʻi Gulch have concluded that the feature is not jurisdictional. The Waiāhole Ditch and Pipeline delineated in the Study Area are also not likely jurisdictional under the 2015 Clean Water Rule. These conclusions are subject to confirmation by the U.S. Army Corps of Engineers, Honolulu District.

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Acronyms and Abbreviations

AES	AES Distributed Energy
CWA	Clean Water Act
DAR	State of Hawaiʻi Department of Aquatic Resources
EPA	Environmental Protection Agency
FAC	Facultative
FACU	Facultative Upland
HECO	Hawaiian Electric Company
MW	megawatt
NHD	National Hydrography Dataset
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OHWM	Ordinary High Water Mark
Project	West Oʻahu Solar Project
Study Area	West Oʻahu Solar Study Area
Tetra Tech	Tetra Tech, Inc.
UPL	Upland
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WoUS	Waters of the United States

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1.0 Introduction

AES Distributed Energy (AES) is proposing to construct and operate the West Oʻahu Solar Project (Project), a solar photovoltaic and battery energy storage system located on the southwest side of Oʻahu, approximately 3 miles northeast of Kapolei (Figure 1). AES contracted Tetra Tech, Inc. (Tetra Tech) to perform a delineation of wetlands and other potential Waters of the United States (WoUS) in the areas that may be impacted by the Project. This report describes the extent and location of potential WoUS in the West Oʻahu Solar Study Area (Study Area).

1.1 Regulatory Setting

The U.S. Army Corps of Engineers (USACE) derives its regulatory authority over WoUS from two federal laws: 1) Section 10 of the Rivers and Harbors Act of 1899, and 2) Section 404 of the Clean Water Act (CWA) of 1972. Under Section 404 of the CWA, dredged and fill material may not be discharged into jurisdictional WoUS (including wetlands, perennial streams, and intermittent streams) without a permit.

The 2015 CWA Rule went into effect for Hawaiʻi in August 2015 (USACE and EPA 2015). This rule was intended to clarify which waters are considered WoUS, and are therefore subject to WoUS jurisdiction. In February 2019, the U.S. Environmental Protection Agency and USACE issued a proposed rule for a revised definition of WoUS (USACE and EPA 2019). Timing of the implementation of the revised definition is undetermined due to ongoing federal review of public comments about the revised definition, and the potential for future litigation challenging the new rule.

1.2 Project Description

The proposed Project consists of construction and operation of an approximately 12.5-megawatt (MW) ground-mounted solar photovoltaic system, coupled with a 50 MW-hour battery energy storage system and related interconnection and ancillary facilities. The Project would connect to a substation via underground electrical conduit. Interconnection of the Project with the Hawaiian Electric Company (HECO) electrical grid would be via an existing 46-kilovolt transmission line that traverses the Study Area. A Project substation and HECO switching station would be located immediately proximate to the existing transmission line, with a short connection installed from the HECO switching station to the transmission line. No new overhead electrical transmission lines will be installed. The Project would be accessed from existing gated entry off Kualakai Parkway and Pueonani Street/Palehua Road and would utilize a network of existing and new onsite access roads. It is anticipated that construction would require approximately 12 to 15 months, with commercial operations commencing in 2021 or 2022.

2.0 Description of the Study Area

As shown in Figure 1, the Study Area is located in the ʻEwa District in southwest Oʻahu, north of the communities of Makakilo, Kapolei, and ʻEwa Villages. The roughly 80-acre Study Area comprises four non-contiguous areas within tax map key (TMK) 9-2-002:007. It encompasses the main solar facility area where the solar panels and battery energy storage system would be located, as well as three areas where Project roads cross potentially jurisdictional features (referred to as Road Crossings 1, 2, and 3). All land within the Study Area is owned by the University of Hawaiʻi.

The Study Area is bordered by agricultural land on all sides. The H-1 Freeway is located roughly 0.4 mile to the south. The Study Area and vicinity was previously cultivated as part of the extensive sugar cane and pineapple plantation that extended across Oʻahu's ʻEwa Plain. Since closure of the plantation in the 1990s, this area has not been recently cultivated and is now undeveloped, vacant land. Domestic cattle grazing occurs within portions of the Study Area. A minimal amount of infrastructure associated with the former plantation remains onsite, including a pump station, an associated wooden structure, and components of the irrigation system.

2.1 Topography and Soils

The Study Area is located on the southwest side of the Waiʻanae Mountain Range. The land generally slopes southeast toward the ocean. Elevation in the Study Area ranges from 235 to 655 feet above sea level.

The Natural Resources Conservation Service (NRCS) identifies eight soil types in the Study Area (Figure 2). Most of the Study Area is mapped as Mahana silty clay loam, 20 to 35 percent slopes, eroded (McE2) and Mahana silty clay loam, 12 to 20 percent slopes, eroded (McD2) (Foote et al. 1972, NRCS 2019a). Small portions of the following soil units are also present in the Study Area: Mahana silty clay loam, 6 – 12, eroded (McC2); Molokai silty clay loam, 7 – 15 percent slopes (MuC); Molokai silty clay loam, 15 – 25 percent slopes (MuD); Kawaihapai clay loam, 2 – 6 percent slopes (KlB); Kawaihapai stony clay loam, 2 – 6 percent slopes (KlaB); Kawaihapai very stony clay loam, 0 – 15 percent slopes (KlbC) (Foote et al. 1972, NRCS 2019b). None of the soil types that are mapped by NRCS within the Study Area are considered hydric soils (NRCS 2019b).

2.2 Hydrology

Mean annual rainfall in the area is approximately 30 inches. Rainfall is typically highest in December and lowest in June/July (Giambelluca et al. 2013). The National Weather Service operates two rain gauges near the Study Area—one in Kunia and one in Honouliuli. In April 2019, the Honululi gauge documented slightly below average rainfall, while the Kunia gauge recorded above average rainfall, likely due to a storm event that occurred on April 28, 2019 (National Weather Service 2019). Heavy rainfall also occurred on the island on May 4, 2019; however, both gauges recorded below average rainfall for the month of May 2019 (National Weather Service 2019).

Prior to the survey, various datasets were reviewed to identify streams, wetlands, and other potential WoUS in the Study Area (see Section 3). Figure 3 depicts water resources mapped within the Study Area as part of the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) dataset, the U.S. Geological Survey (USGS) topographic and National Hydrography Dataset (NHD), and the State of Hawaiʻi Department of Aquatic Resources (DAR) dataset.

The Study Area is within the Kaloʻi Gulch watershed. The Kaloʻi Gulch stream system consists of numerous tributaries that originate in the Waiʻanae Mountain Range near Palikea Ridge and enjoin to form one channel just mauka of the H-1 Freeway (Parham et al. 2008).

Within the Study Area, DAR data identify one feature—the non-perennial Kaloʻi Gulch. This feature is identified as an intermittent stream by the NHD and a Freshwater Forested/Shrub Wetland (PSS3A - Palustrine, Scrub-Shrub, Broad-Leaved Evergreen, Temporary Flooded) by NWI. All three databases show the same alignment for the feature within the Study Area, including a 90-degree shift in course at roughly 400 feet in elevation along the ditch system (Figure 3).

Two tributaries of Kaloʻi Gulch are identified by the NWI, NHD, and DAR data immediately to the west and east of the Study Area. The datasets show the western tributary joining Kaloʻi Gulch near Road Crossing 3, and the eastern tributary joining roughly 220 feet mauka of the H-1 Freeway.

South of the Study Area, Kaloʻi Gulch passes through the University of Hawaiʻi West Oʻahu campus, various residential developments, stormwater retention ponds, and a series of golf courses. Kaloʻi Gulch does not currently have a defined ocean outlet; however, a storm drainage improvement plan for the Kaloʻi Gulch watershed has been proposed for the lowermost reaches, which would create a permanent open channel at the Oneula Beach Park (R.M. Towill Corporation 2005, WRRC 2019). According to NHD, Kaloʻi Gulch terminates as a canal/ditch near the Hoakalei Golf Course roughly 1,800 feet upslope of the Pacific Ocean (Figure 4).

In addition to Kaloʻi Gulch, NHD identifies a canal/ditch and pipeline (Surface Aqueduct) crossing through the Study Area (Figure 3). This feature is part of the Waiāhole Ditch System, which transported water from the northeastern side of the Koʻolau Mountains to leeward Oʻahu to irrigate dry agricultural lands. NWI maps the canal/ditch portion of the ditch system as Riverine (R5UBFx - Riverine, unknown perennial, unconsolidated bottom, semipermanently flooded, excavated) (Figure 3).

2.3 Flora and Fauna

No federal or state-listed threatened, endangered, proposed listed, or candidate species for listing were observed during the biological survey. The flora and fauna observed in the Study Area are primarily non-native to the Hawaiian Islands and not considered unique (Tetra Tech 2019).

The main vegetation type is Koa Haole Scrub which is characterized by open to dense stands of non-native koa haole trees (*Leucaena leucocephala*— UPL), ranging from 4 to 8 feet in height. Guinea grass (*Megathyrsus maximus*—FAC) is the most abundant plant in the understory, although buffelgrass (*Cenchrus ciliaris*— FACU) is also occasionally present. Kiawe trees (*Prosopis pallida*—FACU) are sparsely scattered throughout the area. Other common species widely occurring in the

Study Area include klu (*Acacia farnesiana*—UPL), ʻilima (*Sida fallax* —UPL), ʻuhaloa (*Waltheria indica*—FACU), and *Sida ciliaris* (UPL). Of the 28 plant species observed, only three are native to the Hawaiian Islands: hoary abutilon (*Abutilon incanum*—UPL), ʻilima, and ʻuhaloa. Native wiliwili tree (*Erythrina sandwicensis*) trees occur adjacent to the Study Area (Tetra Tech 2019).

No native wildlife species were observed within the Study Area. A total of 21 bird species were recorded, all of which are non-native and well established throughout Hawaiʻi. The most commonly observed avian species were Zebra dove (*Geopelia striata*) and common myna (*Acridotheres tristis*). Two non-native terrestrial mammalian species—cattle (*Bos taurus*) and small Indian mongooses (*Herpestes auropunctatus*)—were seen. Although not observed in the Study Area, it was noted that several listed wildlife species may occasionally occur in or transverse the area, including the Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*), Hawaiian petrel or ʻuaʻu (*Pterodroma sandwichensis*), Newell's shearwater or ʻaʻo (*Puffinus auricularis newelli*), and Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*) (Tetra Tech 2019).

3.0 Methodology

Before the survey, Tetra Tech reviewed aerial photography, topographic maps, and water resource datasets to inform the field delineation of wetlands and WoUS potentially in the Study Area. This included NWI data (NWI 2018), NHD (NHD 2019), and DAR streams data (DAR 2016), the State of Hawaiʻi Atlas of Hawaiian Watersheds & Their Aquatic Resources (Parham et al. 2008), and the NRCS Soil Survey Geographic Database dataset (NRCS 2019a).

Tetra Tech conducted the WoUS delineation fieldwork on May 9, 10, and 22, 2019. The geographic coordinates of sampling points, locations of Ordinary High Water Marks (OHWM), and other features were collected in the field with an iPad Mini with Collector for ArcGIS and Arrow GNSS receiver, which collects to sub-meter accuracy. The linear length and acreage of these features were calculated by projecting these point and line data files in a geographic information system.

For this Project, Tetra Tech also attempted to determine the potential federal jurisdiction for each feature based on the 2015 Clean Water Rule by investigating downstream connectivity to the Pacific Ocean; however, USACE will ultimately determine jurisdiction.

3.1 Non-Wetland Waters

During the field survey, Tetra Tech walked the Study Area including stream and canal paths identified by USGS, NWI, and DAR. The boundaries of potential non-wetland WoUS were delineated by recording the location of the OHWM, as defined in the USACE Regulatory Guidance Letter 05-05 (USACE 2005) and the 2015 Clean Water Rule (USACE and EPA 2015). Indicators of OHWM can be physical or vegetative, and include benches, shelving, drift lines, natural lines impressed on the bank, changes in the character of soil, transitions in vegetation type and density, destruction of terrestrial vegetation (matted-down vegetation), sediment deposition, presence of litter and debris, presence of wrack lines, bed and banks, multiple observed flow events, scour, sediment sorting, and water staining (USACE 2005, Lichvar and McColley 2008, Mersel and Lichvar 2014). OHWM

indicators and stream characteristics were also recorded along a single representative transect according to the OHWM Delineation Datasheet (developed by USACE Engineer Research and Development Center).

3.2 Wetlands

The 1987 Corps of Engineers Wetlands Delineation Manual (USACE 1987), as amended, outlines the technical guidelines and methods for identifying and delineating wetlands potentially subject to Section 404 of the CWA. This manual is supplemented by the 2012 Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Hawaiʻi and Pacific Islands Region (USACE 2012).

One sampling point was taken in the area designated as a Freshwater Forested/Shrub Wetland by the NWI database. Biologists employed methods for determining the presence or absence of wetlands per general USACE guidance (USACE 1987) and USACE guidance specific to Hawaiʻi (USACE 2012). Based on these documents, jurisdictional wetlands are identified using the following three criteria: hydrophytic vegetation, hydric soils, and wetland hydrology. All three criteria must be present for an area to be considered a wetland, unless problematic natural processes or atypical recent human disturbance has resulted in the absence of positive wetland indicators. Further details on the three wetland criteria are provided below.

3.2.1 Vegetation

At the sampling point, the absolute percentage cover was estimated for each plant species within each vegetation strata (i.e., tree, shrub, herb, woody vine). These species were then compared with State of Hawaiʻi 2016 Wetland Plant List (Lichvar et al. 2016). Taxonomy and nomenclature follow Wagner et al. (1999), Wagner et al. (2012), Wagner and Herbst (2003), and Staples and Herbst (2005).

3.2.2 Soils

The NRCS defines a hydric soil as one that is “formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part” (NRCS 2010). The NRCS National List of Hydric Soils (NRCS 2019b) for Oʻahu Island includes 13 hydric soils for the island. Tetra Tech compared the NRCS National List of Hydric Soils with soils mapped in Study Area by the NRCS.

The generalized NRCS soil survey does not always capture the true hydric condition of the soils on individual sites; therefore, on-site soil evaluations of wetlands by specialists are also necessary. Soil characteristics were determined in the field by digging pits using a shovel. Tetra Tech biologists identified soil samples in the field with standardized color chips (i.e., Munsell Soil Color Charts; Kollmorgen Instruments Corporation 1998) of hue, value, and chroma, and by texture (sand, silt, clay, loam, muck, and peat). Anaerobic soil conditions and the presence of gleyed soils were of particular interest in determining whether hydric soils were present (USACE 1987).

3.2.3 Hydrology

Wetland hydrology refers to the timing and extent of inundation or soil saturation and may be considered as the driving element in wetland formation. Indicators of wetland hydrology are classified as primary or secondary. Examples of primary hydrologic indicators in Hawaiʻi include soil saturation, high water table, surface water, hydrogen sulfide odor, sediment and drift deposits, algal mats, iron deposits, and the presence of tilapia (*Oreochromis* sp./*Sarotherodon* sp.) redds or aquatic fauna (USACE 2012). Secondary regional hydrologic indicators include surface soil cracks and geomorphic position (USACE 2012). Tetra Tech evaluated both primary and secondary hydrology indicators at the sampling point.

4.0 Results

One potential non-wetland WoUS—Kaloʻi Gulch—was delineated in the Study Area, including a main channel and two short branches. Two tributaries of Kaloʻi Gulch located immediately outside of the Study Area were also delineated to ensure all Project activities avoid these features. The Waiāhole Ditch and pipeline, which cross through the Study Area, were delineated. The types and size of the delineated features are summarized in Table 1. The results for each feature are discussed in further detail below.

Appendix A includes the OHWM Delineation Datasheet for Kaloʻi Gulch. The wetland determination data form for the single sampling point is included in Appendix B. Photographs are provided in Appendix C.

Table 1. Potential Waters of the U.S. and Non- Jurisdictional Features Delineated in the Study Area and Immediate Vicinity

Feature Name	Mapped NWI Cowardin Classification	Field Assessed Cowardin Classification	Acres	Length (feet)
Kaloʻi Gulch	PSS3A	R5	0.61	1,768[1/]
Waiāhole Ditch	R5UBFx	R5	0.13	1,162
Waiāhole Pipeline	R5UBFx	R5	N/A	1,158
Erosion Feature 1	N/A	N/A	0.14	897
Erosion Feature 2	N/A	N/A	0.07	910
Tributary 1	N/A	R5	N/A	627
Tributary 2	PSS3A	R5	N/A	1,794

[1/] Length of Kaloʻi Gulch includes only includes the main channel and not the middle or eastern branches.

4.1 Non-Wetland Waters

4.1.1 Kaloʻi Gulch

Approximately 0.61 acre of Kaloʻi Gulch was delineated in the Study Area (see Figures 5 and 6). This includes 0.53 acre for the main channel (labeled as Kaloʻi 1), 0.02 acre for middle branch (labeled as Kaloʻi 2), and 0.06 acre for the eastern branch (labeled as Kaloʻi 3). The multiple branches in the northern portion of the Study Area are likely due to land use practices (e.g., grazing and creation of dirt roads) at the site and vicinity, which created exposed soils less resistant to erosive forces. No flowing or standing water was observed in Kaloʻi Gulch at the time of the survey; however, Tetra Tech observed several indicators of a recent large flow (e.g., freshly eroded banks, large amounts of wrack) likely from the storm events on April 28 and/or May 4, 2019.

The main Kaloʻi Gulch channel (Kaloʻi 1) and the two side channels (Kaloʻi 2 and 3) delineated in the Study Area have a defined bed and bank, and physical indicators of an OHWM. Various indicators of the OHWM were seen along the stream's length, including destruction of terrestrial vegetation, breaks in slope (including shelving), changes in sediment characteristics, erosion and scour, and organic debris collecting behind obstructions (see photographs in Appendix C). Flowing water has created a few plunge pools in the main stream channel. Guinea grass is present above and below the OHWM, but is generally less abundant in the channel compared to above the OHWM. Koa haole is abundant above the OHWM, and generally absent below the OHWM.

4.1.2 Waiāhole Ditch and Pipeline

Waiāhole Ditch is an open-air, human-made, concrete-lined irrigation ditch that was constructed for agriculture and sugarcane cultivation on the leeward plains. A total of 0.13 acre (1,162 linear feet) of this ditch was delineated in the Study Area (Figure 7). The ditch is approximately 5 feet wide. No standing or flowing water was observed in the ditch during the survey. The ditch is overgrown with guinea grass and buffelgrass (see Photos 10 and 11 in Appendix C), suggesting that water no longer flows in the ditch system.

In addition to the concrete ditch, a metal pipe (roughly 4.5 inches in diameter) is present immediately along the makai side of the ditch. A total of 1,158 linear feet of the pipeline was delineated in the Study Area (Figure 7).

4.1.3 Erosional Features

Two erosional features were investigated within the Study Area. These erosional features do not appear to convey flow frequently enough to have a bed and bank and OHWM.

Erosion Feature 1 branches off from the delineated Kaloʻi Gulch continuing west within the Study Area (see Figure 7). Erosion Feature 1 is between 3 and 9.5 feet wide (see Photo 12 in Appendix C). The feature appears to be created by cattle and the use of dirt roads.

Erosion Feature 2 appears to have been created from the concrete structures associated with the Waiāhole Ditch System that channels precipitation from storm events. This feature is generally 3 feet wide in the Study Area (see Photo 13 in Appendix C) and ends at the paved road along the eastern boundary of the Study Area (Figure 8). It does not connect on the surface to any of the tributaries of Kaloʻi Gulch.

4.1.4 Features Adjacent to the Study Area

Two tributaries of Kaloʻi Gulch immediately outside the Study Area were delineated. The western tributary (Tributary 1) is immediately adjacent to the western boundary of the Study Area at a distance of between 10 and 45 feet west (Figure 9). The southern tributary (Tributary 2) is between 67 and 180 feet south of the southern boundary of the Study Area (Figure 10). Physical indicators of an OHWM were apparent at both tributaries including matted vegetation within the channel, the presence of wrack, change in slope, and change in sediment from large cobbles in below the OHWM to fine sediment above the OHWM (see Photos 14 and 15 in Appendix C). Although not shown on the delineation data, Tributary 1 connects to Tributary 2 south of the largest portion of the Study Area.

4.2 Wetlands

As shown in Figure 3, NWI maps a linear Freshwater Forested/Shrub Wetland (PSS3A) within the Study Area. Observations during the survey indicate that the feature is actually an intermittent stream rather than a wetland. The single sampling point (see Figure 5) evaluated by Tetra Tech does not met the three-criterion test indicative of wetland conditions pursuant to the USACE 1987 Manual and the Hawaiʻi and Pacific Island Regional Supplement. The sampling point was not dominated by hydrophytic vegetation, and no wetland hydrology indicators were observed. The soil unit mapped by NRCS in the area is not listed as a hydric soil (NRCS 2019a,b), and no hydric soil indicators were observed. Therefore, no wetlands are present in the Study Area. The wetland determination data form for the sampling point is included in Appendix B.

5.0 Assessment and Conclusions

Tetra Tech delineated a total of 0.61 acre of Kaloʻi Gulch within the Study Area. Indicators of an OHWM are present throughout the entire length of the intermittent stream. Indicators suggest that a recent heavy flow event occurred in the area immediately prior to the May 2019 survey.

Although Kaloʻi Gulch has a defined bed and bank and OHWM (indicators of flow), there is no evidence that it directly or indirectly contributes flow to a traditional navigable water of the United States. Kaloʻi Gulch does not currently have a surface connection to the ocean. The watershed and stream system has been heavily altered by various residential developments, stormwater retention ponds, and golf courses throughout the ʻEwa plain. The exact stream course in the lower reaches is unknown due the amount of alteration, but it possibly terminates near the Hoakalei Golf Course ponds. In May 2015, the USACE Honolulu District stated “The last trace of the Gulch is found just

over one-mile from the shoreline of the Pacific Ocean" (USACE 2015). In addition, the portion of Kaloʻi Gulch within the Study Area does not meet the definition of "adjacent waters" under the 2015 Clean Water Rule; therefore, Kaloʻi Gulch is not likely jurisdictional by rule.

Jurisdiction could be decided based on a case-by-case basis if Kaloʻi Gulch were determined to have a significant nexus to the Pacific Ocean. However, several previous jurisdictional determinations for other portions of Kaloʻi Gulch (e.g., Honolulu Rail Project, Farrington Highway Bridges #1, #2, and #3 Rehabilitation Project) determined Kaloʻi Gulch is not jurisdictional because there was no connection between the gulch and the Pacific Ocean. According to the USACE, these previous determinations, which concluded that Kaloʻi Gulch is an isolated water, are applicable to the Project (V. Koskelo/USACE Honolulu District, pers. comm., June 2019).

Waiāhole Ditch, a concrete, human-made ditch, and its associated metal pipeline were also delineated in the Study Area. It is unlikely that Waiāhole Ditch or Pipeline are considered jurisdictional because the ditch system does not have perennial or intermittent flow, and it is not a relocated tributary, excavated in a tributary, and does not drain wetlands. Based on review of recent aerial imagery and available geospatial data, the ditch system does not appear to have a surface connection to downstream waters.

These conclusions are subject to confirmation by the USACE Honolulu District. The results of this process will be incorporated into planning and design documents in an effort to avoid and minimize impacts to jurisdictional waters wherever practicable. For any unavoidable impacts, AES will consult with USACE and the State Department of Health Clean Water Branch, as appropriate, and obtain all necessary permits (e.g., Nationwide permit, Water Quality Certification, Stream Channel Alteration Permit) before commencing any work. A Clean Water Act Section 404 Permit would be required for unavoidable Project impacts, including placement of dredged or fill material in jurisdictional WoUS.

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Figures

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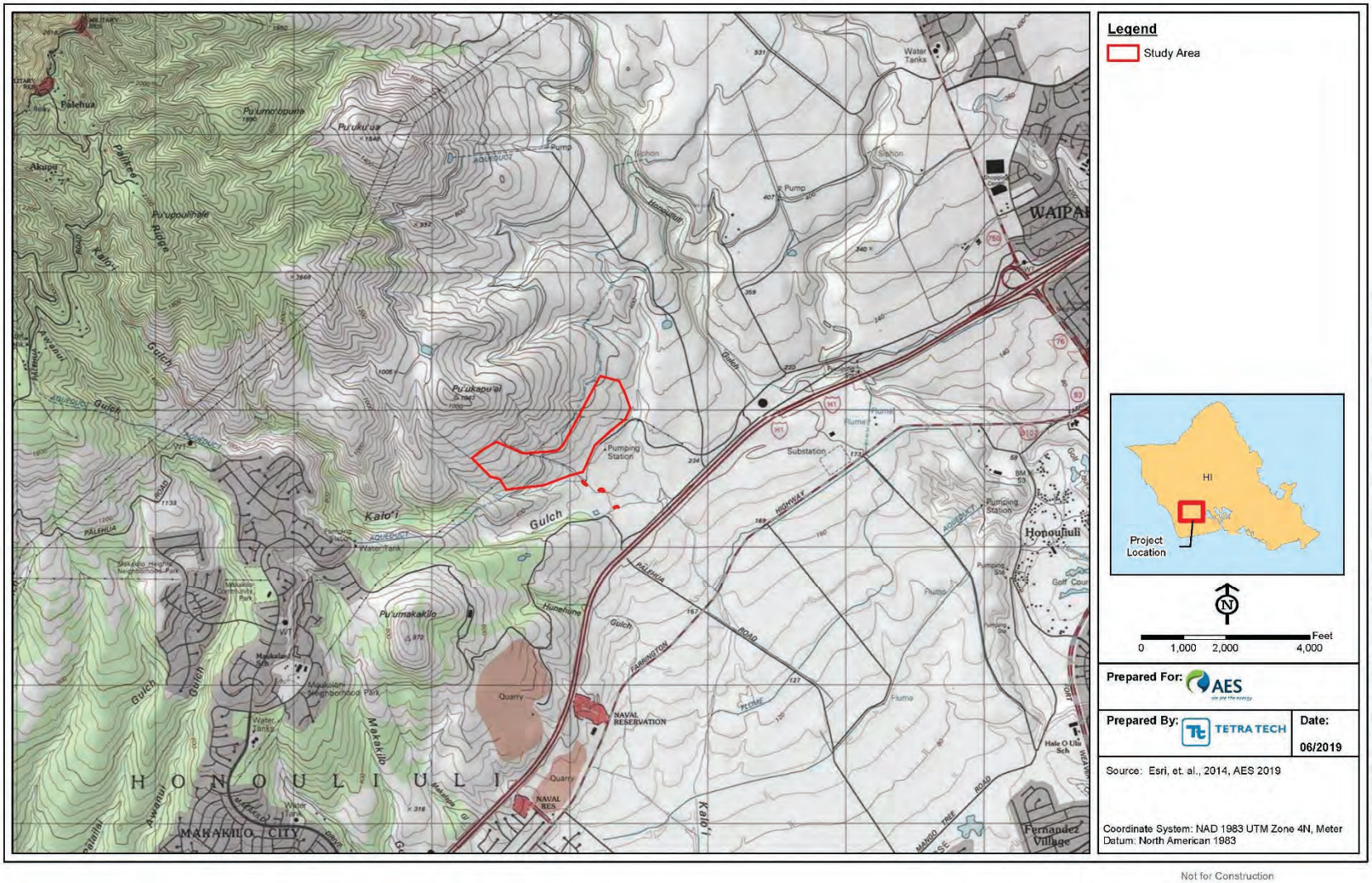

Figure 1. Location of the Study Area.

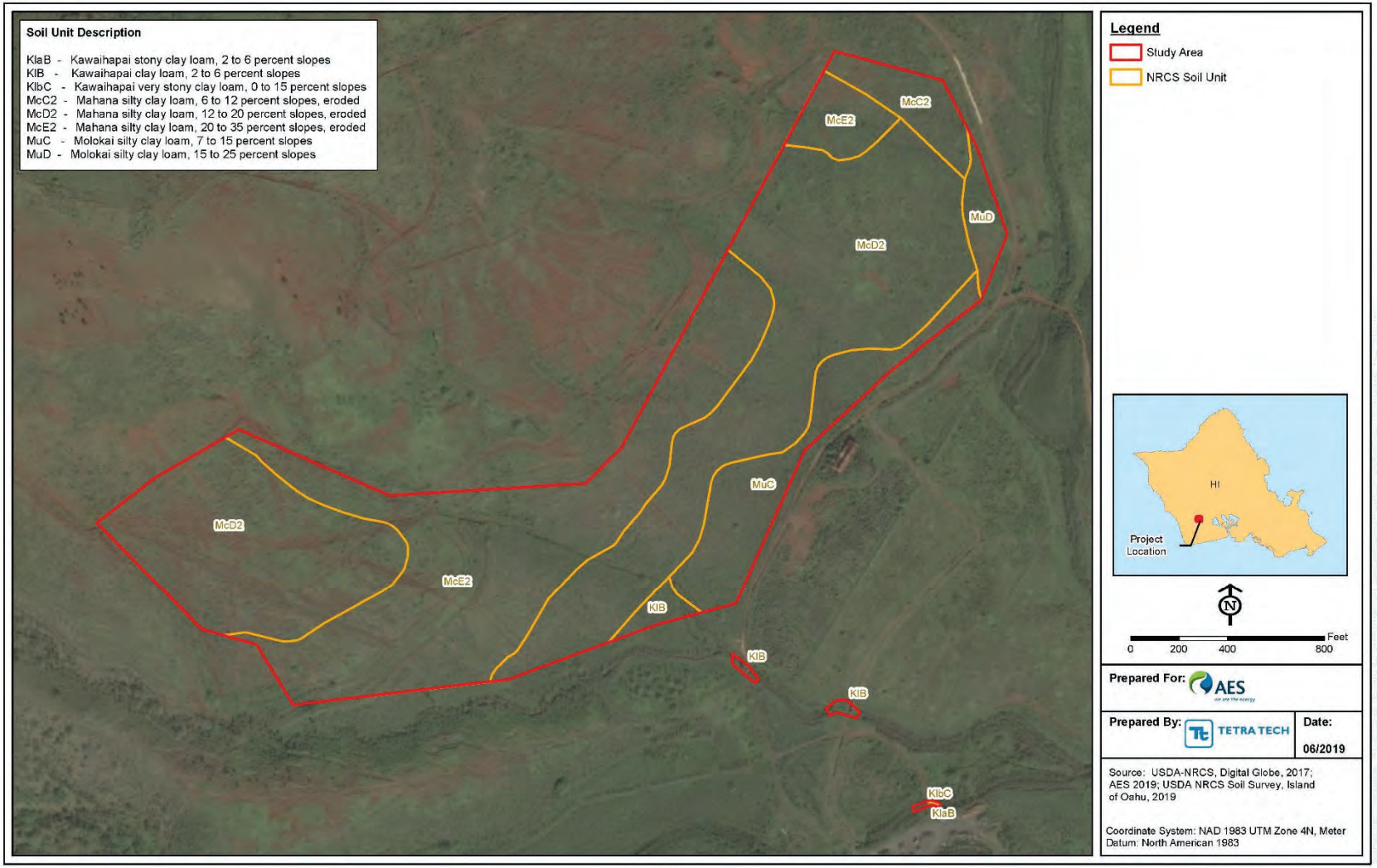

Figure 2. Soils in the Study Area.

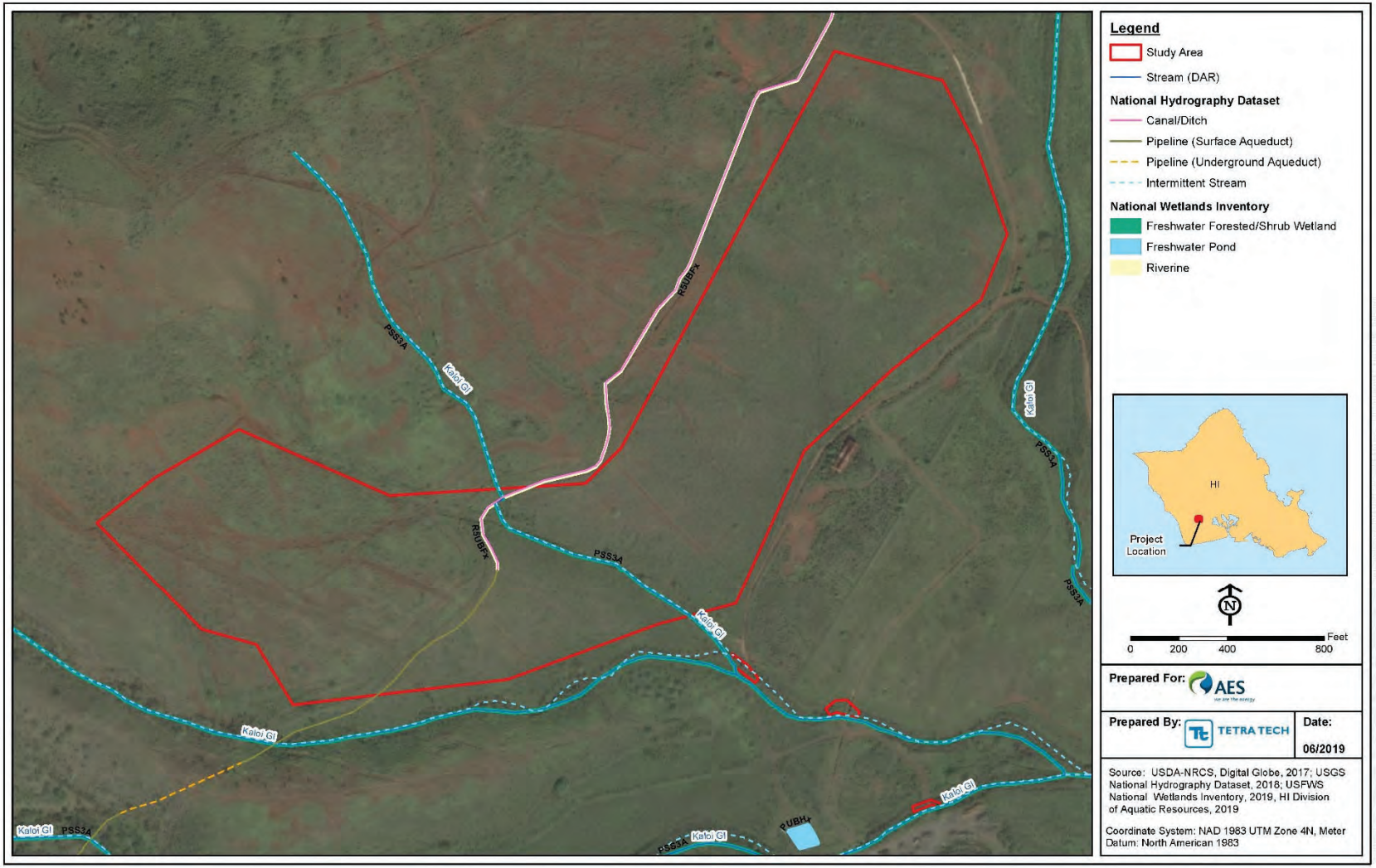

Figure 3. Water Resources in the Study Area Identified by NWI, NHD, and DAR Databases.

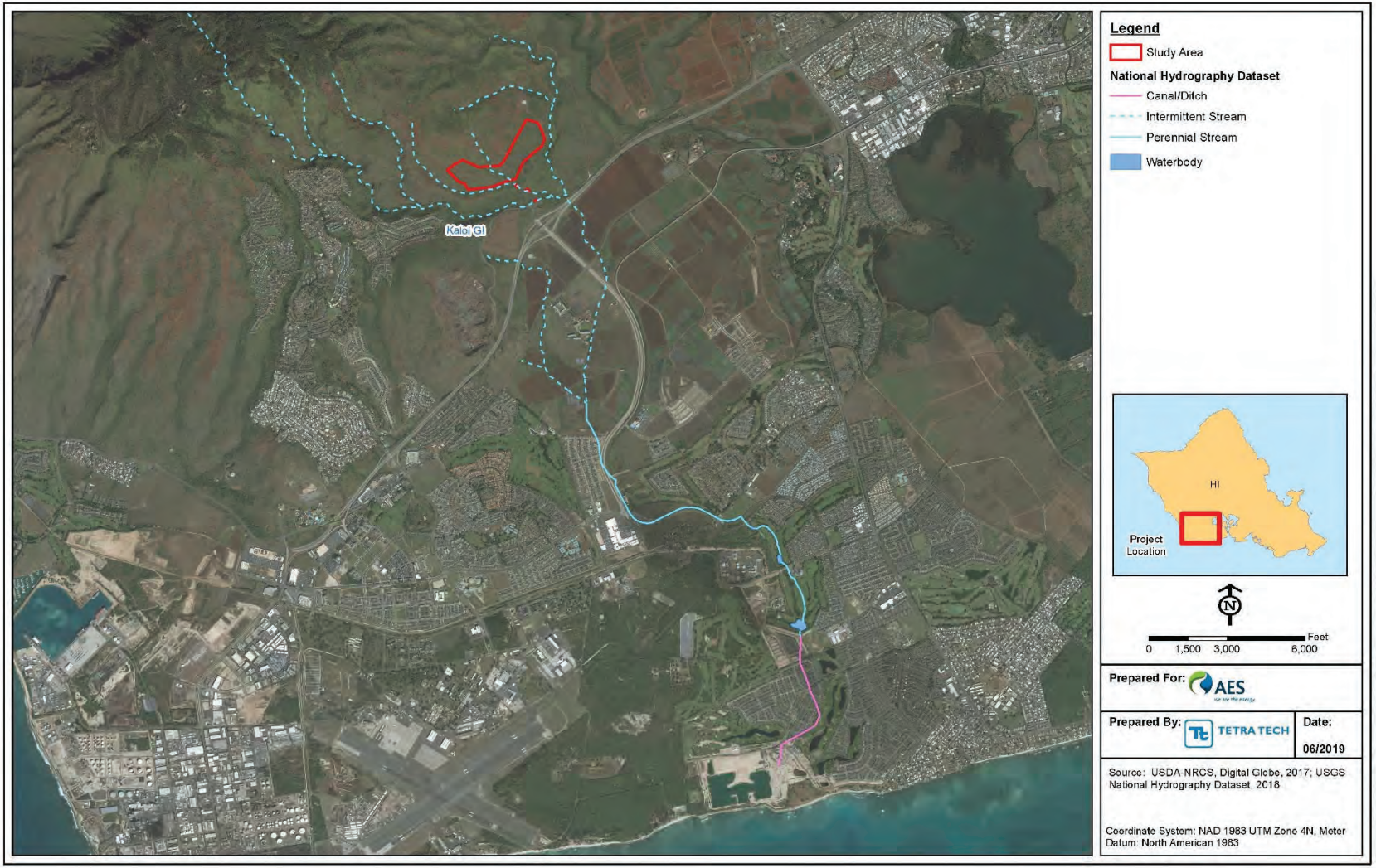

Figure 4. Downstream Location of Kaloʻi Gulch Identified by NHD.

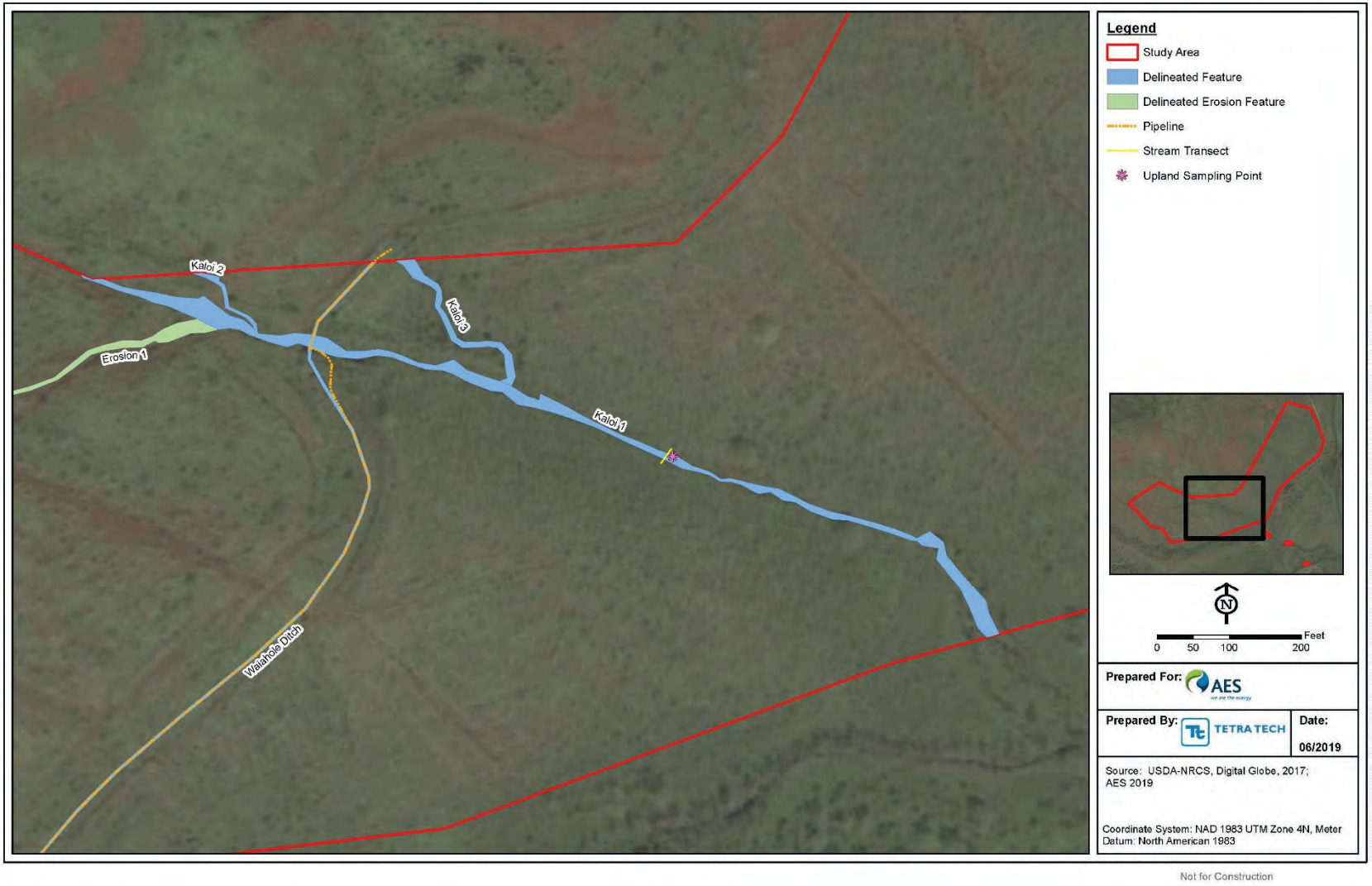

Figure 5. Delineated OHWM of Kaloʻi Gulch.

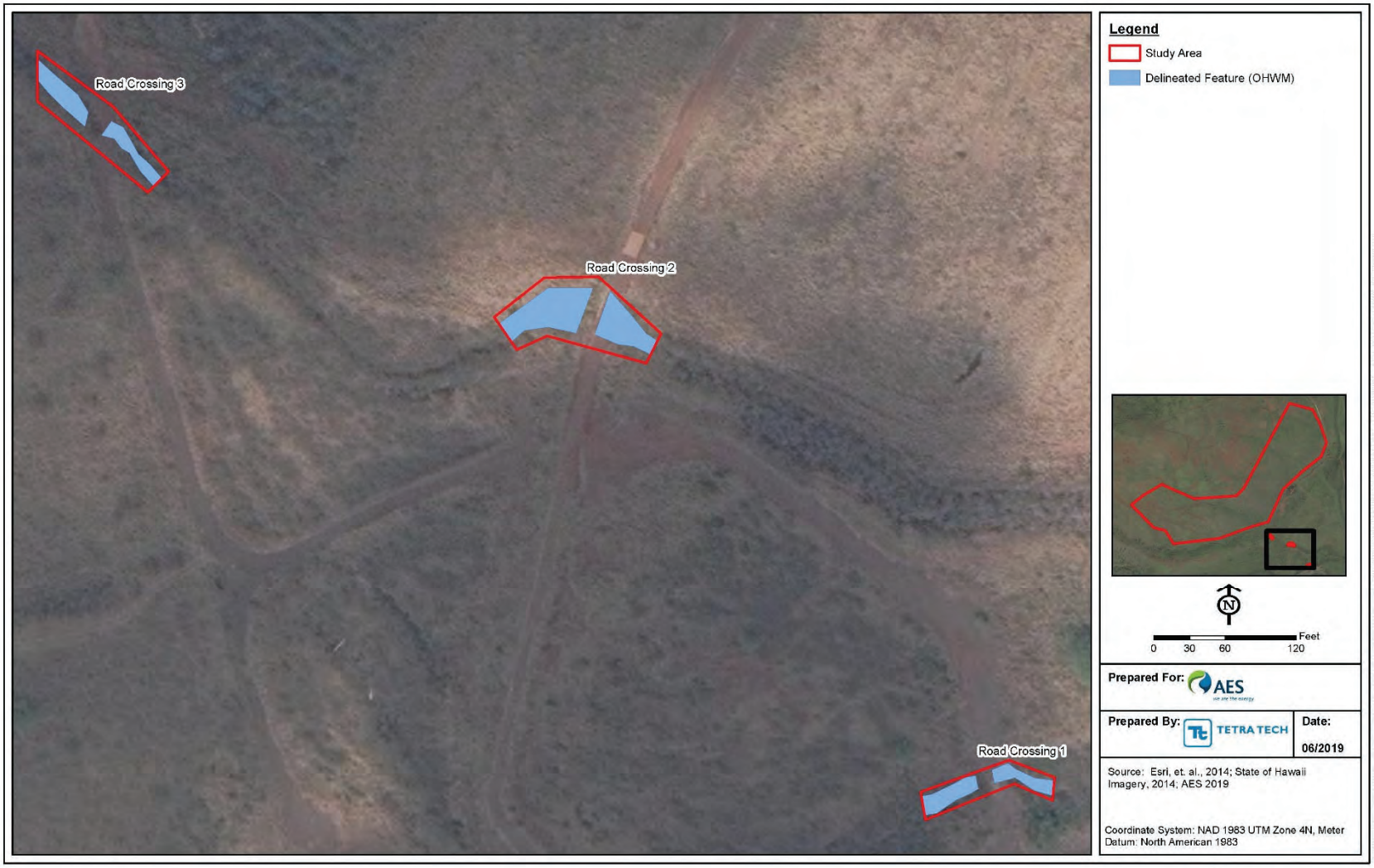

Figure 6. Delineated OHWM of Kalo‘i Gulch at Road Crossings.

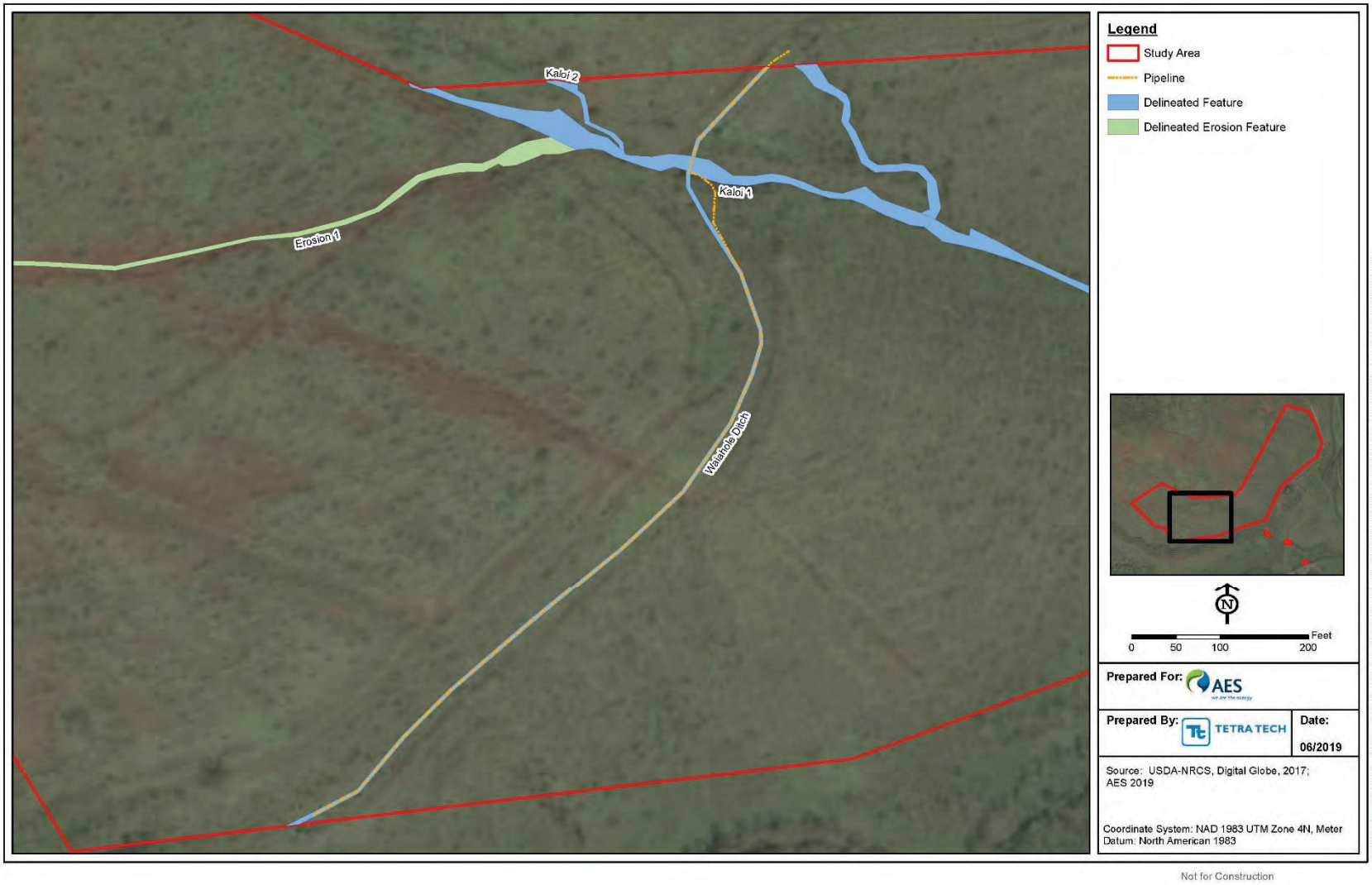

Figure 7. Waiāhole Ditch and Pipeline.

Figure 8. Erosion Feature 2.

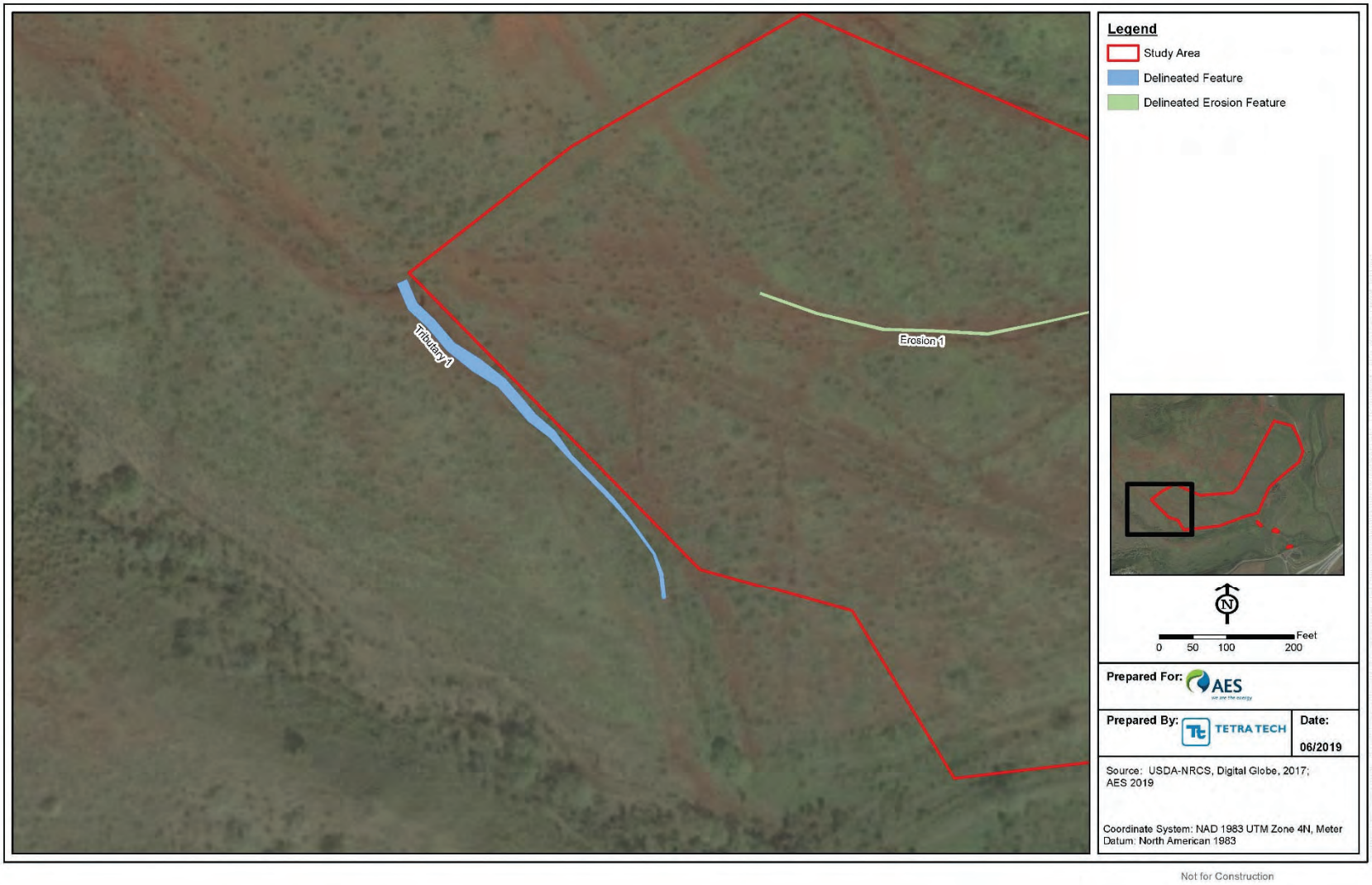

Figure 9. Delineated OHWM of Tributary 1, Located Adjacent to the Study Area.

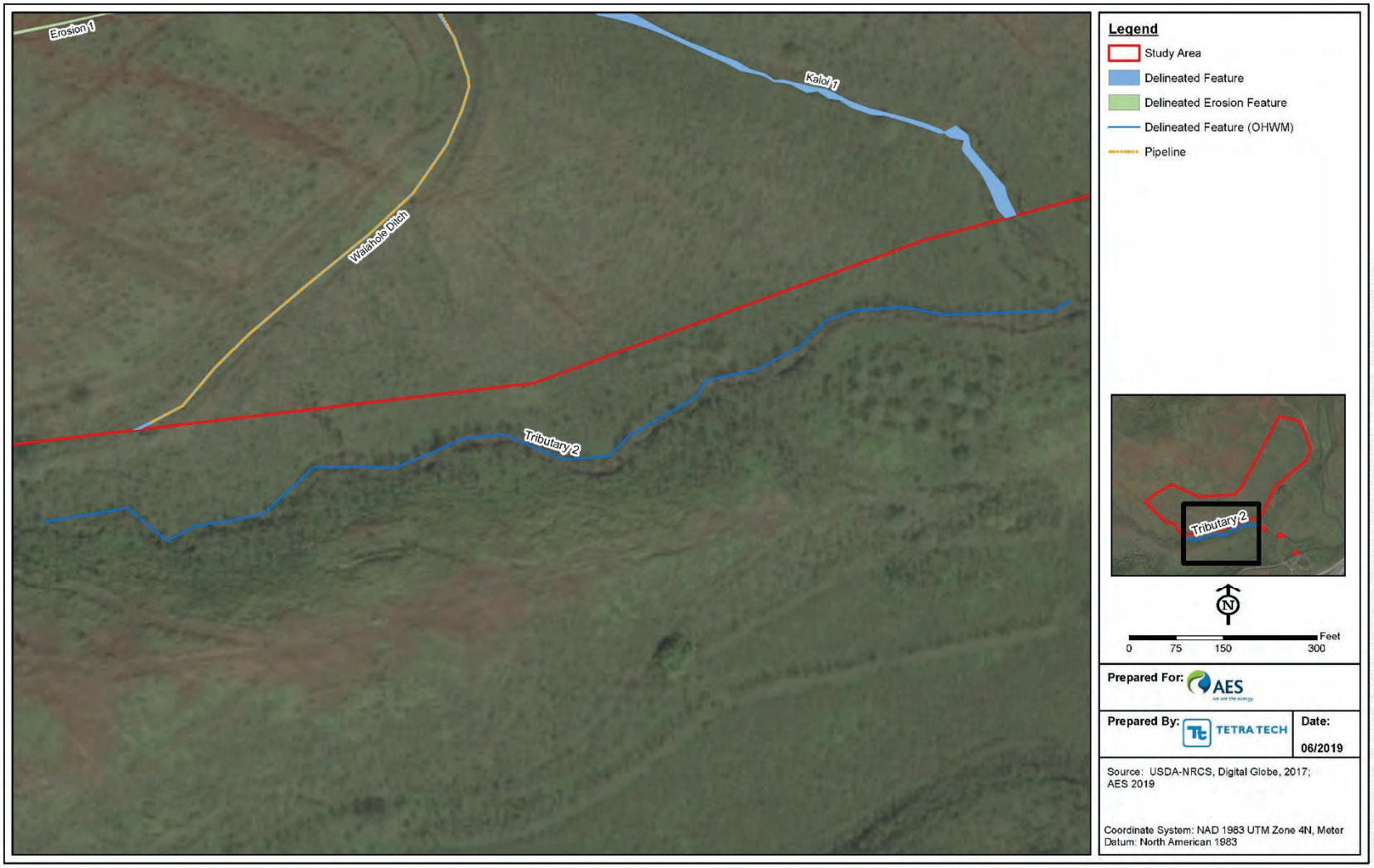

Figure 10. Delineated Left Bank of Tributary 2, Located Adjacent to the Study Area

Appendix A. Ordinary High Water Mark Delineation Datasheet

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OHWM Delineation Cover Sheet

Project: West Oahu Solar **Date:** May 10, 2019

Location: Near Kapolei **Investigator(s):** Tiffany Bovino Agostini & Jacob Dutton

Project Description:

The proposed Project consists of construction and operation of an approximately 12.5-MW ground-mounted photovoltaic solar system, coupled with a 50 MW-hour battery energy storage system and related interconnection and ancillary facilities. The Project would connect to a substation via underground electrical conduit. See Section 1.2 of the report for more details.

Describe the river or stream's condition (disturbances, in-stream structures, etc.):

Kalo'i Gulch is an intermittent stream. The Kalo'i Gulch stream system consists of numerous tributaries that originate in the Wai'anae Mountain Range near Palikea Ridge and enjoin to form one channel just mauka of the H - 1 Freeway. Within the Study Area, Kalo'i Gulch is unimproved, with a natural bottom and sides .. In the northern portion of the Study Area it intersects with the former Waiahole Ditch System.

Off-site Information

Remotely sensed image(s) acquired? ☑ **Yes** ☐ **No** [If yes, attach image(s) to datasheet(s) and indicate approx. locations of transects, OHWM, and any other features of interest on the image(s); describe below] Description:

See figures within report

Hydrologic/hydraulic information acquired? ☐ **Yes** ☑ **No** [If yes, attach information to datasheet(s) and describe below.] Description:

U.S. Geological Survey (USGS) operated a gage on the Kaloi Gulch tributary to the east of the Study Area but no gage information is available for the feature within the Study Area.

Rainfall information is described in Section 2.2 of the report.

List and describe any other supporting information received/acquired:

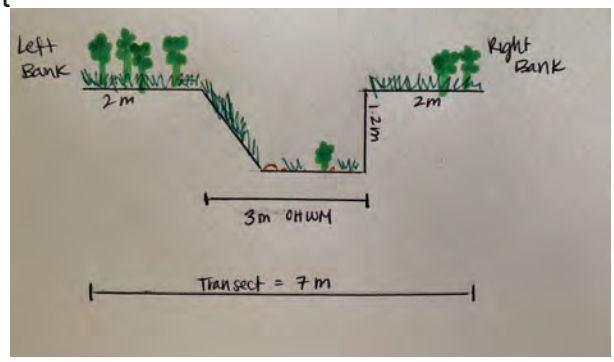
See list of references in Section 6 of the report specifically JD for DA File No. POH-2015-00063.

Instructions: Complete one cover sheet and one or more datasheets for each project site. Each datasheet should capture the dominant characteristics of the OHWM along some length of a given stream. Complete enough datasheets to adequately document up- and/or downstream variability in OHWM indicators, stream conditions, etc. Transect locations can be marked on a recent aerial image or their GPS coordinates noted on the datasheet.

Transect (cross-section) drawing: (choose a location that is representative of the dominant stream characteristics over some distance; label the OHWM and other features of interest along the transect; include an estimate of transect length)

Also See Figure 5 in report

7 m transect



Break in Slope at OHWM: ☑ Sharp (> 60□) | ☐ Moderate (30–60□) | ☐ Gentle (< 30□) | ☐ None

Notes/Description: Right bank = 90 degrees (1m drop); left bank 70-80 degrees

Sediment Texture: Estimate percentages to describe the general sediment texture above and below the OHWM

	Clay/Silt <0.05mm	Sand 0.05 – 2mm	Gravel 2mm – 1cm	Cobbles 1 – 10cm	Boulders >10cm	Developed Soil Horizons (Y/N)
Above OHWM	95			5	0	
Below OHWM	40			40	20	N

Notes/Description:

More boulders and cobbles below the OHWM than above OHWM. Primarily silt above the OHWM.

Vegetation: Estimate absolute percent cover to describe general vegetation characteristics above and below the OHWM

	Tree (%)	Shrub (%)	Herb (%)	Bare (%)
Above OHWM	40	10	90	0
Below OHWM	0	0	50	50

Notes/Description:

Guinea grass dominant above OHWM, but less abundant below OHWM, with some buffelgrass.

Koa haole trees are abundant above the OHWM, but absent below OHWM.

Other Evidence: List/describe any additional field evidence and/or lines of reasoning used to support your delineation

The stream channel is obvious. In addition to changes in slope, vegetation, and sediment other evidence includes wrack deposited from a recent flow event, erosion, bank undercutting, shelving.

Appendix B. Wetland Data Form

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WETLAND DETERMINATION DATA FORM – Hawai'i and Pacific Islands Region

Project/Site: West Oahu Solar City: Near Kapolei Sampling Date: 5/10/2019 Time: 9:00AM

Applicant/Owner: AES/ University of Hawaii State/Terr/Comlth.: HI Island: Oahu Sampling Point: 1

Investigator(s): Tiffany Bovino Agostini & Jacob Dutton TMK/Parcel: 9-2-002:007

Landform (hillslope, coastal plain, etc.): Within dry streambed within plain Local relief (concave, convex, none): None

Lat: 21.372006° Long: -158.065250° Datum: NAD_1983_UTM_Zone_4N Slope (%): 0

Soil Map Unit Name: Mahana silty clay loam, 12 – 20 percent slopes, eroded NWI classification: PSS3A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Within Streambed NWI designated as Freshwater Forested/Shrub Wetland. Sampling point to show feature is non-perennial stream and not wetland.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 5 x 5 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Leucaena leucocephala (koa haole)	20	Y	UPL
2.			
3.			
4.			
5.			
	20 = Total Cover		

Sapling/Shrub Stratum (Plot size: 5 x 5 ft)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		

Herb Stratum (Plot size: 5 x 5 ft)			
1. Megathyrus maximus (guinea grass)	60	Y	FAC
2. Cenchrus ciliaris (bufflegrass)	20	Y	FACU
3.			
4.			
5.			
6.			
7.			
8.			
	80 = Total Cover		

Woody Vine Stratum (Plot size: 5 x 5 ft)			
1.			
2.			
	0 = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0.33 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

Problematic Hydrophytic Vegetation[1] (Explain in Remarks or in the delineation report)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** _____ **No** X

Remarks:

SOIL

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-16	5YR 3/3	97					Silty CL	additional 3% coral rock

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- Histosol (A1)
- Histic Epipedon (A2)
- Black Histic (A3)
- Hydrogen Sulfide (A4)
- Muck Presence (A8)
- Depleted Below Dark Surface (A11)
- Thick Dark Surface (A12)
- Sandy Gleyed Matrix (S4)
- Sandy Redox (S5)
- ___ Dark Surface (S7)
- Loamy Gleyed Matrix (F2)
- Depleted Matrix (F3)
- Redox Dark Surface (F6)
- Depleted Dark Surface (F7)
- Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- Stratified Layers (A5)
- Sandy Mucky Mineral (S1)
- Red Parent Material (F21)
- Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

16 inch pit. Some larger coral and cobble

HYDROLOGY

Wetland Hydrology Indicators: (Explain observations in Remarks, if needed.)

Primary Indicators (minimum of one required; check all that apply)

- Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- ___ Tilapia Nests (B17)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- Fiddler Crab Burrows (C10) (Guam, CNMI, and American Samoa)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- Dry-Season Water Table (C2)
- Salt Deposits (C5)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches):

Water Table Present? Yes _____ No _____ Depth (inches):

Saturation Present? (includes capillary fringe) Yes _____ No _____ Depth (inches):

Wetland Hydrology Present? **Yes** _____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appendix C. Photographs

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Photo 1. Overview of the Study Area showing wetter conditions in May 2019 during the delineation (above) vs. January 2019 (below) based on color of vegetation. Note: Steam plant building in background in both photographs.

Photo 2. Typical conditions of Kaloʻi Gulch, looking upstream from right bank (21.371859°, -158.064719°).

Photo 3. Eroded Bank of Kaloʻi Gulch (21.371730°, -158.064205°).

Photo 4. Main channel of Kaloʻi Gulch (Kaloʻi 1) near the north boundary of the Study Area, mauka of the east and middle branches (21.372641°, -158.067412°).

Photo 5. Kaloʻi Gulch in disturbed dirt road area, looking upstream (21.372582°, -158.067140°).

Photo 6. Location of transect on Kaloʻi Gulch for OHWM Delineation Datasheet looking upstream (21.372050°, -158.065344°).

Photo 7. Left bank of eastern branch of Kaloʻi Gulch (Kaloʻi 3) (21.372617°, -158.066249°).

Photo 8. Road Crossing 1 looking mauka at the culverts on the existing dirt road (21.36916700°, -158.06108200°).

Photo 9. Road Crossing 3, looking mauka from dirt road and showing wrack from recent flow event (21.370683°, -158.063350°).

Photo 10. Waiāhole Ditch and Pipeline crossing over topographic feature (21.372519°, -158.066686°).

Photo 11. Waiāhole Ditch and Pipeline showing overgrown vegetation within the ditch.

Photo 12. Erosion Feature 1 looking makai (21.372470°, -158.067555°).

Photo 13. Erosion Feature 2 in the eastern portion of the Study Area.

Photo 14. Tributary 1 west of the Study Area.

Photo 15. Tributary 2 south of the Study Area.

Photo 16. Wetland Sampling Point 1 (21.372006°, -158.065235°).

Appendix C
Stormwater Management Design Memo

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3J CONSULTING
9600 SW NIMBUS AVENUE, STE 100
BEAVERTON, OREGON 97008
PH: (503) 946.9365
WWW.3J-CONSULTING.COM

TECHNICAL MEMORANDUM

To: Dave Phillips, PLS
Power Delivery Renewable Lead
HDR Engineering, Inc.
412 E Parkcenter Blvd, Suite 100
Boise, ID 834706-6659

From: Phillip Patague, PE
Water Resources Engineer

Joseph Conner, PE
Water Resources Engineer

Kathleen Freeman, PE
Water Resources Project Manager

CC: Aaron Murphy, PE
Senior *Project Manager*

Date: December 20, 2019

Project Name: **AES Solar Oahu – West Oahu**
Project No: **19537**
Subject: **30% Stormwater Management Design**

The project site is located just off Pueonani Street near latitude 21°22'24.39"N and longitude 158°03'56.28"W approximately 0.5 miles north of Queen Liliuokalani Freeway on the island of Oahu. The project proposes five solar array systems, with a total project area of approximately 56.23 ac. Onsite drainage will largely remain unchanged since the solar arrays will be elevated above the undeveloped ground surface. Gravel access roads and concrete equipment pads are proposed which are expected to increase stormwater runoff. Furthermore, the project is expected to disturb more than one acre, requiring the implementation of water quality treatment facilities. Natural drainage patterns divide the project site into smaller drainage management areas (DMA). 35.65 ac of the project site consist of DMAs containing the proposed impervious areas, which will drain to proposed stormwater management best management practices (BMP). The remaining onsite area will contain proposed solar modules but not impervious area; therefore, these areas should not experience altered stormwater runoff quantity and quality. It is important to note that onsite wetlands flow through the project site; however, runoff to the wetland areas generated by onsite impervious areas will be mitigated through design.

This memorandum will discuss the methodologies used in (1) quantifying stormwater runoff for the affected areas and (2) sizing the required stormwater management BMPs.

The design and analysis of onsite BMPs are based on the County of Honolulu's "Rules Relating to Storm Drainage Standards", "Post-Construction Water Quality Requirements" and "Storm Water BMP Guide for

New and Redevelopment". The memo will refer to all of these guidance documents collectively as "the Standards".

Existing Conditions

The existing site is undeveloped and sparsely covered with vegetation. Onsite drainage patterns will remain mostly unchanged due to this project; however, to implement a Low Impact Development (LID) approach, stormwater management BMPs will be proposed directly downstream of impervious areas. By considering the onsite grading and desired BMP locations, the storm drainage analysis is focused on six (6) drainage management areas (DMA). The remaining onsite area will not be re-graded; the proposed solar systems will be elevated above the existing ground surface. Therefore, runoff flows and volumes for these areas were not evaluated and these drainage areas are considered Self-Mitigating because the stormwater quality and quantity are not expected to change as a result of this project.

Table 1 below outlines each DMA in existing conditions; all areas are pervious.

DMA	Area (ac)
1	3.11
2	3.45
3	2.34
4	13.81
5	12.37
6	0.57
Total	35.65

Table 1 – Existing DMAs

Developed Conditions

The developed site consists of proposed solar array systems with appurtenant concrete equipment pads and gravel access roads. Grading activities will be primarily concentrated around the impervious areas only. Table 2 below outlines the drainage areas in developed conditions. Please see attached "Developed Conditions Exhibit".

DMA	Total Area (ac)	Impervious Area (ac)	Pervious Area (ac)
1	3.11	0.27	2.84
2	3.45	0.30	3.15
3	2.34	0.28	2.07
4	13.81	0.29	13.52
5	12.37	0.63	11.74
6	0.57	0.16	0.41
Total	35.65	1.92	33.73

Table 2 – Developed DMAs

Stormwater Management Design Standards

Water Quality Treatment

The project will disturb more than one acre, which requires specific sizing criteria be met for stormwater quality facilities. This project proposes infiltration trenches for water quality treatment. A Geotech Report prepared by GeoLabs, Inc., dated September 13, 2019, measured onsite infiltration at multiple locations and determined a site average of 11.7 in/hr. For preliminary BMP sizing, the average infiltration rate will be used with a safety factor of 2 per the Standards.

Water Quantity Management

For water quantity management, the infiltration trenches will be sized to mitigate the developed peak flow rate to the predevelopment value. To accomplish this, the storage volume of an infiltration trench shall equal at least the total additional runoff volume for the appropriate storm intensity. Since all the drainage areas are less than 100 acres, the appropriate storm intensity corresponds to the 50-yr, 1-hr storm event. Per Plate 2 (see attached), the precipitation depth for the 50-yr storm is 3.2 inches (see attached). The corresponding peak rainfall intensity will be discussed in a later section.

Rational Method

Per the Standards, the Rational Method shall be used for drainage areas of 100 acres or less. Therefore, hand calculations in conjunction with reference tables and charts provided in the Standards were used to quantify all relevant runoff values. The Rational Method is dependent upon the runoff coefficient (C), rainfall intensity (I) and drainage area (A). The drainage areas are outlined in a previous section, while the methodologies for deriving C and I are discussed in the following sections.

Time of Concentration

The time of concentration (Tc) is needed to determine the peak rainfall intensity (I) for determining runoff via the Rational Method. Since the drainage areas have no well-defined channels, it is assumed all runoff with occur as overland flow. The times of concentration were determined for each drainage area using Plate 3 (see attached) of the Standards and are shown in Table 3.

DMA	Tc (min)
1	26
2	29
3	27.8
4	28.5
5	28.5
6	19.5

Table 3 – Times of Concentration

The proposed impervious areas will typically be implemented at the most downstream point of each drainage area, which is not expected to alter the times of concentration.

Correction Factor

A correction factor is used to convert the 50-yr, 1-storm precipitation depth to the rainfall intensity. Using the Tc calculated and Plate 4 from the Storm Drainage Standards, a correction factor was determined for each sub basin. Table 4 below shows the correction factor for each sub basin.

DMA	Correction Factor
1	1.6
2	1.5
3	1.6
4	1.5
5	1.5
6	1.8

Table 4 – Correction Factor

Rainfall Intensity

The appropriate rainfall value for the 50-yr, 1-hr storm were determined for the site using Plate 2 (see attached) of the Standards. This value was determined to be 3.2 in The rainfall value from Plate 2 was then multiplied by the correction factor determined in table 4 to calculate the rainfall intensity for each basin. Table 5 shows the peak rainfall intensity for each basin.

DMA	Intensity (in/hr)
1	5.12
2	4.80
3	5.12
4	4.80
5	4.80
6	5.76

Table 5 – Rainfall Intensity

Runoff Coefficient

In existing conditions, all drainage areas are undeveloped with sparse vegetation, which reflects a runoff coefficient (C) of 0.30.

Per the Standards, runoff coefficients for existing conditions were determined using the peak rainfall intensities shown in Table 5 and Table 1 of The Standards. In developed conditions, certain areas will be paved or gravel, while most of the pervious area will remain the same cover type as in existing conditions. The runoff coefficient for developed conditions was weighted to account for different cover types. Runoff coefficients for each basin are shown in Table 6.

DMA	Existing C	Developed C
1	0.43	0.47
2	0.41	0.45
3	0.43	0.49
4	0.41	0.42
5	0.41	0.43
6	0.44	0.57

Table 6 – Runoff Coefficients

Volumetric Runoff Coefficient

The volumetric runoff coefficient (C_{WQV}) is used to determine the water quality volume (WQV) for the infiltration trenches. The C_{WQV} shall be calculated using the following equation as developed by the EPA for smaller storms in urban areas;

$$C_{WQV} = 0.05 + 0.009 \cdot A_i$$

Where A_i is impervious fraction of the DMA represented as a percent. The C_{WQV} for each basin is shown in Table 7.

DMA	A_i (%)	C_{WQV}
1	8.6	0.1274
2	8.8	0.1292
3	11.8	0.1562
4	2.1	0.0689
5	5.1	0.0959
6	28.3	0.3047

Table 7 –Runoff Coefficients for WQV

Water Quality Volume

Per the Standards, the proposed infiltration trenches shall be designed to fully retain the water quality volume (WQV) onsite by infiltration or evapotranspiration. The design storm runoff depth of 1 inch shall be used. The WQV is calculated using the following calculation.

$$WQV = P \cdot C_{WQV} \cdot A \cdot 3630$$

Where, P = Design storm runoff depth (when on-site retention is feasible) = 1 in.
C = C_{WQV}
A = Total drainage area (ac)

Table 8 shows the calculated WQV for each basin.

DMA	WQV (cf)
1	1,439
2	1,618
3	1,328
4	3,453
5	4,305
6	632

Table 8 – Water Quality Flow Rates

Infiltration Trenches

The proposed infiltration trenches will be sized to retain and infiltrate to total WQV shown in Table 8. Preliminary sizing was performed using the BMP Sizing Worksheets from the Post-Construction Water Quality Requirements. The final design for the trenches will be included in the final design phase of the project.

Conclusions

This project proposes minimal surface improvements, which is not expected to affect the drainage patterns of most of the site. In developed conditions, the ground underneath the solar panels will be unchanged and grading activities will be concentrated around the access roads and equipment pads. Runoff is expected to occur only as overland flow and will discharge to proposed infiltration trenches for stormwater management. All details regarding the proposed stormwater BMPs will be described in the Final Drainage Report.

Please take the time to review this memo and contact us if you have any questions or require clarification.

Attachments

1. Developed Conditions Exhibit
2. Time of Concentration (Plate 3)
3. Correction Factors (Plate 4)
4. 50-yr, 1-hr Rainfall Depth (Plate 2)
5. Coefficient of Runoff (Table 1)
6. BMP Sizing Worksheet: Infiltration Trench – Basins 1–6

- - - END OF DOCUMENT - - -

LEGEND

- BASIN BOUNDARY
- # BASIN TAG
- IMPERVIOUS AREA
- DRAINAGE DIRECTION

DEVELOPED DRAINAGE AREAS

DMA	A ac	Aimp ac	Aper ac
1	3.11	0.27	2.84
2	3.45	0.30	3.15
3	2.34	0.28	2.07
4	13.81	0.29	13.52
5	12.37	0.63	11.74
6	0.57	0.16	0.41
Total	*35.65*	*1.92*	*33.73*

N
W E
S

SCALE: 1" = 400'

0 400 800 FT

AES SOLAR FARM - WEST OAHU

3J CONSULTING, INC
CIVIL ENGINEERING
WATER RESOURCES
COMMUNITY PLANNING

COUNTY OF HONOLULU

DEVELOPED CONDITIONS EXHIBIT

DEC 2019

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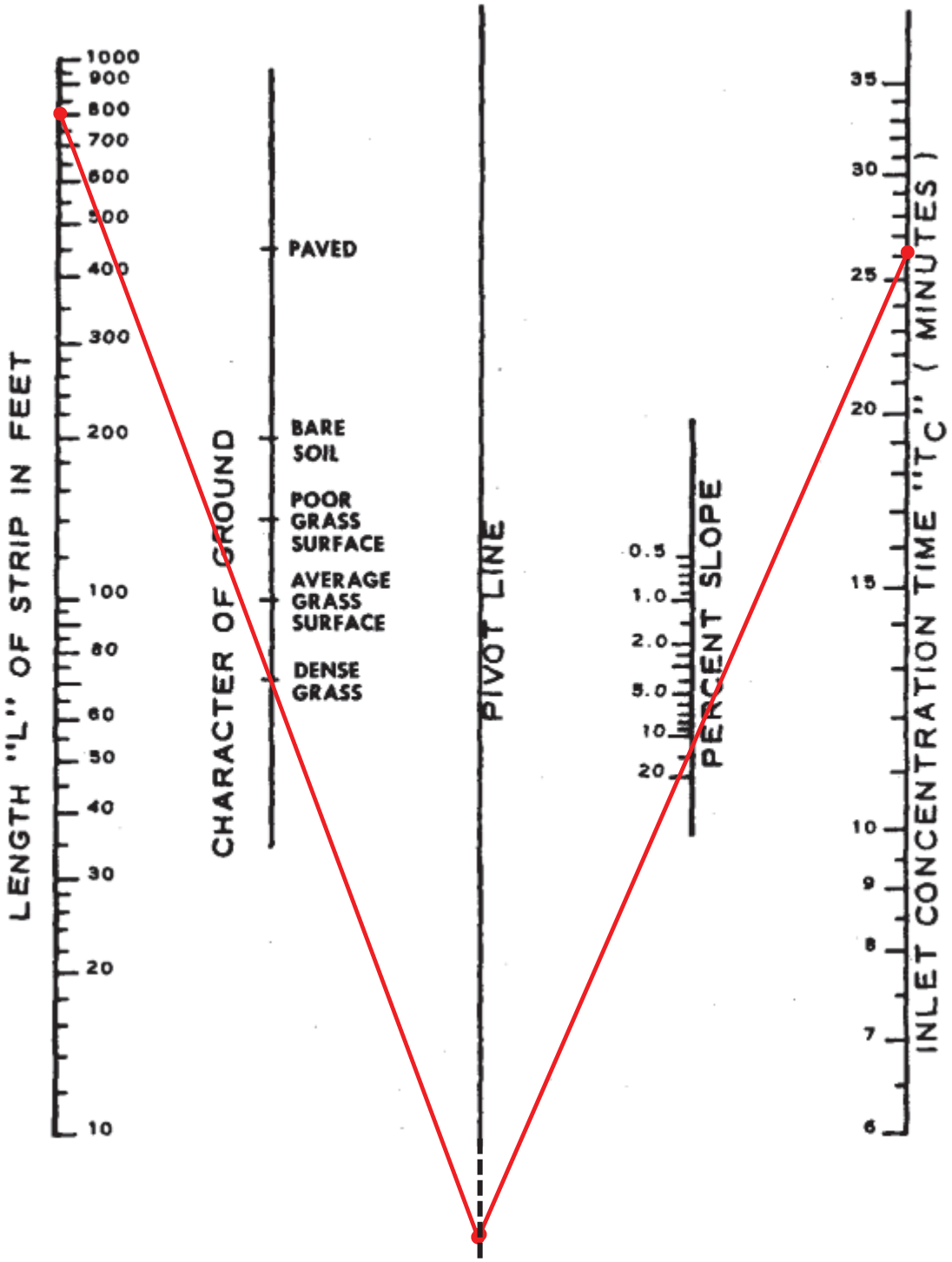
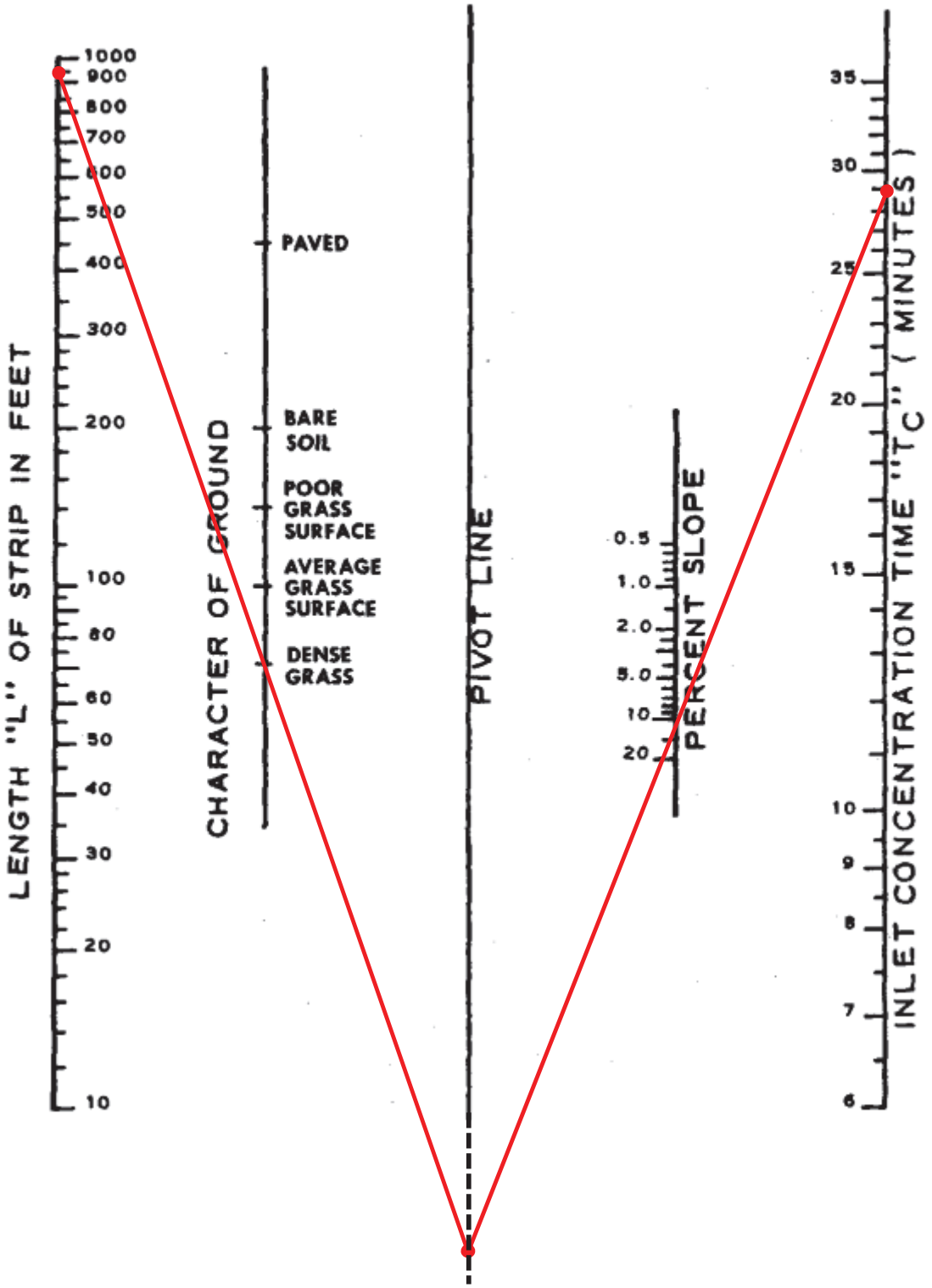
Time of Concentration (Plate 3 from Storm Drainage Standards)

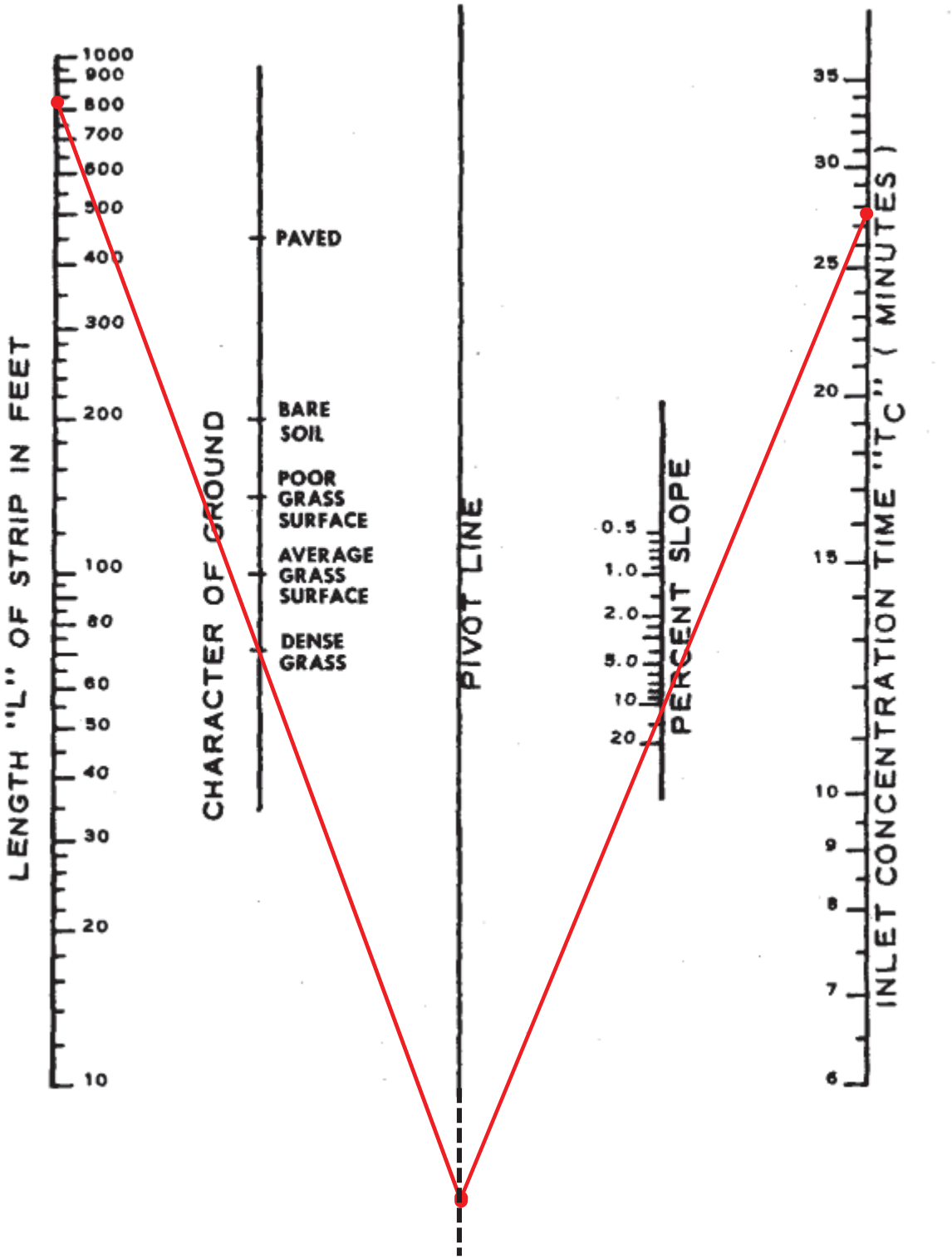
Basin 1



Basin 2


LENGTH "L" OF STRIP IN FEET
1000
900
800
700
600
500
400
300
200
100
80
60
50
40
30
20
10
CHARACTER OF GROUND
PAVED
BARE SOIL
POOR GRASS SURFACE
AVERAGE GRASS SURFACE
DENSE GRASS
PIVOT LINE
PERCENT SLOPE
0.5
1.0
2.0
5.0
10
20
INLET CONCENTRATION TIME "TC" (MINUTES)
35
30
25
20
15
10
9
8
7
6

Basin 3


LENGTH "L" OF STRIP IN FEET
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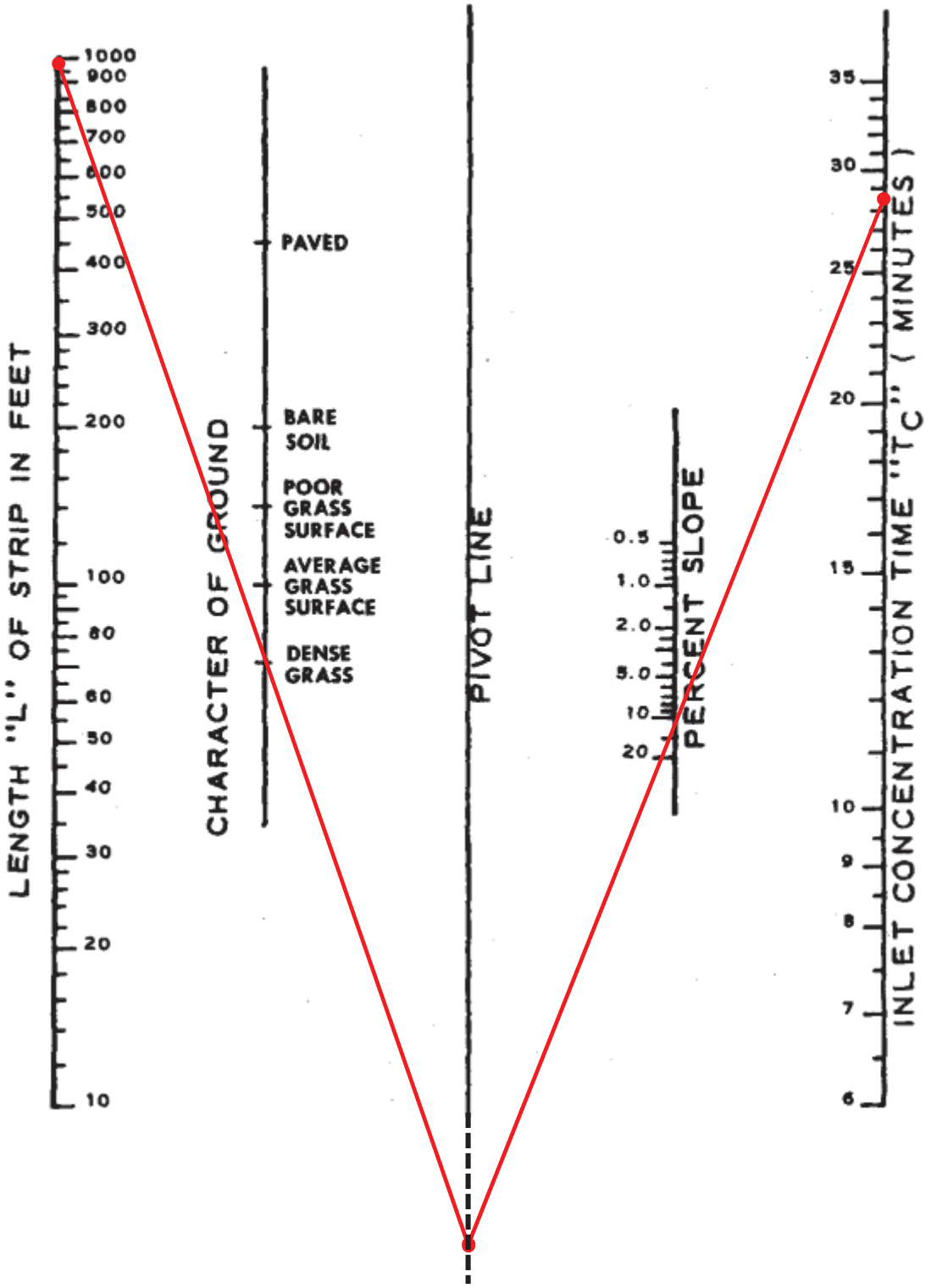
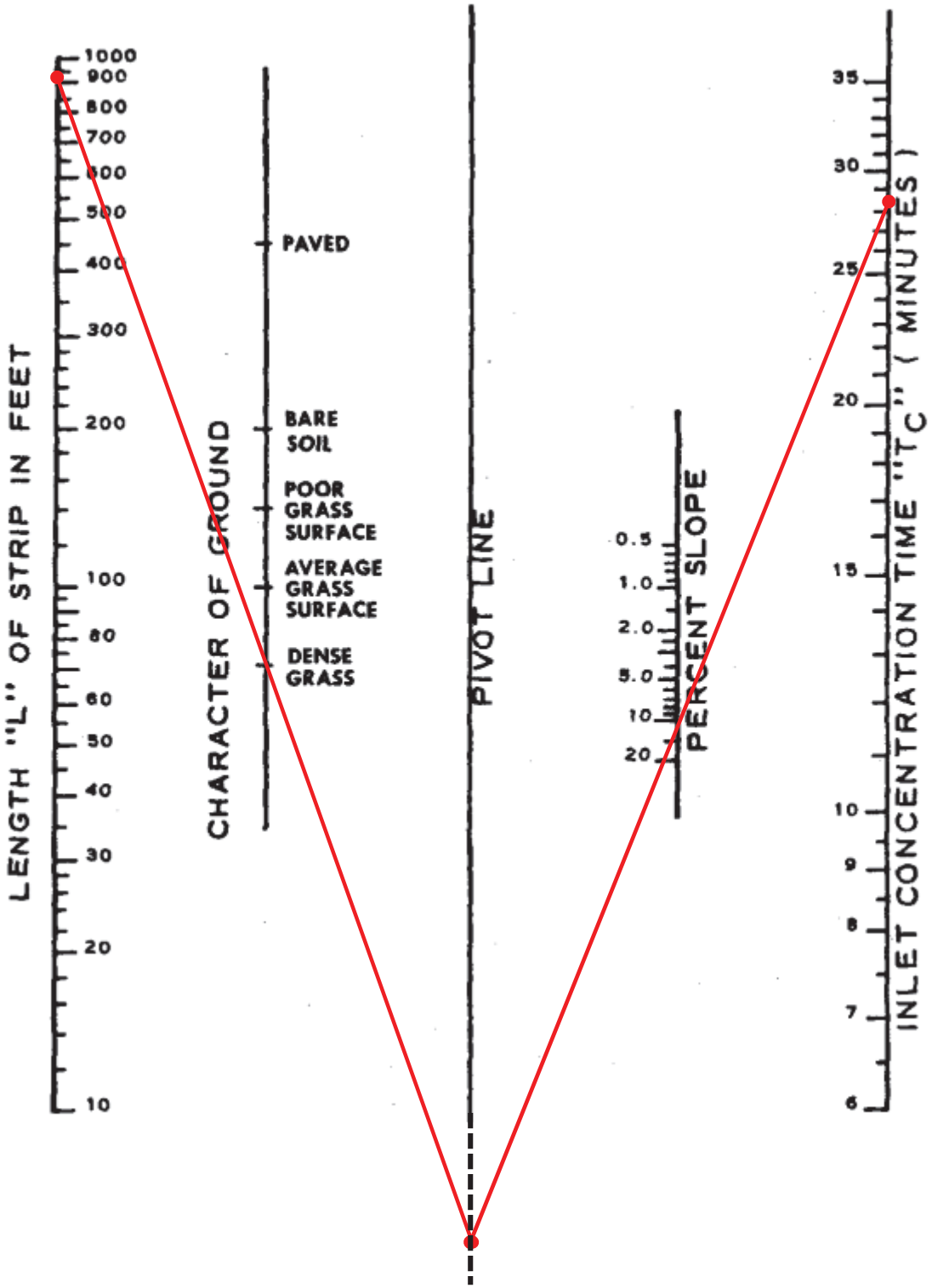
900
800
700
600
500
400
300
200
100
80
60
50
40
30
20
10
CHARACTER OF GROUND
PAVED
BARE SOIL
POOR GRASS SURFACE
AVERAGE GRASS SURFACE
DENSE GRASS
PIVOT LINE
PERCENT SLOPE
0.5
1.0
2.0
5.0
10
20
INLET CONCENTRATION TIME "TC" (MINUTES)
35
30
25
20
15
10
9
8
7
6

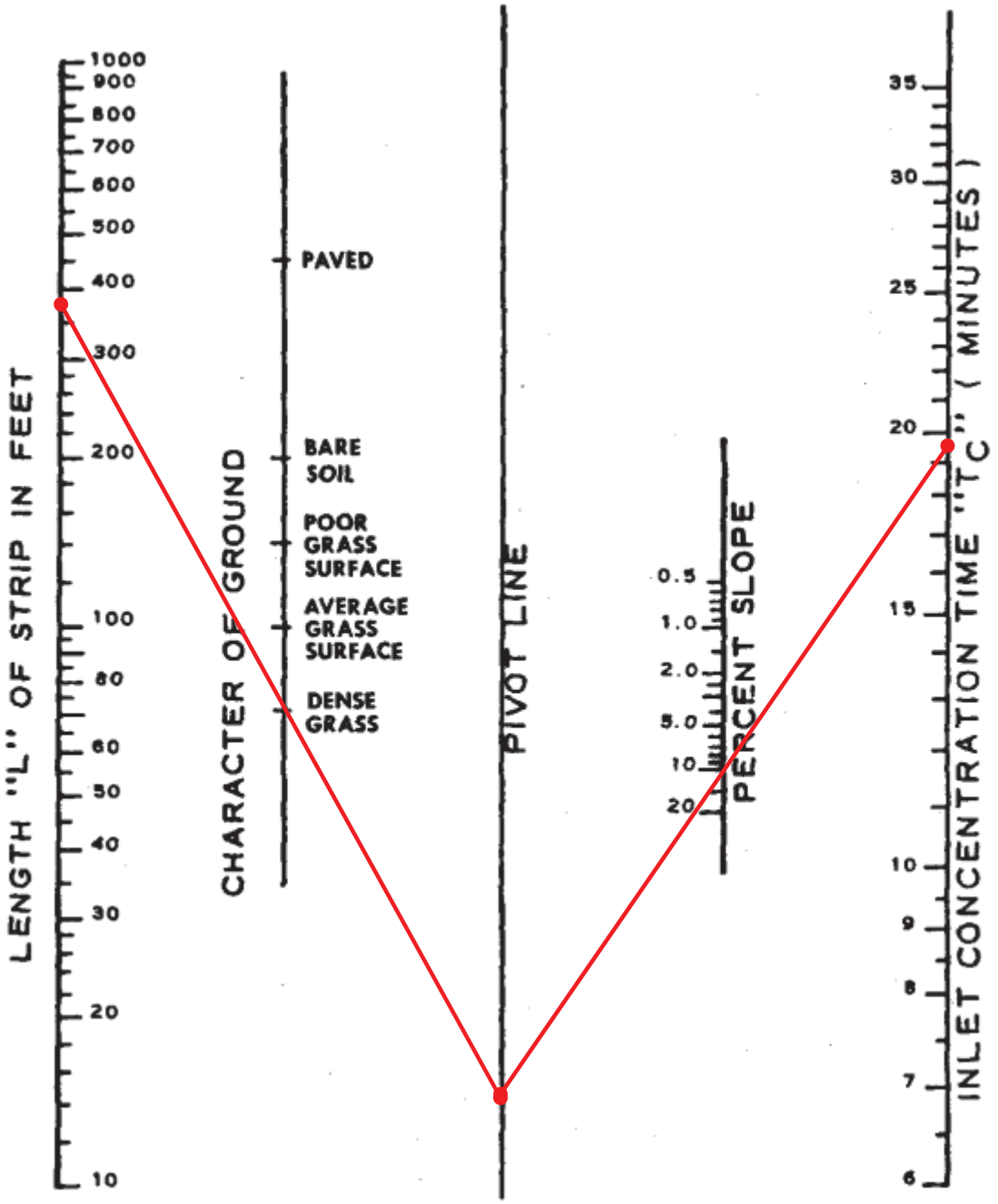
Basin 4


LENGTH "L" OF STRIP IN FEET
1000
900
800
700
600
500
400
300
200
100
80
60
50
40
30
20
10
CHARACTER OF GROUND
PAVED
BARE SOIL
POOR GRASS SURFACE
AVERAGE GRASS SURFACE
DENSE GRASS
PIVOT LINE
PERCENT SLOPE
0.5
1.0
2.0
5.0
10
20
INLET CONCENTRATION TIME "TC" (MINUTES)
35
30
25
20
15
10
9
8
7
6

Basin 5

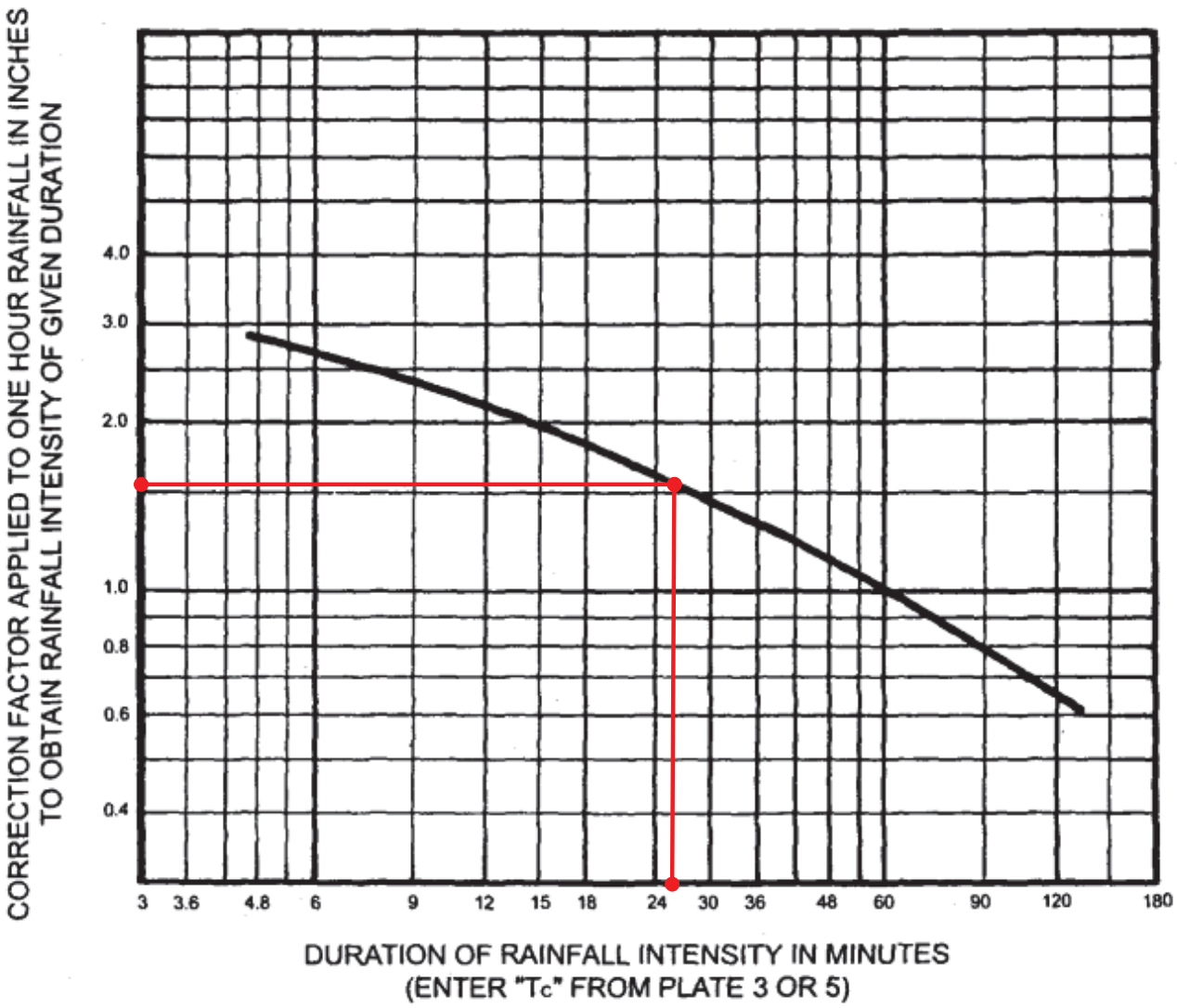

LENGTH "L" OF STRIP IN FEET
1000
900
800
700
600
500
400
300
200
100
80
60
50
40
30
20
10
CHARACTER OF GROUND
PAVED
BARE SOIL
POOR GRASS SURFACE
AVERAGE GRASS SURFACE
DENSE GRASS
PIVOT LINE
PERCENT SLOPE
0.5
1.0
2.0
5.0
10
20
INLET CONCENTRATION TIME "TC" (MINUTES)
35
30
25
20
15
10
9
8
7
6

Basin 6

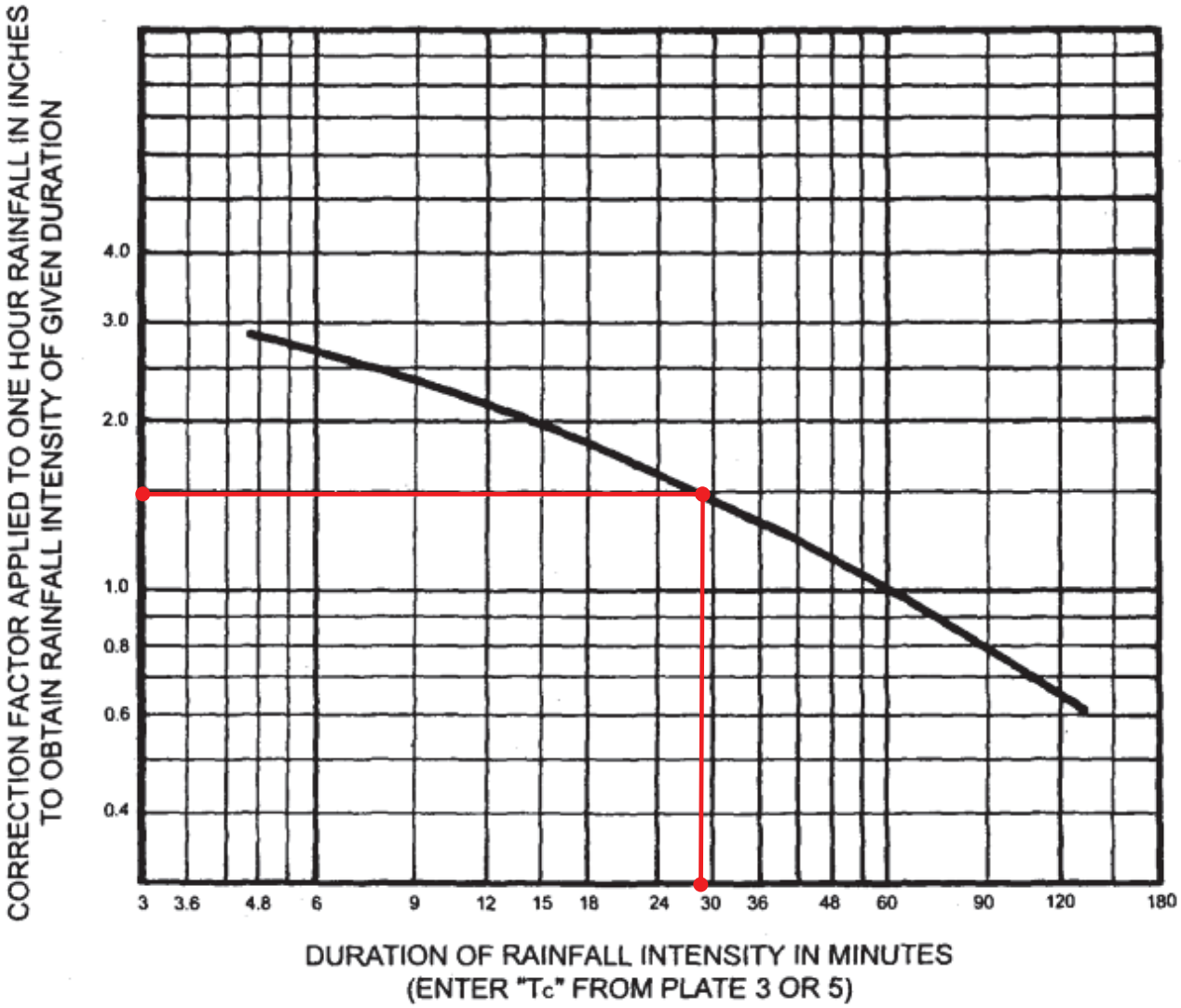

LENGTH "L" OF STRIP IN FEET
1000
900
800
700
600
500
400
300
200
100
80
60
50
40
30
20
10
CHARACTER OF GROUND
PAVED
BARE SOIL
POOR GRASS SURFACE
AVERAGE GRASS SURFACE
DENSE GRASS
PIVOT LINE
PERCENT SLOPE
0.5
1.0
2.0
5.0
10
20
INLET CONCENTRATION TIME "TC" (MINUTES)
35
30
25
20
15
10
9
8
7
6

Rainfall Intensity (Plate 4 from Storm Drainage Standards)

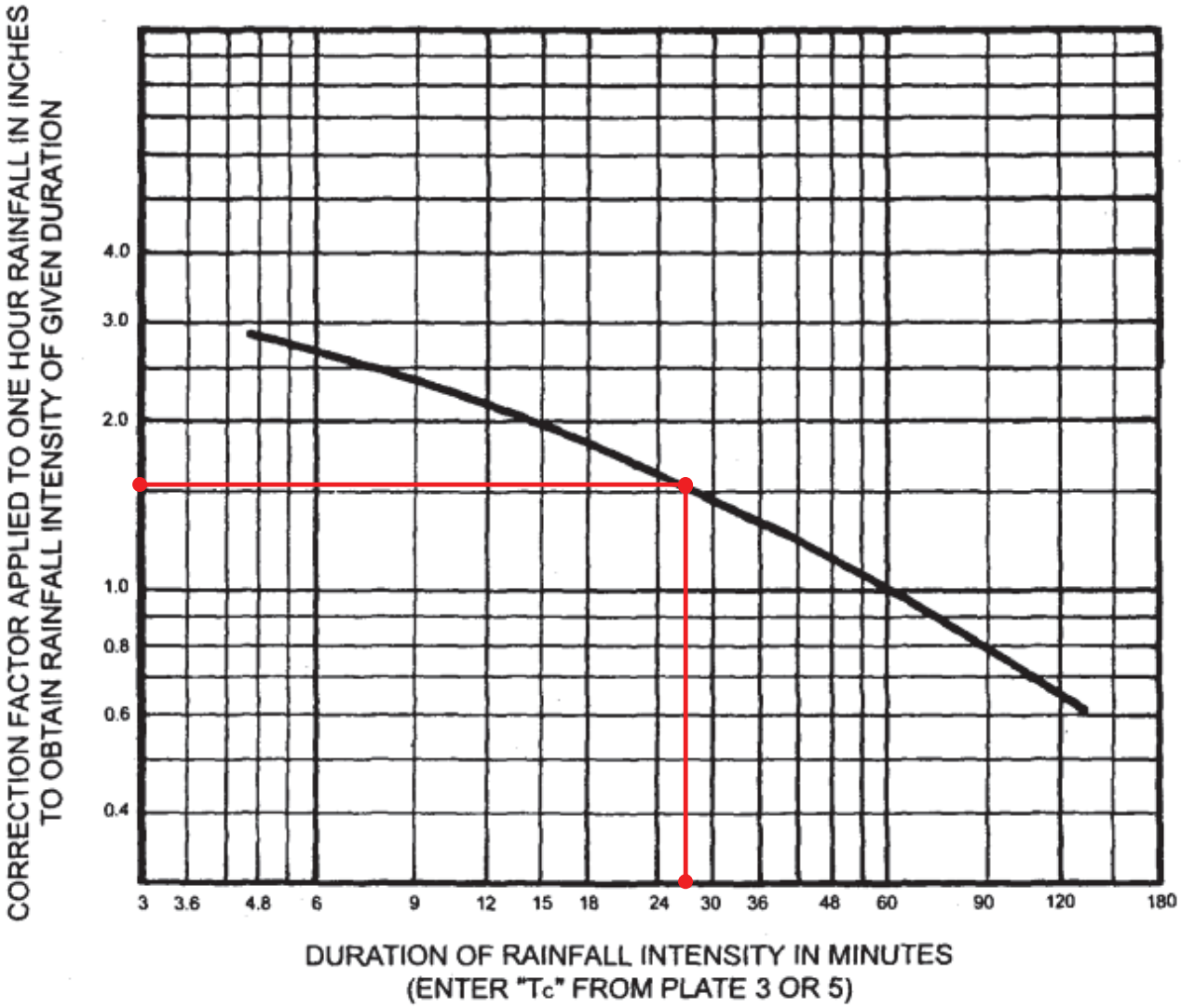
Basin 1



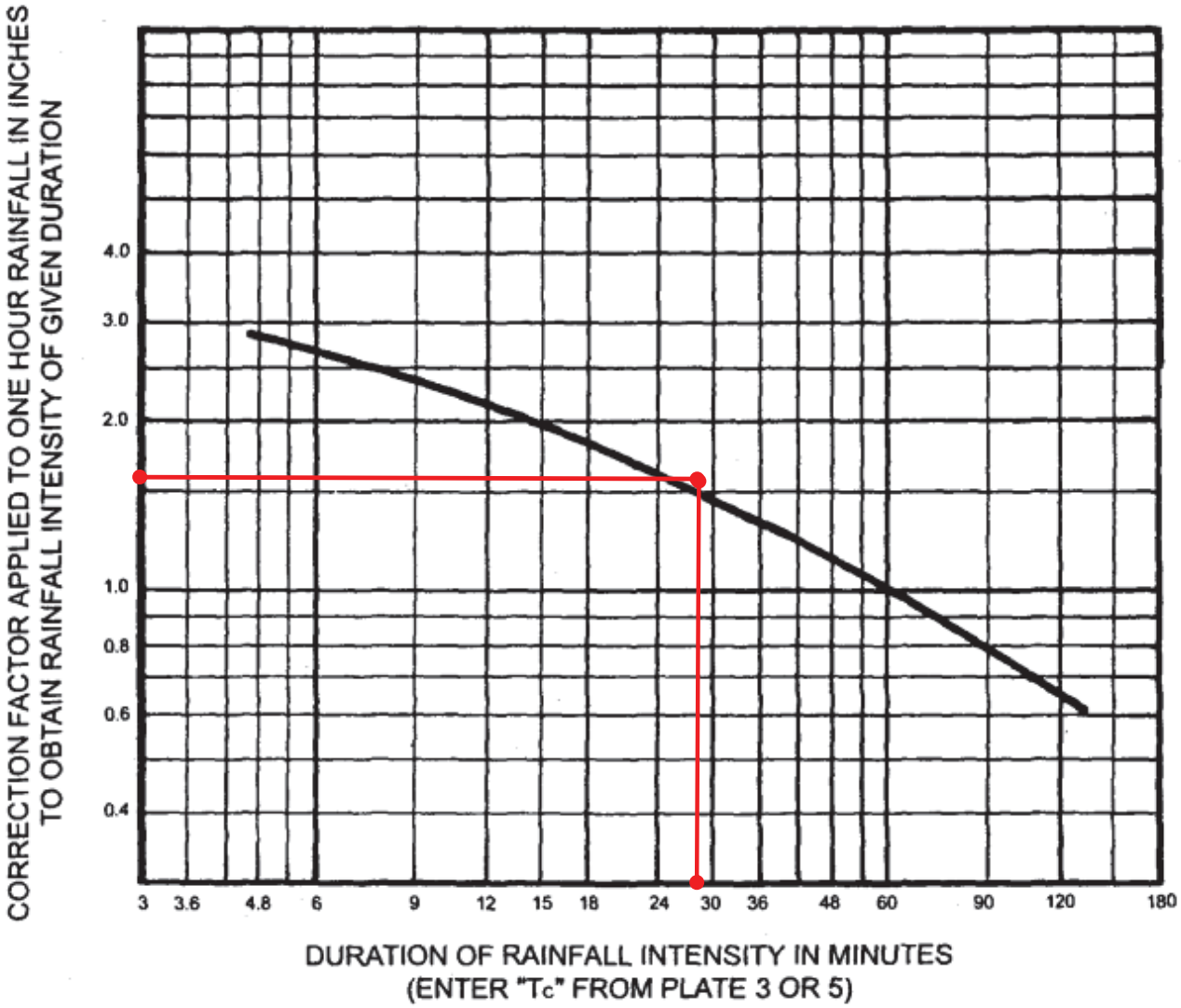
Basin 2


CORRECTION FACTOR APPLIED TO ONE HOUR RAINFALL IN INCHES
TO OBTAIN RAINFALL INTENSITY OF GIVEN DURATION
4.0
3.0
2.0
1.0
0.8
0.6
0.4
3
3.6
4.8
6
9
12
15
18
24
30
36
48
60
90
120
180
DURATION OF RAINFALL INTENSITY IN MINUTES
(ENTER "Tc" FROM PLATE 3 OR 5)

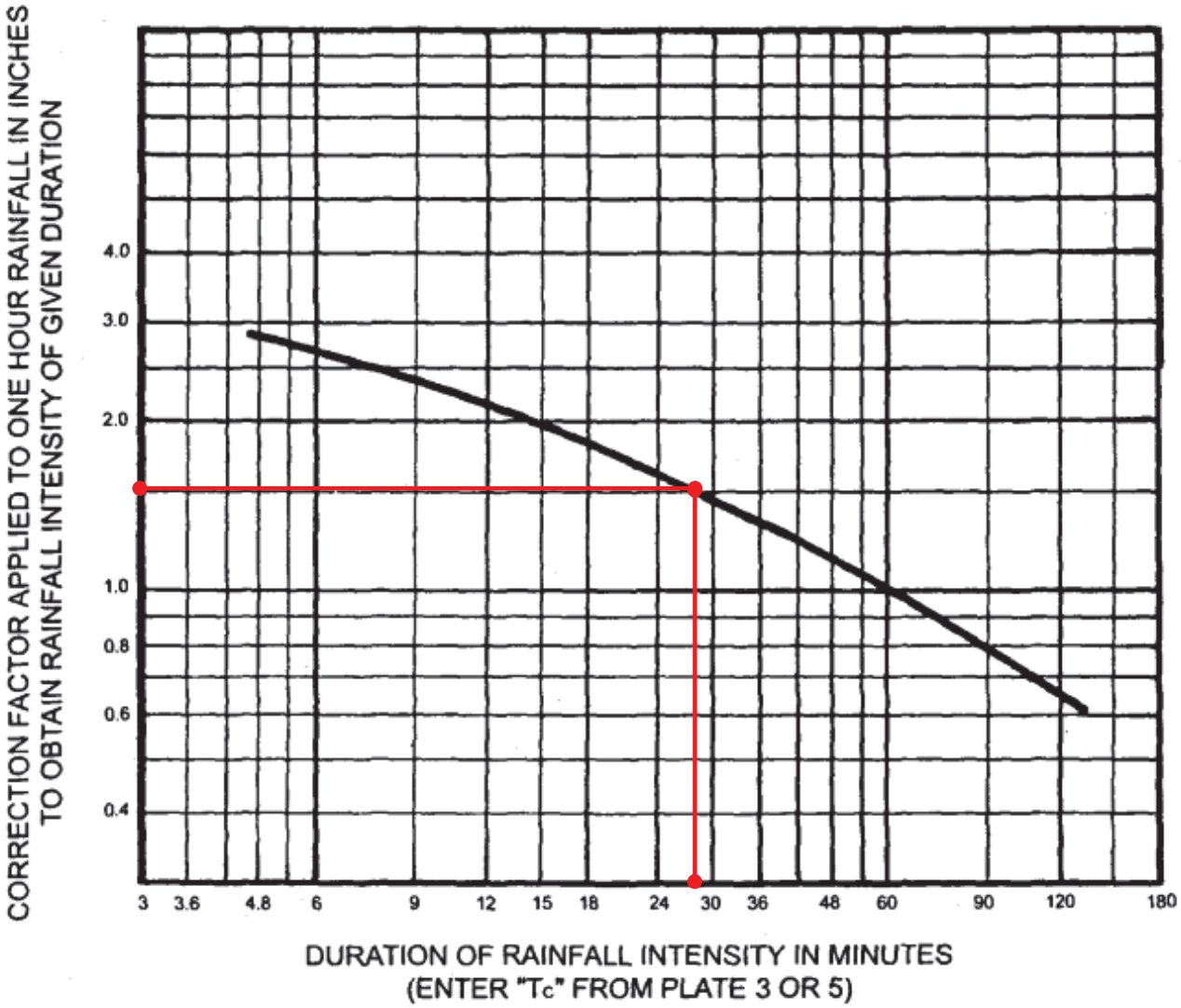
Basin 3


CORRECTION FACTOR APPLIED TO ONE HOUR RAINFALL IN INCHES
TO OBTAIN RAINFALL INTENSITY OF GIVEN DURATION
4.0
3.0
2.0
1.0
0.8
0.6
0.4
3
3.6
4.8
6
9
12
15
18
24
30
36
48
60
90
120
180
DURATION OF RAINFALL INTENSITY IN MINUTES
(ENTER "Tc" FROM PLATE 3 OR 5)

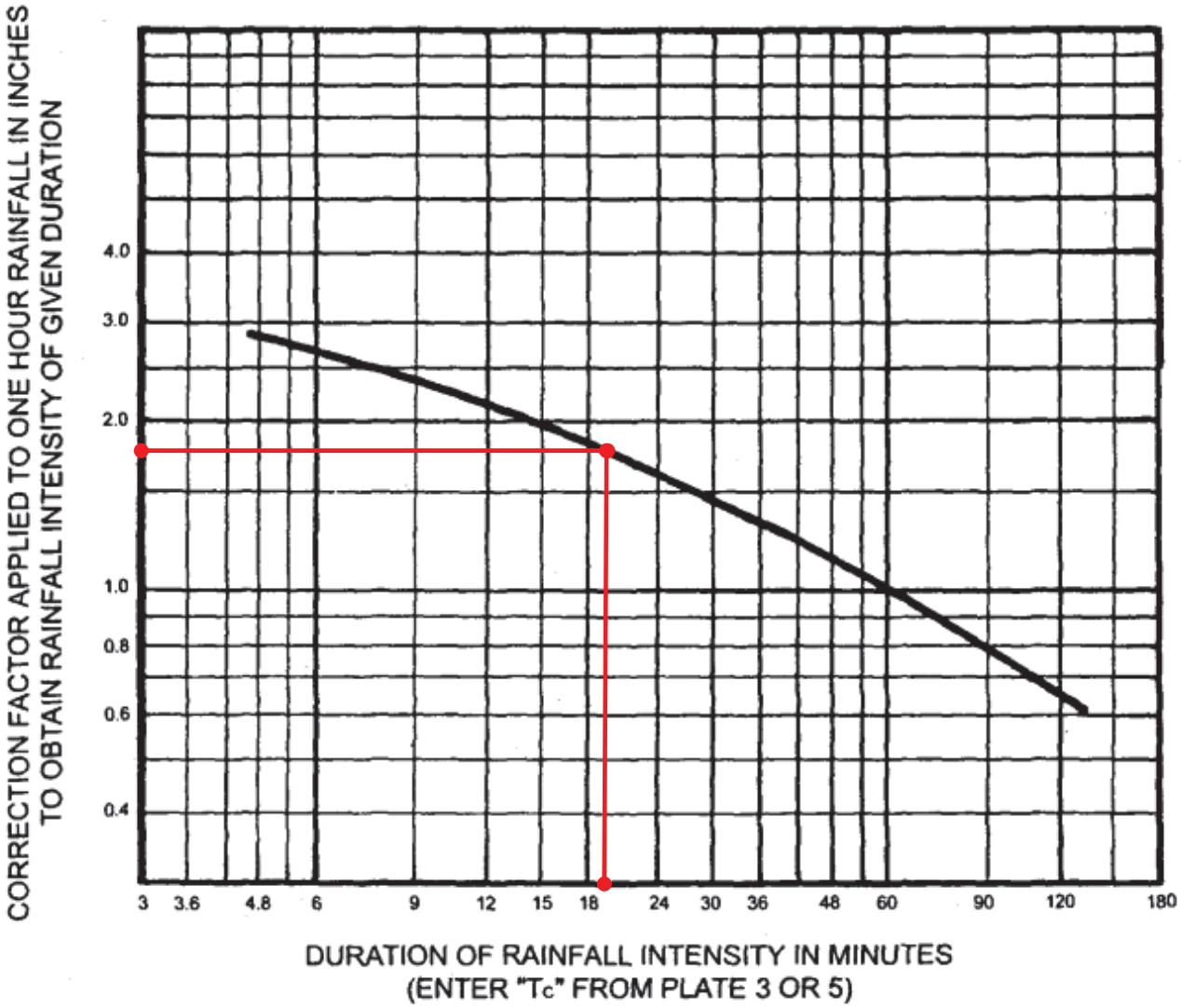
Basin 4

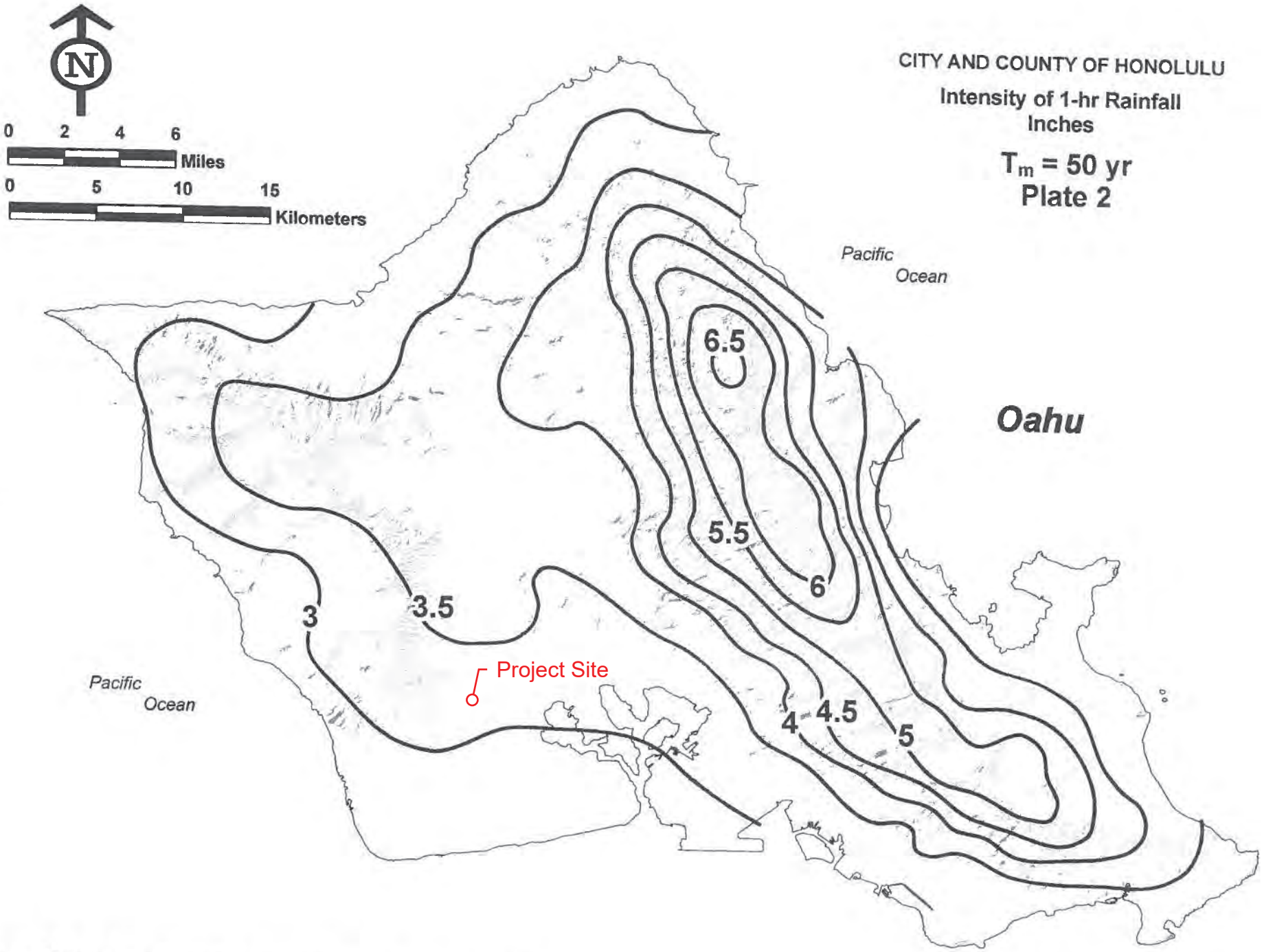

CORRECTION FACTOR APPLIED TO ONE HOUR RAINFALL IN INCHES
TO OBTAIN RAINFALL INTENSITY OF GIVEN DURATION
4.0
3.0
2.0
1.0
0.8
0.6
0.4
3
3.6
4.8
6
9
12
15
18
24
30
36
48
60
90
120
180
DURATION OF RAINFALL INTENSITY IN MINUTES
(ENTER "Tc" FROM PLATE 3 OR 5)

Basin 5


CORRECTION FACTOR APPLIED TO ONE HOUR RAINFALL IN INCHES
TO OBTAIN RAINFALL INTENSITY OF GIVEN DURATION
4.0
3.0
2.0
1.0
0.8
0.6
0.4
3
3.6
4.8
6
9
12
15
18
24
30
36
48
60
90
120
180
DURATION OF RAINFALL INTENSITY IN MINUTES
(ENTER "Tc" FROM PLATE 3 OR 5)

Basin 6


CORRECTION FACTOR APPLIED TO ONE HOUR RAINFALL IN INCHES
TO OBTAIN RAINFALL INTENSITY OF GIVEN DURATION
4.0
3.0
2.0
1.0
0.8
0.6
0.4
3
3.6
4.8
6
9
12
15
18
24
30
36
48
60
90
120
180
DURATION OF RAINFALL INTENSITY IN MINUTES
(ENTER "Tc" FROM PLATE 3 OR 5)

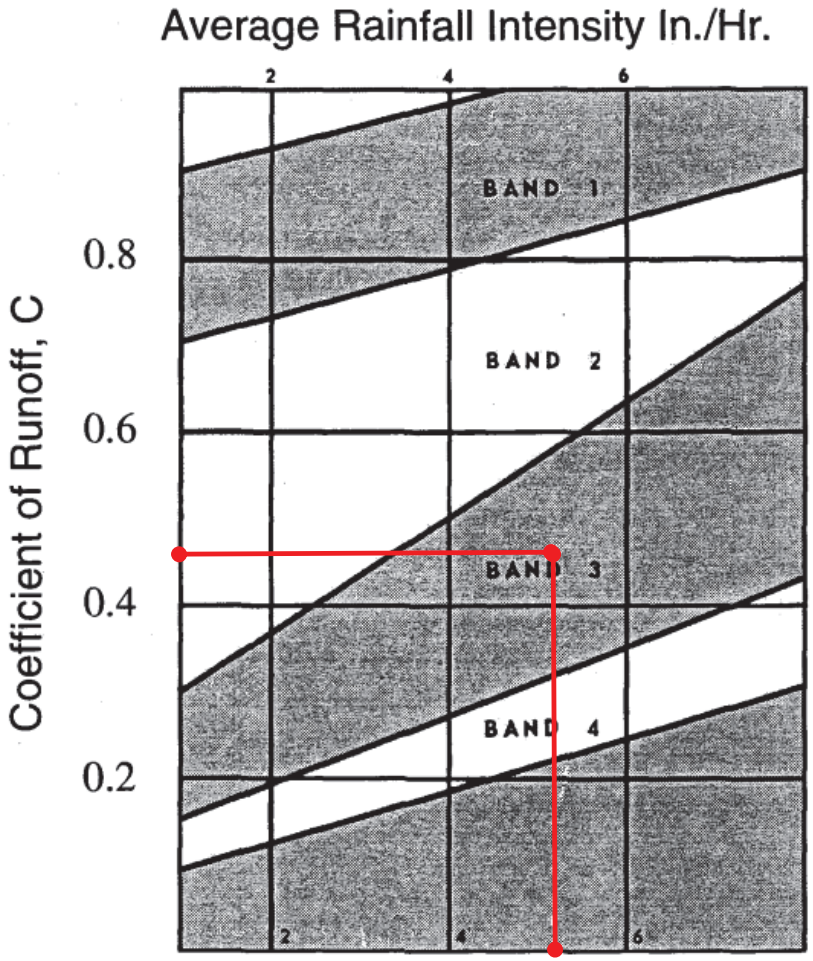


[Eff: APR 0 8 2011] (Auth: Sec 14-12.31, ROH) (Imp: Sec 14-12.31, ROH)

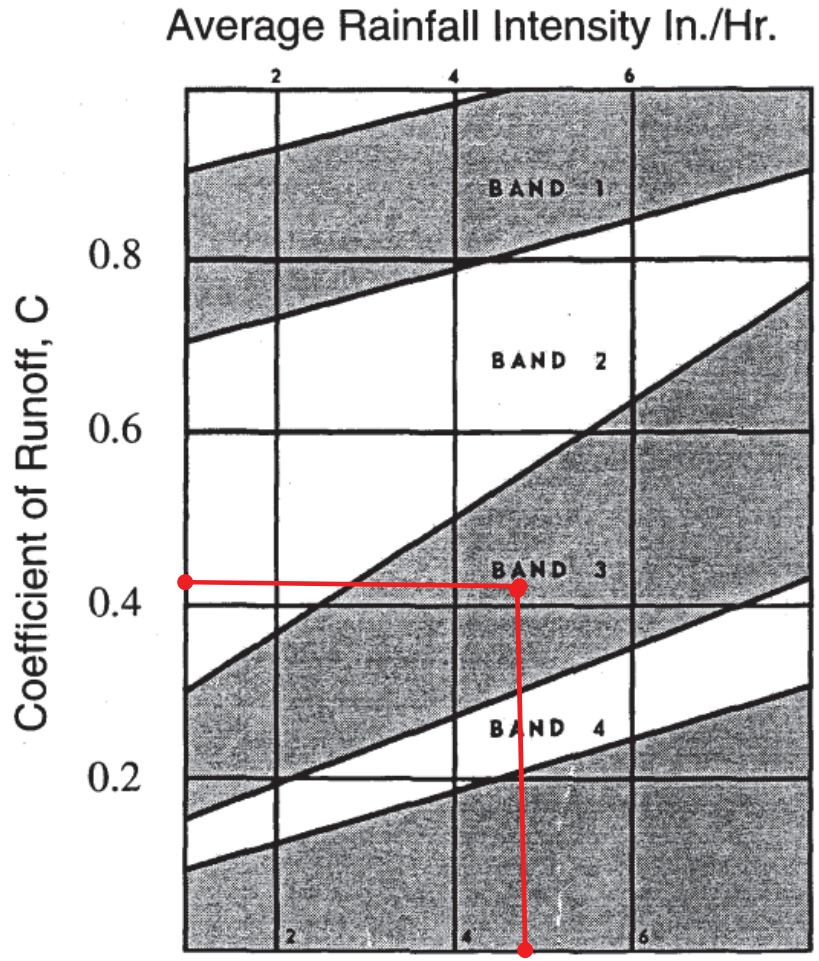
Source: National Oceanic and Atmospheric Administration (NOAA), National Weather Service, Silver Spring, Maryland, 2009

Runoff Coefficient (Table 1 from Storm Drainage Standards)

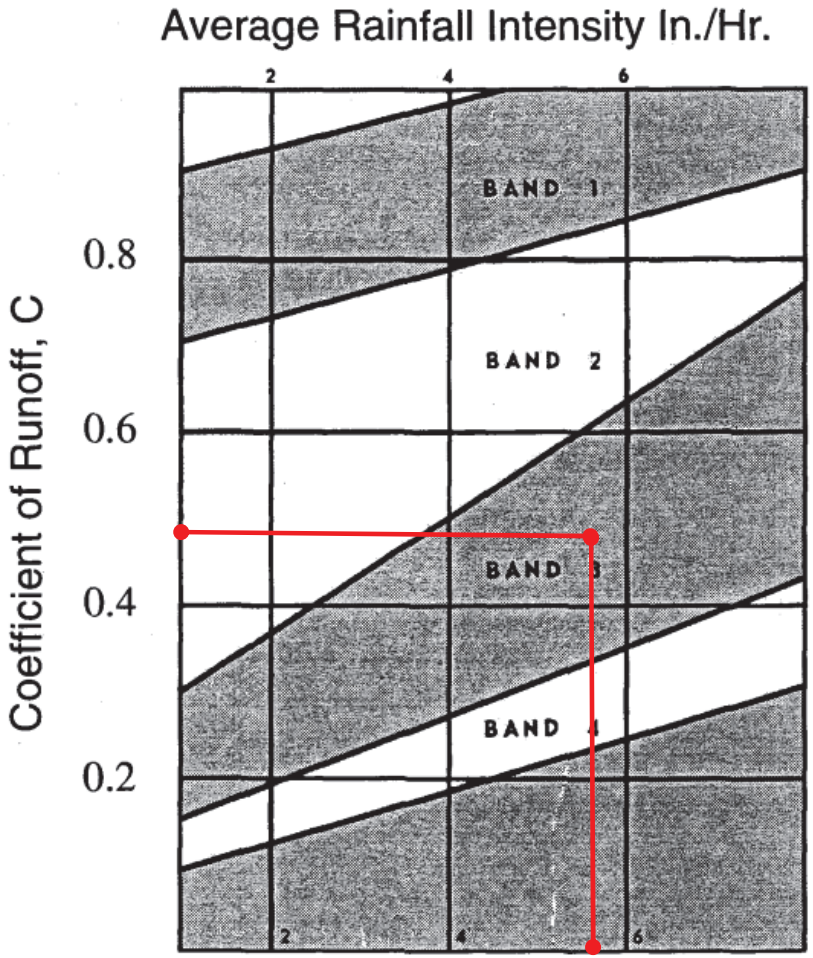
Basins 1 & 3



Basins 2, 4 & 5



Basin 6


Average Rainfall Intensity In./Hr.
2
4
6
Coefficient of Runoff, C
0.8
0.6
0.4
0.2
BAND 1
BAND 2
BAND 3
BAND 4

BMP Sizing Worksheet: Infiltration Trench

Worksheet No. 1 of 6

Project: AES Solar Site - West Oahu **Date:** 12/20/2019

1. Water Quality Volume		
a. BMP Tributary Drainage Area, **A**	3.1	ac
b. % Impervious Area, **I**	8.6	%
c. Water Quality Design Storm Depth, **P**	1.0	in
d. Volumetric Runoff Coefficient, **C**	0.1274	
e. Water Quality Volume, **WQV**	1,439	cu-ft
2. Maximum Storage Depth		
a. Soil Infiltration Rate, **k** (0.5 min)	11.7	in/hr
b. Infiltration Rate Safety Factor, **Fs** (2 min)	2	
c. Drawdown Time, **t**	48	hrs
d. Max. Storage Depth, $\mathbf{d_{max}}$	23.4	ft
3. Design Storage Depths		
a. Ponding Depth, $\mathbf{d_p}$	0.00	ft
b. Backfill Material (Trench Rock) Thickness, $\mathbf{l_b}$	3.00	ft
c. Sand Layer Thickness, $\mathbf{l_s}$	1.0	ft
d. Backfill Material Porosity, $\mathbf{n_b}$	0.35	
e. Sand Porosity, $\mathbf{n_s}$	0.40	
f. Total Effective Storage Depth, $\mathbf{d_t}$	1.45	ft
4. BMP Area Requirements		
a. Reservoir Fill Time, **T**	2	hrs
b. Min. Surface Area excluding pretreatment, $\mathbf{A_{BMP}}$	593	sq-ft

BMP Sizing Worksheet: Infiltration Trench

Worksheet No. 2 of 6

Project: AES Solar Site - West Oahu **Date:** 12/20/2019

1. Water Quality Volume		
a. BMP Tributary Drainage Area, **A**	3.5	ac
b. % Impervious Area, **I**	8.8	%
c. Water Quality Design Storm Depth, **P**	1.0	in
d. Volumetric Runoff Coefficient, **C**	0.1292	
e. Water Quality Volume, **WQV**	1,618	cu-ft
2. Maximum Storage Depth		
a. Soil Infiltration Rate, **k** (0.5 min)	11.7	in/hr
b. Infiltration Rate Safety Factor, **Fs** (2 min)	2	
c. Drawdown Time, **t**	48	hrs
d. Max. Storage Depth, $\mathbf{d_{max}}$	23.4	ft
3. Design Storage Depths		
a. Ponding Depth, $\mathbf{d_p}$	0.00	ft
b. Backfill Material (Trench Rock) Thickness, $\mathbf{l_b}$	3.00	ft
c. Sand Layer Thickness, $\mathbf{l_s}$	1.0	ft
d. Backfill Material Porosity, $\mathbf{n_b}$	0.35	
e. Sand Porosity, $\mathbf{n_s}$	0.40	
f. Total Effective Storage Depth, $\mathbf{d_t}$	1.45	ft
4. BMP Area Requirements		
a. Reservoir Fill Time, **T**	2	hrs
b. Min. Surface Area excluding pretreatment, $\mathbf{A_{BMP}}$	667	sq-ft

BMP Sizing Worksheet: Infiltration Trench

Worksheet No. 3 of 6

Project: AES Solar Site - West Oahu **Date:** 12/20/2019

1. Water Quality Volume		
a. BMP Tributary Drainage Area, **A**	2.3	ac
b. % Impervious Area, **I**	11.8	%
c. Water Quality Design Storm Depth, **P**	1.0	in
d. Volumetric Runoff Coefficient, **C**	0.1562	
e. Water Quality Volume, **WQV**	1,328	cu-ft
2. Maximum Storage Depth		
a. Soil Infiltration Rate, **k** (0.5 min)	11.7	in/hr
b. Infiltration Rate Safety Factor, **Fs** (2 min)	2	
c. Drawdown Time, **t**	48	hrs
d. Max. Storage Depth, $\mathbf{d_{max}}$	23.4	ft
3. Design Storage Depths		
a. Ponding Depth, $\mathbf{d_p}$	0.00	ft
b. Backfill Material (Trench Rock) Thickness, $\mathbf{l_b}$	3.00	ft
c. Sand Layer Thickness, $\mathbf{l_s}$	1.0	ft
d. Backfill Material Porosity, $\mathbf{n_b}$	0.35	
e. Sand Porosity, $\mathbf{n_s}$	0.40	
f. Total Effective Storage Depth, $\mathbf{d_t}$	1.45	ft
4. BMP Area Requirements		
a. Reservoir Fill Time, **T**	2	hrs
b. Min. Surface Area excluding pretreatment, $\mathbf{A_{BMP}}$	548	sq-ft

BMP Sizing Worksheet: Infiltration Trench

Worksheet No. 4 of 6

Project: AES Solar Site - West Oahu **Date:** 12/20/2019

1. Water Quality Volume		
a. BMP Tributary Drainage Area, **A**	13.8	ac
b. % Impervious Area, **I**	2.1	%
c. Water Quality Design Storm Depth, **P**	1.0	in
d. Volumetric Runoff Coefficient, **C**	0.0689	
e. Water Quality Volume, **WQV**	3,453	cu-ft
2. Maximum Storage Depth		
a. Soil Infiltration Rate, **k** (0.5 min)	11.7	in/hr
b. Infiltration Rate Safety Factor, **Fs** (2 min)	2	
c. Drawdown Time, **t**	48	hrs
d. Max. Storage Depth, $\mathbf{d_{max}}$	23.4	ft
3. Design Storage Depths		
a. Ponding Depth, $\mathbf{d_p}$	0.00	ft
b. Backfill Material (Trench Rock) Thickness, $\mathbf{l_b}$	3.00	ft
c. Sand Layer Thickness, $\mathbf{l_s}$	1.0	ft
d. Backfill Material Porosity, $\mathbf{n_b}$	0.35	
e. Sand Porosity, $\mathbf{n_s}$	0.40	
f. Total Effective Storage Depth, $\mathbf{d_t}$	1.45	ft
4. BMP Area Requirements		
a. Reservoir Fill Time, **T**	2	hrs
b. Min. Surface Area excluding pretreatment, $\mathbf{A_{BMP}}$	1,424	sq-ft

BMP Sizing Worksheet: Infiltration Trench

Worksheet No. 5 of 6

Project: AES Solar Site - West Oahu **Date:** 12/20/2019

1. Water Quality Volume		
a. BMP Tributary Drainage Area, **A**	12.4	ac
b. % Impervious Area, **I**	5.1	%
c. Water Quality Design Storm Depth, **P**	1.0	in
d. Volumetric Runoff Coefficient, **C**	0.0959	
e. Water Quality Volume, **WQV**	4,305	cu-ft
2. Maximum Storage Depth		
a. Soil Infiltration Rate, **k** (0.5 min)	11.7	in/hr
b. Infiltration Rate Safety Factor, **Fs** (2 min)	2	
c. Drawdown Time, **t**	48	hrs
d. Max. Storage Depth, $\mathbf{d_{max}}$	23.4	ft
3. Design Storage Depths		
a. Ponding Depth, $\mathbf{d_p}$	0.00	ft
b. Backfill Material (Trench Rock) Thickness, $\mathbf{l_b}$	3.00	ft
c. Sand Layer Thickness, $\mathbf{l_s}$	1.0	ft
d. Backfill Material Porosity, $\mathbf{n_b}$	0.35	
e. Sand Porosity, $\mathbf{n_s}$	0.40	
f. Total Effective Storage Depth, $\mathbf{d_t}$	1.45	ft
4. BMP Area Requirements		
a. Reservoir Fill Time, **T**	2	hrs
b. Min. Surface Area excluding pretreatment, $\mathbf{A_{BMP}}$	1,775	sq-ft

BMP Sizing Worksheet: Infiltration Trench

Worksheet No. 6 of 6

Project: AES Solar Site - West Oahu **Date:** 12/20/2019

1. Water Quality Volume		
a. BMP Tributary Drainage Area, **A**	0.6	ac
b. % Impervious Area, **I**	28.3	%
c. Water Quality Design Storm Depth, **P**	1.0	in
d. Volumetric Runoff Coefficient, **C**	0.3047	
e. Water Quality Volume, **WQV**	632	cu-ft
2. Maximum Storage Depth		
a. Soil Infiltration Rate, **k** (0.5 min)	11.7	in/hr
b. Infiltration Rate Safety Factor, **Fs** (2 min)	2	
c. Drawdown Time, **t**	48	hrs
d. Max. Storage Depth, $\mathbf{d_{max}}$	23.4	ft
3. Design Storage Depths		
a. Ponding Depth, $\mathbf{d_p}$	0.00	ft
b. Backfill Material (Trench Rock) Thickness, $\mathbf{l_b}$	3.00	ft
c. Sand Layer Thickness, $\mathbf{l_s}$	1.0	ft
d. Backfill Material Porosity, $\mathbf{n_b}$	0.35	
e. Sand Porosity, $\mathbf{n_s}$	0.40	
f. Total Effective Storage Depth, $\mathbf{d_t}$	1.45	ft
4. BMP Area Requirements		
a. Reservoir Fill Time, **T**	2	hrs
b. Min. Surface Area excluding pretreatment, $\mathbf{A_{BMP}}$	261	sq-ft

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Appendix D
Biological Resource Survey and Supplemental Pueo Survey

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West O'ahu Solar Plus Storage Project Biological Resources Survey Report

Prepared for:

AES Distributed Energy

May 2019

TETRA TECH

complex world | CLEAR SOLUTIONS™

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Table of Contents

List of Figures

List of Appendices

1 Introduction

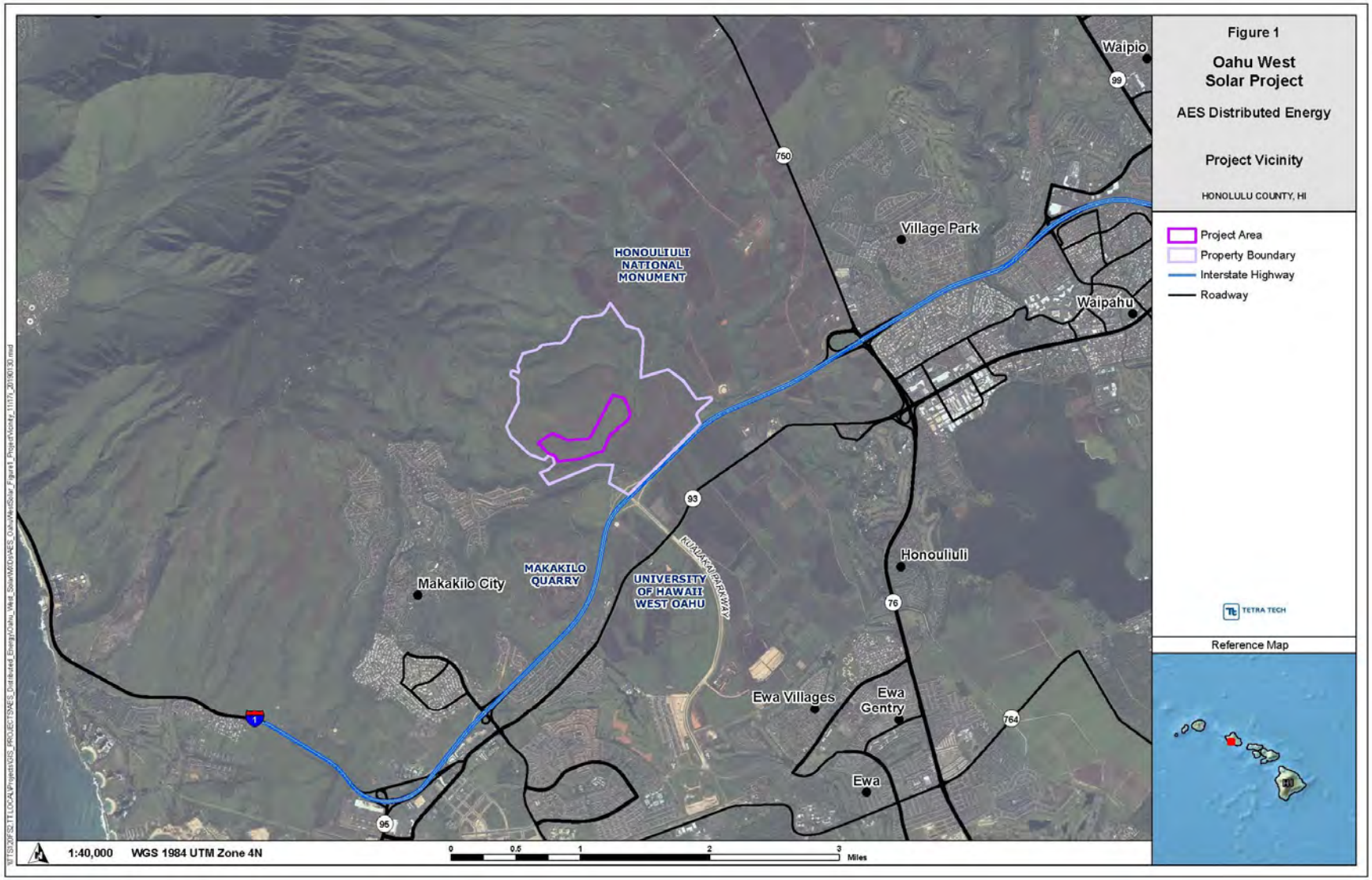
AES Distributed Energy (AES) is proposing the West O‘ahu Solar Plus Storage Project (Project) near Kapolei on the island of O‘ahu. The Project will involve construction and operation of a solar photovoltaic and battery energy storage system on land owned by University of Hawai‘i (UH). The major components of the Project will be an approximately 12.5-megawatt (MW) ground-mounted solar photovoltaic system coupled with a 50 MW-hour battery energy storage system, and related interconnection and ancillary facilities. Interconnection of the Project with the Hawaiian Electric Company (HECO) electrical grid will be via an existing 46-kilovolt transmission line that traverses the Project Area. A Project substation and interconnection equipment will be located immediately proximate to the existing transmission line, with a short connection installed to the transmission line. The Project will be accessed via the existing gated entry off Palehua Road and Kualakai Parkway, and will utilize a network of existing and new on-site access roads. Temporary construction staging and laydown will occur within the Project Area.

Tetra Tech, Inc. (Tetra Tech) was contracted by AES to conduct a general biological survey for the Project. The purpose of the survey was to characterize the habitat and determine whether state or federally listed threatened, endangered, or otherwise rare plants or animals have the potential to occur within the Project Area, and whether they could be impacted by construction or operation of the Project. In addition, the survey evaluated the potential occurrence of streams, wetlands, and other features that may be considered Waters of the U.S. (WoUS), and therefore subject to agency jurisdiction under the Clean Water Act. This report summarizes the results of the biological survey conducted within the Project Area by Tetra Tech on January 31, 2019 and February 5, 2019.

2 Description of Project Area

As shown in Figure 1, the Project Area is located on the southwest side of O‘ahu, approximately 3 miles northeast of Kapolei. It encompasses approximately 80 acres in an area commonly referred to as the UH West O‘ahu Mauka property and is within tax map key 9-2-002:007. The Project Area and vicinity was previously cultivated as part of the extensive sugar cane and pineapple plantation that extended across O‘ahu’s ‘Ewa Plain. Since closure of the plantation in the 1990s, this area has not been recently cultivated and is now undeveloped, vacant land, with domestic cattle grazing occurring within portions of the Project Area. A minimal amount of infrastructure associated with the former plantation remains in the area, including a pump station, an associated wooden structure, and components of the irrigation system. A tributary to Kalo‘i Gulch runs through the central portion of the Project Area. Elevation in the Project Area ranges from approximately 300 to 600 feet above sea level.

Figure 1. Project Area and Vicinity



3 Methods

Prior to the field survey, Tetra Tech conducted a review of relevant publicly available literature and data with respect to biological resources in and near the Project Area. This review included environmental assessments and environmental impact statements, National Wetlands Inventory (NWI) data, the U.S. Geological Survey National Hydrography Dataset (NHD), scientific journals and reports, and available, unpublished data that are relevant to the natural history and ecology of the area. In addition, Tetra Tech reviewed available geospatial data, aerial photographs, and topographic maps of the area to identify occurrences of state or federally listed species, or habitats that could support these species. Details of the field survey conducted by Tetra Tech on January 31, 2019 and February 5, 2019 are provided below.

3.1 Plants

A pedestrian survey was conducted to record common plant species and dominant vegetation types, as well as rare or listed plant species within the Project Area. Areas more likely to support native plants (e.g., rocky outcrops and shady areas) were more intensively examined. Plant identifications were made in the field; plants that could not be positively identified were photo documented for comparison with the recent taxonomic literature.

Plants recorded during this survey are indicative of the season and environmental conditions at the time of the survey. Since plants are dynamic and influenced by seasonal and temporal changes, there may be additional species that occur on site, but which were not present during this survey.

The taxonomy and nomenclature of the flowering plants are in accordance with Wagner et al. (1999, Wagner et al. 2012) and Wagner and Herbst (2003) for native and naturalized flowering plants, and Staples and Herbst (2005) for ornamental plants. In Section 4 and Appendix B, common/Hawaiian names are provided first, followed by scientific names in parentheses. If no common or Hawaiian name is known, only the scientific name is provided.

3.2 Wildlife

Wildlife surveys consisted of observations of birds, mammals, and large insects and other invertebrates. All species detected by sight and sound were recorded, and any wildlife sign (e.g., scat, tracks, feeding) noted. Specific survey methods of each wildlife group are provided below.

3.2.1 Birds

Tetra Tech recorded all birds seen or heard within the Project Area. Habitats or plants that could support listed birds were also identified, if present (e.g., water features as potential habitat for listed Hawaiian waterbirds).

A survey specifically to detect the pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*) was conducted in the morning on February 5, 2019. Pueo are not federally listed but are listed as endangered by the State of Hawai'i for the Island of O'ahu. The survey followed the Pueo Project Survey

Protocol (Price and Cotín 2018), and was conducted from civil twilight to 60 minutes after sunrise on February 5, 2019. A single survey location was chosen to provide the best vantage point of the Project Area, which was scanned with binoculars and the naked eye.

Scientific nomenclature for birds follows the American Ornithologists' Union *Check-list of North American Birds 7th Edition* (American Ornithologists' Union 1998) and the 42nd through the 46th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000, Banks et al. 2002, Banks et al. 2003, Banks et al. 2004, Banks et al. 2005).

3.2.2 Mammals

The mammal survey was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. Scientific names for mammals follow Tomich (1986).

Specific surveys for the endangered Hawaiian hoary bat or 'ōpe'ape'a (*Lasiurus cinereus semotus*), through the use of acoustic bat detectors or night vision goggles, were not conducted. The U.S. Fish and Wildlife Service (USFWS) recognizes woody vegetation greater than 15 feet tall as potential bat roosting habitat (USFWS 2019). For this reason, Tetra Tech noted the presence/absence of trees or shrubs greater than 15 feet tall within the Project Area.

3.2.3 Insects and Other Invertebrates

Large insects and other invertebrates were noted while conducting the pedestrian surveys. Scientific nomenclature follows Nishida (2002) for insects.

3.3 Waters of the U.S.

Prior to the survey, data from the NWI, NHD, and the State of Hawai'i Department of Aquatic Resources (DAR) dataset were reviewed to identify streams, wetlands, and other potential jurisdictional features in the Project area. These features may be potential WoUS, regulated under Sections 404 and 401 of the Clean Water Act. During the survey, streams and ditches identified by these datasets were visited to evaluate the presence of an ordinary high water mark (OHWM) and assess whether the features are potentially jurisdictional. This survey did not constitute a formal delineation of WoUS but was intended to determine whether a formal delineation is warranted.

4 Results and Discussion

In general, the biological resources in the Project Area have been modified by previous agricultural use and the introduction of invasive species, which has resulted in a reduction of the number and abundance of native species and the habitats suitable for native species. No federal or state-listed species were recorded during the survey. Although not observed, several listed animal species, including the Hawaiian hoary bat and pueo, may occasionally occur in or transverse the area. These species are

discussed in further detail below. No critical habitat has been designated by USFWS within or adjacent to the Project Area.

Conditions during the survey were relatively dry, particularly for the wet season. The National Weather Service rainfall gages closest to the Project Area (Kunia and Honouliulli) documented below average rainfall for January 2019 and the months preceding the survey (National Weather Service 2019). Representative photographs from the survey are presented in Appendix A.

4.1 Plants

In all, 28 plant species were observed during the survey (Appendix B). Of these, only three are native to the Hawaiian Islands and include: hoary abutilon (*Abutilon incanum*), 'ilima (*Sida fallax*), and 'uhaloa (*Waltheria indica*). These three native plants are indigenous, that is found in the Hawaiian Islands and elsewhere. Two additional native plant species—wiliwili (*Erythrina sandwicensis*) and 'a'ali'i (*Dodonaea viscosa*)—were observed immediately outside the Project Area. No federal or state-listed threatened, endangered, proposed listed, or candidate plant species were observed in the Project Area during the survey. None of the native plants observed are considered rare throughout the Hawaiian Islands (Wagner et al. 1999).

The area is dominated by Koa Haole Scrub. This vegetation type is characterized by open to dense stands of non-native koa haole trees (*Leucaena leucocephala*), ranging from 4 to 8 feet in height. Guinea grass (*Urochloa maxima*) is the most abundant plant in the understory, although buffelgrass (*Cenchrus ciliaris*) is also occasionally present. Kiawe trees (*Prosopis pallida*) are sparsely scattered throughout the area. Other common species widely occurring in the Project Area include klu (*Acacia farnesiana*), 'ilima, 'uhaloa, and *Sida ciliaris*.

4.2 Wildlife

4.2.1 Birds

A total of 21 bird species were recorded during the survey (Table 1). All of these species are non-native to the Hawaiian Islands and are commonly found in rural or agricultural areas. Zebra dove (*Geopelia striata*) and common myna (*Acridotheres tristis*) were the most common bird species recorded during the survey. Several of the bird species seen or heard are protected under the Migratory Bird Treaty Act (Table 1).

Table 1. Birds Recorded in the Project Area during the Survey

Common Name	Scientific Name	Status	MBTA
Barn owl	*Tyto alba*	NN	X
Black francolin	*Francolinus francolinus*	NN	
Cattle egret	*Bubulcus ibis*	NN	X
Chestnut munia	*Lonchura atricapilla*	NN	

Common Name	Scientific Name	Status	MBTA
Common myna	*Acridotheres tristis*	NN	
Common waxbill	*Estrilda astrild*	NN	
Gray francolin	*Francolinus pondicerianus*	NN	
House finch	*Haemorhous mexicanus*	NN	X
Japanese White-eye	*Zosterops japonicus*	NN	
Java sparrow	*Padda oryzivora*	NN	
Northern cardinal	*Cardinalis cardinalis*	NN	X
Northern mockingbird	*Mimus polyglottos*	NN	X
Nutmeg mannikin	*Lonchura punctulata*	NN	
Red avadavat	*Amandava amandava*	NN	
Red-crested Cardinal	*Paroaria coronata*	NN	
Red-vented Bulbul	*Pycnonotus cafer*	NN	
Rock pigeon	*Columba livia*	NN	
Sky lark	*Alauda arvensis*	NN	X
Spotted dove	*Streptopelia chinensis*	NN	
White-rumped Shama	*Copsychus malabaricus*	NN	
Zebra dove	*Geopelia striata*	NN	
Status: E = Endemic, End = Endangered, I = Indigenous, M = Migrant, NN = non-native established species. MBTA = Migratory Bird Treaty Act.			

No state or federally listed bird species were recorded during the survey, but several such species have the potential be present in or transverse the Project Area, as discussed below.

- **Pueo:** The state-listed pueo was not seen nor heard during the survey; however, pueo have been reported to use the surrounding areas and have been observed in similar vegetation types (Price and Cotín 2018, Pueo Project 2019). Pueo could also potentially forage or nest in and around the Project Area, given the habitat present.
- **Seabirds:** The endangered Hawaiian petrel (*Pterodroma sandwichensis*) and threatened Newell's shearwater (*Puffinus newelli*) (collectively referred to as seabirds) have not been documented in the Project Area, and suitable nesting habitat does not occur in the area. However, suitable nesting habitat may exist in upper elevations of the Wai'anae Mountains, suggesting the potential for these birds to fly over the area at night while transiting between nest sites and the ocean. These listed seabirds may be attracted to construction lights at night. Disorientation and fallout as a result of light attraction could occur for individuals attracted to nighttime construction lighting and unshielded nighttime facility lighting. Juvenile birds are particularly vulnerable to light attraction, and grounded birds are vulnerable to mammalian predators or vehicle strikes.

- **Waterbirds:** Listed waterbird species include Hawaiian stilt or ae'o (*Himantopus mexicanus knudseni*), Hawaiian coot or 'alea kea (*Fulica alai*), Hawaiian common gallinule, 'alea 'ula (*Gallinula galeata sandvicensis*), and Hawaiian duck or koloa (*Anas wyvilliana*). No listed waterbirds or their habitat were observed in the Project Area. At solar facilities in the continental U.S., water dependent birds (e.g., grebes, loons, rails, coots, shorebirds, and waterfowl) have been documented to collide with photovoltaic arrays. It has been hypothesized that water-dependent birds perceive the panel arrays to be bodies of water and collide with the panels while attempting a water landing (Kagan et al. 2014, WEST 2014, Walston et al. 2016). This hypothesis is termed the "lake effect." Much more research is needed to investigate whether water-dependent birds are actually attracted to solar arrays, and how proximity to water sources relates to avian mortality at the facilities. There has been no evidence from operating solar facilities in Hawai'i to suggest the lake effect occurs in Hawai'i. It is possible the lake effect would not occur in Hawai'i, where water is generally not limited in the surrounding environment.

4.2.2 Mammals

Two non-native terrestrial mammalian species - cattle (*Bos taurus*) and small Indian mongooses (*Herpestes auropunctatus*) - were seen in the area during the survey. Although not observed, other introduced mammals, such as dogs (*Canis familiaris*), cats (*Felis catus*), house mice (*Mus musculus*), and rats (*Rattus* spp.) are likely to occur within the Project Area.

The endangered Hawaiian hoary bat is also likely to forage in the Project Area. This species will forage in open and semi-cluttered landscapes in a wide range of habitats and vegetation types (Bonaccorso et al. 2015). Although the majority of the woody vegetation within the Project Area is under 15 feet (primarily shorter koa haole trees), some kiawe trees greater than 15 feet tall are scattered throughout the Project Area. According to USFWS and the State of Hawai'i Department of Land and Natural Resources Division of Forestry and Wildlife (DOFAW), these trees have the potential to function as bat roost trees (USFWS 2019; ESRC 2015).

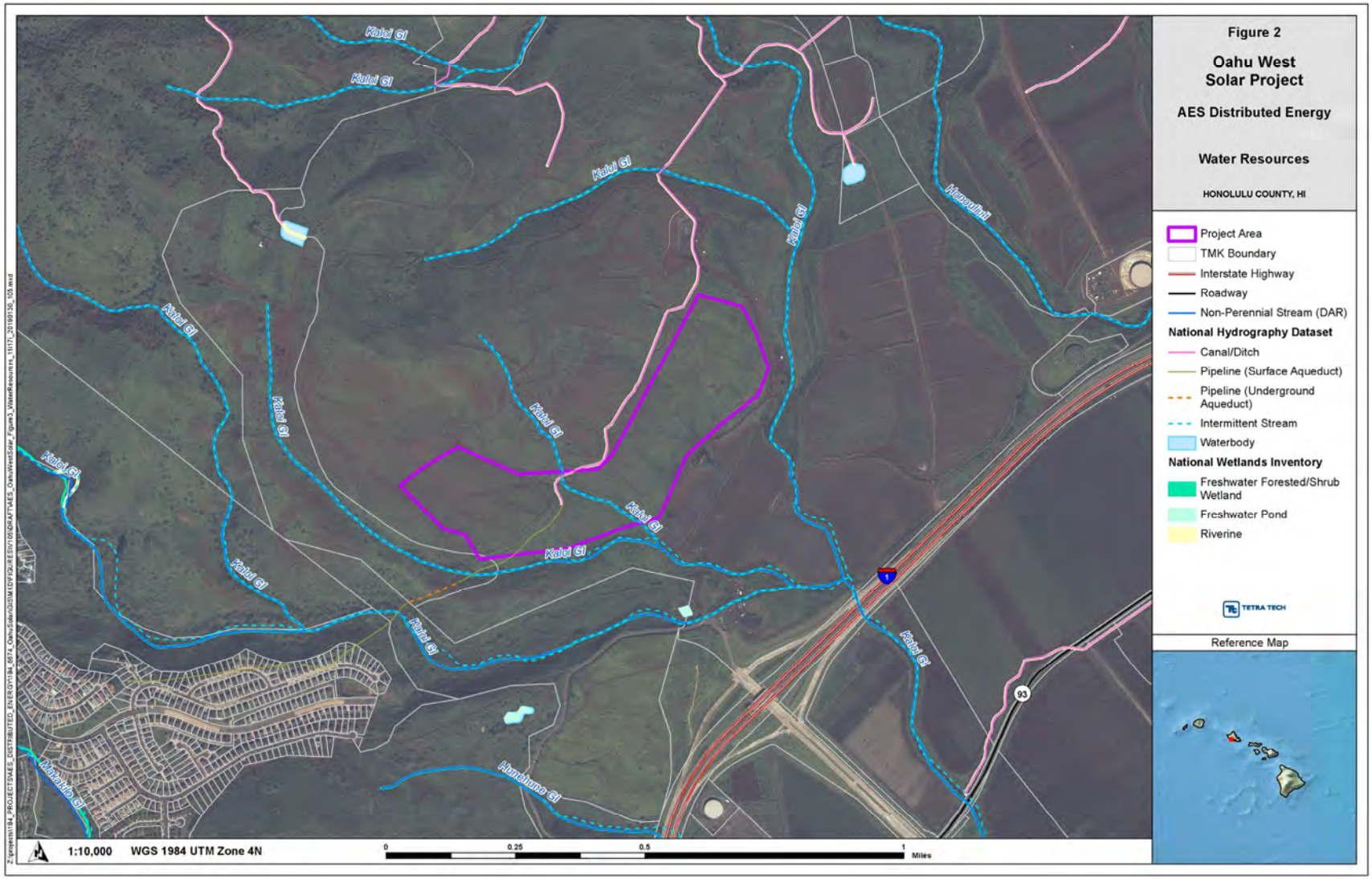
4.2.3 Insects and Other Invertebrates

Large insects observed during the survey include: yellow garden spider (*Argiope aurantia*), globe skimmer (*Pantala flavescens*), fork-tailed bush katydid (*Scudderia furcata*), praying mantis (*Mantis religiosa*), large orange sulfur (*Phoebis agarithe*), gulf fritillary (*Agraulis vanillae*), and Carolina locust (*Dissosteira carolina*). Of these species, only the globe skimmer is native to the Hawaiian Islands.

4.3 Waters of the U.S.

Figure 2 depicts water resources identified by the NWI, NHD, and Hawai'i DAR data in relation to the Project Area. The Project is located in the Kalo'i Gulch watershed. The Kalo'i Gulch stream system consists of numerous tributaries that originate in the Wai'anae Mountain Range near Palikea Ridge and

Figure 2. Water Resources in the Project Area and Vicinity



enjoin just mauka of the H-1 Freeway (Parham et al. 2008). One intermittent tributary of Kalo‘i Gulch occurs within the Project Area. Various indicators of OHWM were observed at this tributary during the survey. Additional tributaries skirt the Project Area to the west and east.

South of the Project Area, the Kalo‘i Gulch passes through the UH West O‘ahu campus, various residential developments, and a series of golf courses. Kalo‘i Gulch does not currently have a defined ocean outlet; however, a storm drainage improvement plan for the Kalo‘i Gulch watershed has been proposed for the lowermost reaches, which would create a permanent open channel at the Oneula Beach Park (R.M. Towill Corporation 2005, WRRC 2019).

In addition to Kalo‘i Gulch, NHD identifies a canal/ditch and pipeline crossing through the Project Area that intersects with Kalo‘i Gulch. The canal/ditch is identified as riverine by NWI data (Figure 2). This feature is part of the former Waiāhole Ditch System. The potential jurisdictional status of the ditch and pipeline will need to be further evaluated based on connection to other jurisdictional waters, flow regime, and the recently implemented federal Clean Water Rule.

5 Conclusions and Recommendations

As described in Section 4, no federal or state-listed threatened, endangered, proposed listed, or candidate species for listing were observed during the biological survey. The species observed in the Project Area are primarily non-native and not considered unique. Although not observed, the following listed wildlife have the potential to occur in or transit through the Project Area: pueo, Hawaiian petrel, Newell’s shearwater, and Hawaiian hoary bat. Recommended measures to avoid and minimize potential impacts to listed species that may occur in the Project area are included below.

5.1 Plants

Overall, the vegetation in the Project Area is disturbed from previous and current land use activities. Only three native plant species were observed within the Project Area, all of which commonly occur throughout Hawai‘i; no federal or state-listed threatened, endangered, proposed listed, or candidate plant species were observed. No specific impact avoidance or minimization measures are warranted for plants; however, Tetra Tech encourages the use of native species as part of any landscaping or revegetation activities.

5.2 Wildlife

5.2.1 Pueo

Although not observed in the Project Area during the biological survey, pueo have been reported to use the surrounding areas (Price and Cotín 2018, Pueo Project 2019) and it is possible that pueo may fly through or nest within the Project Area. Should this species occur within the Project Area, it could be impacted by construction activities. Tetra Tech recommends the following avoidance measures, which are consistent with the protocols established by UH for their West O‘ahu property:

- At least two (preferably three) additional pueo surveys should be conducted in the Project Area to increase detectability; two survey points for each survey would ensure the entire Project Area is visible. Because most pueo detections have occurred in the evenings (Price and Cotín 2018), twilight pueo surveys are preferred over morning surveys. Additional pueo surveys should follow the Pueo Project Survey Protocol (Price and Cotín 2018).
- Conduct pre-construction pueo nest surveys to confirm no pueo are nesting in the area prior to any vegetation clearing or ground-disturbing activities.
- All regular, on-site staff should be trained to identify pueo and implement the appropriate steps to take if pueo are present in the Project Area.
- If a ground nest or an owl nesting on the ground is observed, an approximately 50-foot buffer should be established and marked in the field.
- A designated UH representative should be contacted immediately, and the UH representative should notify USFWS and DOFAW.

5.2.2 Seabirds

The Project Area does not provide suitable nesting or foraging habitat for listed Hawaiian seabirds. However, individuals may fly over the area at night, and may be attracted to construction lights at night. Tetra Tech recommends the following measures to avoid and minimize potential impacts to listed seabirds:

- Construction activity should be restricted to daylight hours as much as possible during the seabird peak fallout period (September 15–December 15) to avoid the use of nighttime lighting that could attract seabirds.
- Should nighttime construction be required, construction lighting should be shielded, directed downward, and fitted with non-white lights if construction safety is not compromised, to minimize the attractiveness of construction lights to seabirds.
- If nighttime construction occurs during the seabird peak fallout period, a biological monitor should be present in the construction area between approximately 0.5 hours before sunset to 0.5 hours after sunrise to watch for the presence of seabirds. Should a seabird be observed, and appears affected by the lighting, the monitor should notify the construction manager to reduce or turn off construction lighting until the individual(s) move out of the area.
- Operational on-site lighting should consist of fixtures that will be shielded or directed downward to prevent upward radiation, triggered by a motion detector, and fitted with non-white light bulbs to the extent possible.

5.2.3 Hawaiian Hoary Bat

It is possible that Hawaiian hoary bats could forage or possibly roost within the Project Area. Direct impacts to bats could occur if a juvenile bat that is too small to fly, but too large to be carried by a parent, is present in a tree that is cut down or disturbed. The USFWS provides the following avoidance and minimization measures for the Hawaiian hoary bat (USFWS 2019):

- No woody vegetation (trees or shrubs) taller than 15 feet should be disturbed, removed, or trimmed between June 1 and September 15, which is when juvenile bats that are not yet capable of flying may be roosting in the trees and have the potential to be impacted.
- Barbed wire should not be used for any fences that are erected as part of the Project to prevent entanglement.

5.2 Waters of the U.S.

Tetra Tech recommends a complete WoUS determination and delineation be completed to identify the boundaries of potentially jurisdictional waters, so that the Project can be sited to avoid impacts to the extent possible. Kalo'i Gulch may be jurisdictional based on evidence of OHWM and bed and bank. The features related to the Waiāhole Ditch System may also be jurisdictional. If the features identified in Figure 2 are considered jurisdictional by the U.S. Army Corps of Engineers (USACE) and the Project intends to place dredged or fill material within these features, a Clean Water Act 404 permit may be required from USACE, Honolulu District. The determination will need to be verified by USACE, Honolulu District.

In general, if USACE requires a permit (e.g., Nationwide Permit) under Section 404, the applicant will likely also need a Section 401 Water Quality Certification from the Hawai'i Department of Health Clean Water Branch. In addition, depending on the activities proposed, a Stream Channel Alteration Permit may be required from the Commission on Water Resource Management, pursuant to the State Water Code.

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APPENDIX A

REPRESENTATIVE PHOTOGRAPHS OF THE WEST O‘AHU SOLAR PROJECT AREA

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Photo 1. Overview of the site showing dry conditions during the survey. 1/31/2019.

Photo 2. Typical Koa Haole Scrub vegetation dominated by koa haole trees and Guinea grass. 1/31/2019.

Photo 3. Native *Abutilon incanum* in the foreground. 1/31/2019.

Photo 4. Waiahole Ditch pipe and former concrete ditch crossing over a gulch in the northern section of the Project Area. 1/31/2019.

Photo 5. Eroded right bank and bed of Kalio Gulch within the Project Area. 1/31/2019.

APPENDIX B

LIST OF PLANT SPECIES OBSERVED DURING SURVEYS

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The table below provides a list of plant species observed in the Project Area by Tetra Tech on January 31 and February 5, 2019. The plant names are arranged alphabetically by family and then by species into two groups: monocots and dicots. The taxonomy and nomenclature of the flowering plants are in accordance with Wagner et al. (1999), Wagner and Herbst (2003), and Staples and Herbst (2005). Recent name changes are those recorded in Wagner et al. (2012).

Status:

- E = endemic = native only to the Hawaiian Islands
- I = indigenous = native to the Hawaiian Islands and elsewhere
- P = Polynesian = introduced by Polynesians
- X = introduced/ non-native = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact (Cook's arrival in the islands in 1778)

List of Plant Species Observed During Surveys for the West O'ahu Solar Project

Scientific Name and Authorship	Hawaiian/Common Name	Status
MONOCOTS		
Poaceae		
Cenchrus ciliaris L.	buffelgrass	X
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X
Urochloa maxima (Jacq.) R.D.Webster	Guinea grass	X
DICOTS		
Apocynaceae		
Stapelia gigantea (N.E. Brown)	zulu giant	X
Asteraceae		
Pluchea carolinensis (Jacq.) G.Don	sourbush, marsh fleabane	X
Chenopodiaceae		
Salsola tragus L.	tumbleweed	X
Convolvulaceae		
Ipomoea obscura (L.) Ker Gawl.	morning glory	X
Euphorbiaceae		
Ricinus communis L.	castor bean	X
Fabaceae		
Acacia confusa Merr.	Formosa koa	X
Acacia farnesiana (L.) Wild.	klu	X
Crotalaria pallida Aiton	smooth rattlepod, pikakani	X
Indigofera spicata Forssk.	creeping indigo	X

List of Plant Species Observed During Surveys for the West O'ahu Solar Project

Scientific Name and Authorship	Hawaiian/Common Name	Status
Chamaecrista nictitans (L.) Moench	partridge pea	X
Leucaena leucocephala (Lam.) de Wit	koa haole	X
Macroptilium atropurpureum (DC.) Urb.	–	X
Mimosa pudica var. *unijuga* (Duchass. & Walp.) Griseb.	sensitive plant, sleeping grass, pua hilahila	X
Pithecellobium dulce (Roxb.) Benth.	Manila tamarind, opiuma	X
Prosopis pallida Kunth	kiawe	X
Lamiaceae		
Hyptis pectinata (L.) Poit.	comb hyptis	X
Leonotis nepetifolia (L.) R.Br.	lion's ear	X
Malvaceae		
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X
Abutilon incanum (Link.) Sweet	hoary abutilon	I
Sida ciliaris L.	–	X
Sida fallax L.	'ilima	I
Sida sp.	–	X
Polygonaceae		
Antigonon leptopus Hook. & Arn.	Mexican creeper	X
Sterculiaceae		
Waltheria indica L.	'uhaloa	I?
Verbenaceae		
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oī	X

Pueo Surveys for the West Oʻahu Solar Plus Storage Project

To:	AES Distributed Energy
From:	Tetra Tech, Inc.
Date:	January 2020
Subject:	West Oʻahu Solar Plus Storage Project Pueo Surveys

Introduction

AES Distributed Energy, Inc. (AES) is proposing the West Oʻahu Solar Plus Storage Project (Project), a 12.5-megawatt ground-mounted solar photovoltaic (PV) and battery energy storage system (BESS) facility located approximately 3 miles northeast of Kapolei on the island of Oʻahu. The Project area encompasses approximately 95.5 acres in an area commonly referred to as the University of Hawaiʻi (UH) West Oʻahu Mauka Lands property and is within tax map key 9-2-002:007.

As part of the due diligence efforts for the Project, Tetra Tech conducted general biological surveys within the Project area in January and February 2019. The results of the surveys indicate that the Project area has been heavily modified over time by agricultural practices and the introduction of invasive species. The vegetation in the Project area is primarily Koa Haole Scrub. This vegetation type is characterized by open to dense stands of non-native koa haole trees (*Leucaena leucocephala*), ranging from 4 to 8 feet in height, with guinea grass (*Urochloa maxima*) as the most abundant plant in the understory.

As part of the general biological surveys, Tetra Tech conducted a survey specifically to detect the pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*) in the morning on February 5, 2019. The Hawaiian short-eared owl or pueo is listed as endangered by the State of Hawaiʻi only on the island of Oʻahu; it is not a federally listed species. Although not detected within the Project area during the biological surveys, this species been previously reported from the surrounding areas; the nearest known observation to the Project area is near the southern edge of the UH West Oahu campus (Price and Cotín, 2018, Pueo Project, 2019). Based on the habitat that is present, Tetra Tech's biologists determined it was possible that pueo may fly through or nest within the Project Area. Because pueo is listed by the State and has the potential to be impacted by construction activities, Tetra Tech recommended at least two (preferably three) additional pueo surveys be conducted in the Project area according to the Pueo Project survey protocol (Price and Cotín 2018). This technical memorandum documents the methodology and results of the additional pueo survey efforts in the Project area.

Methodology

Tetra Tech conducted pueo surveys on the evenings of September 26, November 14, and December 19, 2019, following the protocol outlined for the Pueo Project (Price and Cotín 2018). Because most pueo detections have occurred in the evenings (M. Price/ UH Mānoa, pers. comm., September 2019; Cotin et.

al. 2018), twilight pueo surveys were conducted. Surveys began 60 – 75 minutes before sunset and finished at civil twilight. Two survey points were established in the Project area to ensure that the entire Project area was visible (see Attachments 1 and 2). A biologist was present at each survey point for the duration of each of the three surveys to increase detectability. The ground and sky within the viewshed of each survey point were scanned with binoculars and the naked eye throughout the survey period.

The following general information was collected during each survey: date, observer, GPS coordinates, start time, and end time. Environmental information was recorded, including: cloud cover, wind speed, temperature, precipitation, extent of surveyed area (maximum length of viewshed surveyed in cardinal directions), and habitat classification. For any pueo observations, the following information would be collected: detection start time, detection end time, detection type, owl behavior classification, owl vocalization description, distance from observer, direction from observer, habitat where owl observed, and courtship behavior description. All surveys were conducted in good weather with light winds, few clouds, and no precipitation.

Results and Recommendations

No pueo were documented during the three surveys within the Project area (see Attachment 3). Although pueo were not observed or heard during the surveys, this species has been reported to use the surrounding areas (Price and Cotín 2018, Pueo Project 2019). Given the habitat present, pueo could potentially forage or nest in and around the Project area. However, based on consultation with DOFAW biologists and Pueo Project researchers regarding the survey results and previous pueo detections in the vicinity, it is understood that pueo are not likely to use the Project area on a regular basis as they were not detected during any of the pueo-specific surveys (A. Siddiqui/ DOFAW, pers. comm., October 2019).

Based on the survey results, Tetra Tech recommends the following avoidance and minimization measures, which are consistent with the protocols established by UH for their West Oʻahu property as well as input from DOFAW:

- A wildlife education and observation program should be implemented for all construction and regular on-site staff. Staff should be trained to identify pueo (and other listed species) and to take appropriate steps if a pueo is detected in the Project area.
- Prior to clearing vegetation within the Project area, pre-construction pueo surveys should be conducted by a qualified biologist (following the Pueo Project survey protocol) to confirm no pueo are nesting in the area. Nests are constructed by females and are comprised of simple scrapes in the ground lined with grasses and feather down (Holt 1993).
- If a ground nest or an owl nesting on the ground is observed at any time (prior to construction, during construction, or during operation), an approximately 50-foot buffer should be established and marked in the field. In accordance with existing protocol for UH West Oʻahu, a designated UH West Oʻahu representative should be contacted immediately, and that representative should provide notification to DOFAW. No vegetation clearing should occur until pueo nesting ceases.
- If a live pueo is observed on-site by Project staff all activities within 50 feet of the bird should cease, and the bird should not be approached.

Literature Cited

Cotín, J., K.E. Davis, A. Siddiqi, and M. Price. 2018. The Pueo Project Annual Report 2018. Breeding phenology and daily activity of the Hawaiian Short-eared Owl (*Asio flammeus sandwichensis*) on O'ahu.

Holt, D.W. and S.M. Leasure. 1993. Short-eared owl (*Asio flammeus*). In The Birds of North America, No. 62 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Price, M. and J. Cotín. 2018. The Pueo Project. Final Report. April 2017-March 2018. Population size, distribution and habitat use of the Hawaiian Short-eared Owl (*Asio flammeus sandwichensis*) on O'ahu.

Pueo Project. 2019. Pueo Distribution and Sightings Map. https://www.pueoproject.com/distribution-map

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Attachment 1. Location of Pueo Survey Points within Project Area

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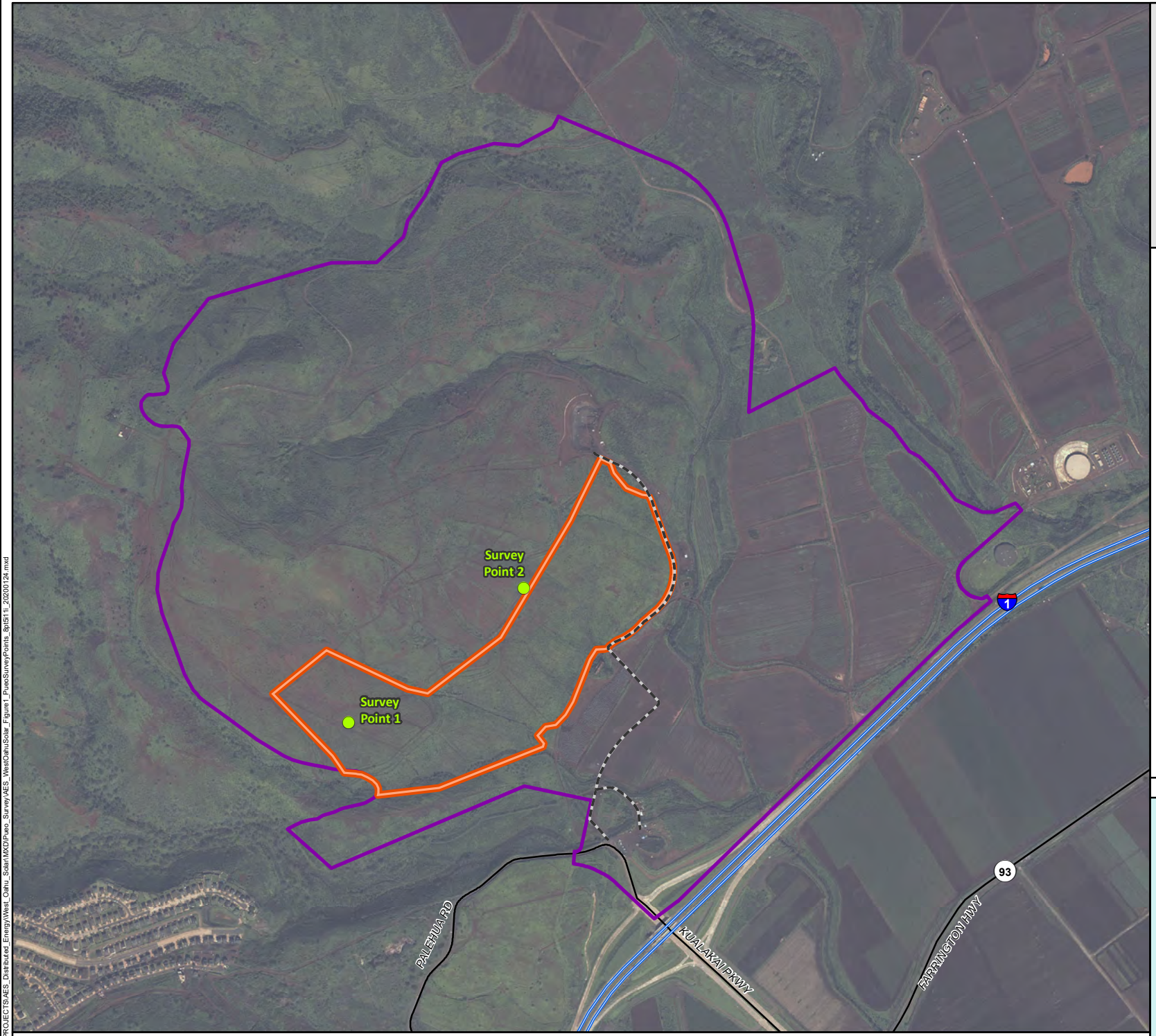


Figure 1

West Oahu Solar Plus Storage Project

AES Distributed Energy

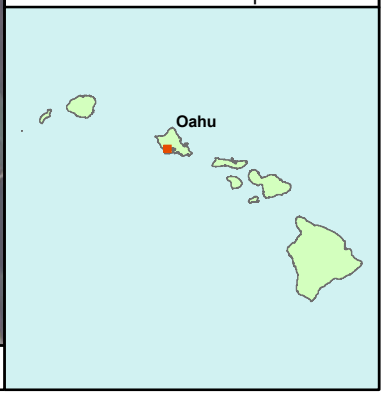
Pueo Survey Points

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- Interstate Highway
- Roadway
- Survey Point

TETRA TECH

Reference Map



1:15,000 WGS 1984 UTM Zone 4N

0 0.25 0.5 1 Miles

NOT FOR CONSTRUCTION

P:\GIS_PROJECTS\AES_Distributed_Energy\West_Oahu_Solar\MXD\Pueo_Survey\AES_WestOahuSolar_Figure1_PueoSurveyPoints_8p15i11_20200124.mxd

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Attachment 2. Photographs from the Pueo Survey Points

Photo 1. View from pueo survey point 1 looking to the southeast over the Project area. Notice the steam plant in the middle left of the photo for reference between photos of survey points 1 and 2.

Photo 2. View from pueo survey point 2 looking to the southeast over the Project area.

Attachment 3. Pueo Survey Datasheets

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Pueo Project Survey Datasheet 2017

Site: UH West Solar GPS point: 286 (Western Corner) GPS coordinates: (D.dddddd, -D.dddddd) 576517 2363571

Date: 9/26/19 Visit # (1, 2 or 3): 1 Survey Start Time: 5:35 Survey Stop Time: 6:50 Observers: JD

Temperature: 80 Cloud cover (Clear, PC, MC, Cloudy): PC Rain: None Wind (0-7): 0-1

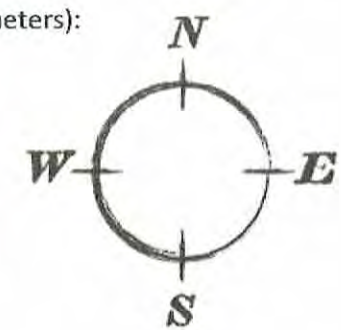
Detection start time	Detection end time	Number	Initial distance	Initial direction	Sounds	Behavior	Habitat
—	—	—	—	—	—	—	—
No	detections						

% Habitat w/in 400 m or surveyed area (must be 100%):

Developed	Wetland	Agricultural Crops	Agricultural Dirt	Grasslshort Grazed	Grasslshort Golf	Grasslshort Mowed
Grassland Fallow	**Grasslands Tall >75cm**	**Shrublands**	**Non Native Forest**	**Native Forest**	**Other**	**Total**
100%						

Surveyed area (max visible meters):

N: 400 S: 800
NE: 1000+ SW: 800
E: 1000+ W: 1000+
SE: 1000+ NW 400



Observations: Lots of cattle and egrets onsite

Pueo Project Survey Datasheet 2017

Site: UH West Solar GPS point: survey point GPS coordinates: (D.dddddd, -D.dddddd) 0597019, 2363956 ±4m

Date: 9-26-19 Visit # (1, 2 or 3): ___ Survey Start Time: 5:15 pm Survey Stop Time: 6:50pm Observers: Philip Taylor

Temperature: 82°F Cloud cover (Clear, PC, MC, Cloudy): PC Rain: 0 Wind (0-7): 1

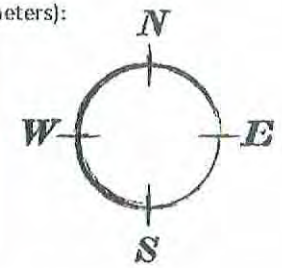
Detection start time	Detection end time	Number	Initial distance	Initial direction	Sounds	Behavior	Habitat

% Habitat w/in 400 m or surveyed area (must be 100%):

Developed	Wetland	Agricultural Crops	Agricultural Dirt	Grass|short Grazed	Grass|short Golf	Grass|short Mowed
Grassland Fallow	Grasslands Tall >75cm	Shrublands	Non Native Forest	Native Forest	Other	Total
100%						

Surveyed area (max visible meters):

N: 250 S: 1000
NE: 600 SW: 500
E: 1000 W: 150
SE: 1000 NW 200



Observations: other species observed: Cattle egret, zebra dove, red-vented bulbul, red avadavat

Limited visibility after 6:40pm.

Pueo Project Survey Datasheet 2017

Western Point ~~596557 2363566 (299)~~ ~~[illegible]~~ ?

Site: UH West Solar GPS point: (286) GPS coordinates: (D.dddddd, -D.dddddd) 596517 2363571 (286)

Date: 11/14/19 Visit # (1, 2 or 3): 2 Survey Start Time: 4:30 pm Survey Stop Time: 6:17 Observers: JD

Temperature: 78 Cloud cover (Clear, PC, MC, Cloudy): PC Rain: None Wind (0-7): 2 From South

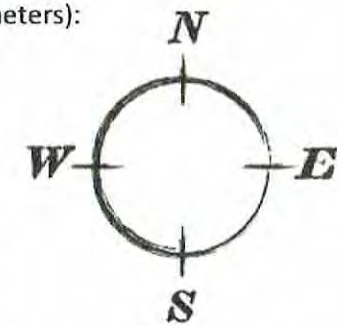
Detection start time	Detection end time	Number	Initial distance	Initial direction	Sounds	Behavior	Habitat
—	—	—	—	—	—	—	—

% Habitat w/in 400 m or surveyed area (must be 100%):

Developed	Wetland	Agricultural Crops	Agricultural Dirt	Grasslshort Grazed	Grasslshort Golf	Grasslshort Mowed
Grassland Fallow	Grasslands Tall >75cm	Shrublands	Non Native Forest	Native Forest	Other	Total
100%						

Surveyed area (max visible meters):

N: 400 S: 800
NE: 1000+ SW: 800
E: 1000+ W: 1000+
SE: 1000+ NW 400



Observations: Good conditions, no detections

Pueo Project Survey Datasheet 2017

Site: UH West GPS point: _____ GPS coordinates: (D.dddddd, -D.dddddd) 0597016, 2363956 ±3m

Date: 11-14-19 Visit # (1, 2 or 3): 2 Survey Start Time: 4:45p Survey Stop Time: 6:20p Observers: Philip Taylor

Temperature: 75°F Cloud cover (Clear, PC, MC, Cloudy): PC Rain: 0 Wind (0-7): 3

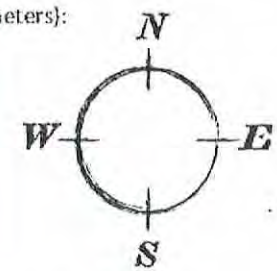
Detection start time	Detection end time	Number	Initial distance	Initial direction	Sounds	Behavior	Habitat

% Habitat w/in 400 m or surveyed area (must be 100%):

Developed	Wetland	Agricultural Crops	Agricultural Dirt	Grasslshort Grazed	Grasslshort Golf	Grasslshort Mowed
Grassland Fallow	Grasslands Tall >75cm	Shrublands	Non Native Forest	Native Forest	Other	Total

Surveyed area (max visible meters):

N: 300 S: 500+
NE: 500+ SW: 100
E: 500+ W: 200
SE: 500+ NW 250



Observations: No pueo observed. Barn owl heard inside structure at bottom of survey area.

Pueo Project Survey Datasheet 2017

Site: VH West Solar GPS point: (286) Western Corner GPS coordinates: (D.dddddd, -D.dddddd) 596517 2363571

Date: 12/19/19 Visit # (1, 2 or 3): 3 Survey Start Time: 4:35 PM Survey Stop Time: 6:21 PM Observers: JD

Temperature: 86 Cloud cover (Clear, PC, MC, Cloudy): PC Rain: None Wind (0-7): 2-3

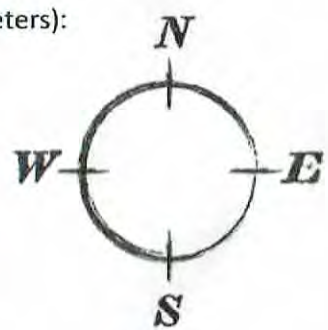
Detection start time	Detection end time	Number	Initial distance	Initial direction	Sounds	Behavior	Habitat
—	—	—	—	—	—	—	—

% Habitat w/in 400 m or surveyed area (must be 100%):

Developed	Wetland	Agricultural Crops	Agricultural Dirt	Grasslshort Grazed	Grasslshort Golf	Grasslshort Mowed
Grassland Fallow	Grasslands Tall >75cm	Shrublands	Non Native Forest	Native Forest	Other	Total

Surveyed area (max visible meters):

N: 400 S: 500+
NE: 500+ SW: 500+
E: 500+ W: 500+
SE: 500+ NW 400



Observations: A little breezy but overall good survey conditions

Pueo Project Survey Datasheet 2017

Site : UH West GPS point: East GPS coordinates: (D.dddddd, -D.dddddd) 0597019 , 2363756 ± 4m

Date: 12/19/19 Visit # (1, 2 or 3): 3 Survey Start Time: 4:30p Survey Stop Time: 6:20p Observers: Phil Taylor

Temperature: 78°F Cloud cover (Clear, PC, MC, Cloudy): _____ Rain: 0 Wind (0-7): 4

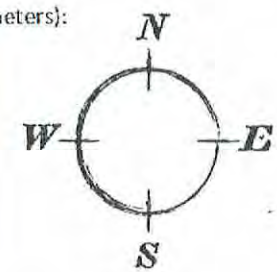
Detection start time	Detection end time	Number	Initial distance	Initial direction	Sounds	Behavior	Habitat

% Habitat w/in 400 m or surveyed area (must be 100%):

Developed	Wetland	Agricultural Crops	Agricultural Dirt	Grass\short Grazed	Grass\short Golf	Grass\short Mowed
Grassland Fallow	Grasslands Tall >75cm	Shrublands	Non Native Forest	Native Forest	Other	Total
100%						

Surveyed area (max visible meters):

N: 200 S: 500
NE: 500+ SW: 100
E: 500+ W: 100
SE: 500+ NW 100



Observations: No pueo observed.

Appendix E
U.S. Fish and Wildlife Service and State of Hawai‘i Department of Land and Natural Resources Division of Forestry and Wildlife Consultation Letters

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawai‘i 96850

In Reply Refer To:
01EPIF00-2019-TA-460

September 3, 2019

Mr. Nick Molinari
AES Distributed Energy
282 Century Place
Louisville, Colorado 80027

Subject: Response to your Request for Technical Assistance Regarding the Proposed West O‘ahu Solar Plus Storage Project

Dear Mr. Molinari,

Thank you for your recent correspondence requesting technical assistance on species biology, habitat, or life requisite requirements. The Pacific Islands Fish and Wildlife Office (PIFWO) of the U.S. Fish and Wildlife Service (Service) appreciates your efforts to avoid or minimize effects to protected species associated with your proposed actions. We provide the following information for your consideration under the authorities of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 *et seq*.), as amended.

Due to significant workload constraints, PIFWO is currently unable to specifically address your information request. The table below lists the protected species most likely to be encountered by projects implemented within the Hawaiian Islands. Based on your project location and description, we have noted the species most likely to occur within the vicinity of the project area, in the ‘**Occurs In or Near Project Area’** column. Please note this list is not comprehensive and should only be used for general guidance. We have added to the PIFWO website, located at https://www.fws.gov/pacificislands/promo.cfm?id=177175840 recommended conservation measures intended to avoid or minimize adverse effects to these federally protected species and best management practices to minimize and avoid sedimentation and erosion impacts to water quality.

If you are representing a federal action agency, please use the official species list on our web-site for your section 7 consultation. You can find out if your project occurs in or near designated critical habitat here: https://ecos.fws.gov/ipac/.

Under section 7 of the ESA, it is the Federal agency’s (or their non-Federal designee) responsibility to make the determination of whether or not the proposed project “may affect” federally listed species or designated critical habitat. A “may affect, not likely to adversely affect” determination is appropriate when effects to federally listed species are expected to be discountable (*i.e*., unlikely to occur), insignificant (minimal in size), or completely beneficial.

This conclusion requires written concurrence from the Service. If a “may affect, likely to adversely affect” determination is made, then the Federal agency must initiate formal consultation with the Service. Projects that are determined to have “no effect” on federally listed species and/or critical habitat do not require additional coordination or consultation.

Implementing the avoidance, minimization, or conservation measures for the species that may occur in your project area will normally enable you to make a “may affect, not likely to adversely affect” determination for your project. If it is determined that the proposed project may affect federally listed species, we recommend you contact our office early in the planning process so that we may assist you with the ESA compliance. If the proposed project is funded, authorized, or permitted by a Federal agency, then that agency should consult with us pursuant to section 7(a)(2) of the ESA. If no Federal agency is involved with the proposed project, the applicant should apply for an incidental take permit under section 10(a)(1)(B) of the ESA. A section 10 permit application must include a habitat conservation plan that identifies the effects of the action on listed species and their habitats, and defines measures to minimize and mitigate those adverse effects.

We appreciate your efforts to conserve endangered species. We regret that we cannot provide you with more specific protected species information for your project site. If you have questions that are not answered by the information on our website, you can contact PIFWO at (808) 792-9400 and ask to speak to the lead biologist for the island where your project is located.

Sincerely,

Island Team Manager
Pacific Islands Fish and Wildlife Office

cc: Ms. Lisa Kettley and Ms. Tiffany Agostini, Tetra Tech, Inc.

The table below lists the protected species most likely to be encountered by projects implemented within the Hawaiian Islands. For your guidance, we've marked species that may occur in the vicinity of your project, this list is not comprehensive and should only be used for general guidance.

Scientific Name	**Common Name / Hawaiian Name**	**Federal Status**	**May Occur In Project Area**
Mammals			
Lasiurus cinereus semotus	Hawaiian hoary bat/ ‘ōpe‘ape‘a	E	☒
Reptiles			
Chelonia mydas	Green sea turtle/honu - Central North Pacific DPS	T	☐
Erectmochelys imbricata	Hawksbill sea turtle/ Honu ‘ea	E	☐
Birds			
Anas wyvilliana	Hawaiian duck/ koloa	E	☐
Branta sandvicensis	Hawaiian goose/ nēnē	E	☐
Fulica alai	Hawaiian coot/ ‘alae kea	E	☐
Gallinula galeata sandvicensis	Hawaiian gallinule/ ‘alae ‘ula	E	☐
Himantopus mexicanus knudseni	Hawaiian stilt/ Ae‘o	E	☐
Oceanodroma castro	Band-rumped storm-petrel/ ‘akē‘akē	E	☒
Pterodroma sandwichensis	Hawaiian petrel/ ‘ua‘u	E	☒
Puffinus auricularis newelli	Newell's shearwater/ ‘a‘o	T	☒
Ardenna pacificus	Wedge-tailed Shearwater/ ‘ua‘u kani	MBTA	☐
Gygis alba	White Tern/ manu-o-kū	MBTA	☐
Buteo solitarius	Hawaiian hawk/ ‘io	E	☐
Insects			
Manduca blackburni	Blackburn's sphinx moth	E	☐
Megalagrion pacificum	Pacific Hawaiian Damselfly	E	☐
M. xanthomelas	Orangeblack Hawaiian Damselfly	E	☐
M. nigrohamatum nigrolineatum	Blackline Hawaiian Damselfly	E	☐

Plants				
Scientific Name	**Common Name or Hawaiian Name**	**Federal Status**	**Locations**	**May Occur In Project Area**
Abutilon menziesii	Koʻoloaʻula	E	O, L, M, H	☐
Achyranthes splendens var. *rotundata*	ʻEwa hinahina	E	O	☐
Bonamia menziesii	No common name	E	K, O, L, M, H	☐
Canavalia pubescens	ʻĀwikiwiki	E	Ni, K, L, M	☐
Colubrina oppositifolia	Kauila	E	O, M, H	☐
Cyperus trachysanthos	Puʻukaʻa	E	K, O	☐
Gouania hillebrandii	No common name	E	Mo, M	☐
Hibiscus brackenridgei	Maʻo hau hele	E	O, Mo, L, M, H	☐
Ischaemum byrone	Hilo ischaemum	E	K, O, Mo, M, H	☐
Isodendrion pyrifolium	Wahine noho kula	E	O, H	☐
Marsilea villosa	ʻIhiʻihi	E	Ni, O, Mo	☐
Mezoneuron kavaiense	Uhiuhi	E	O, H	☐
Nothocestrum breviflorum	ʻAiea	E	H	☐
Panicum fauriei var. *carteri*	Carter's panicgrass	E	Molokini Islet (O), Mo	☐
Panicum niihauense	Lauʻehu	E	K	☐
Peucedanum sandwicense	Makou	E	K, O, Mo, M	☐
Pleomele (Chrysodracon) hawaiiensis	Halapepe	E	H	☐
Portulaca sclerocarpa	ʻIhi	E	L, H	☐
Portulaca villosa	ʻIhi	E	Le, Ka, Ni, O, Mo, M, L, H, Nihoa	☐
Pritchardia affinis (maideniana)	Loulu	E	H	☐
Pseudognaphalium sandwicensium var. *molokaiense*	ʻEnaʻena	E	Mo, M	☐
Scaevola coriacea	Dwarf naupaka	E	Mo, M	☐
Schenkia (*Centaurium*) *sebaeoides*	ʻĀwiwi	E	K, O, Mo, L, M	☐
Sesbania tomentosa	ʻŌhai	E	Ni, Ka, K, O, Mo, M, L, H, Necker, Nihoa	☐
Tetramolopium rockii	No common name	T	Mo	☐
Vigna o-wahuensis	No common name	E	Mo, M, L, H, Ka	☐

Location key: O=Oʻahu, K=Kauaʻi, M=Maui, H=Hawaiʻi Island, L=Lānaʻi, Mo=Molokaʻi, Ka=Kahoʻolawe, Ni=Niʻihau, Le=Lehua

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
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET, ROOM 325
HONOLULU, HAWAII 96813

JUN 28 2019

Mr. Nick Molinari
AES Distributed Energy, Inc.
4875 Pearl East Circle, Suite 200
Boulder, CO 80301

Log No. 19803

Dear Mr. Molinari:

The Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) has received your inquiry regarding Hawaii Revised Statutes Chapter 195D consultation for the proposed AES West O'ahu Solar Plus Storage Project near Kapolei in the 'Ewa District on the island of O'ahu, Hawai'i, TMK: (1) 9-2-002:007. Proposed work would include construction and operation of a 12.5 megawatt solar photovoltaic system on an approximately 80 acre parcel of land commonly known as the University of Hawai'i West O'ahu Mauka property.

We appreciate the inclusion of mitigation measures in the submitted Biological Report intended to avoid construction and operational impacts to State listed species. DOFAW provides the following additional comments on the potential of the proposed work to affect listed species in the vicinity of the project area in support of your request for information.

The State endangered Hawaiian Short-eared Owl or Pueo (*Asio flammeus sandwichensis*) is known to occur in the project site vicinity. Pueo are a crepuscular species, most active during dawn and dusk twilights. DOFAW recommends twilight pre-construction surveys by a qualified biologist prior to clearing vegetation. If Pueo nests are present, a buffer zone should be established in which no clearing occurs until nesting ceases, and DOFAW staff should be notified.

We note that artificial lighting can adversely impact seabirds that may pass through the area at night by causing disorientation. This disorientation can result in collision with manmade artifacts or grounding of birds. For nighttime lighting that might be required, DOFAW recommends that all lights be fully shielded and directed to avoid reflecting off the panels to minimize impacts. Solar panels may also reflect moonlight during moonlit nights that may attract and disorient seabirds; monitoring during moon phases should be considered to assess if impacts are occurring. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season from September 15 through December 15. This is the period when young seabirds take their maiden voyage to the open sea.

Studies have shown that solar power facilities on the mainland have been linked with avian mortality of a variety of bird species including waterbirds and raptors. As aforementioned, the project area is on open habitat where the Pueo may transit or reside near. In addition to pre-

construction surveys, you should consider implementing avian mortality avoidance measures during design and conducting surveys and monitoring during operation to assess the impacts of the project on listed species.

We appreciate your efforts to work with our office for the conservation of our native species. Should the scope of the project change significantly, or should it become apparent that threatened or endangered species may be impacted, please contact our staff as soon as possible. If you have any questions, please contact Jim Cogswell, Wildlife Program Manager at (808) 587-4187 or James.M.Cogswell@hawaii.gov.

Sincerely,

DAVID G. SMITH
Administrator

Appendix F
Archaeological Inventory Survey Report

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Draft
Archaeological Inventory Survey Report for the AES West O‘ahu Solar Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu TMK: [1] 9-2-002:007 (por.)

Prepared for
Tetra Tech, Inc.
on behalf of
AES Distributed Energy

Prepared by
Alison Welser, M.A.,
Scott Belluomini, B.A.,
Tyler Turran, B.A.,
David W. Shideler, M.A.,
and
Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai‘i, Inc.
Kailua, Hawai‘i
(Job Code: HONOULIULI 171)

February 2020

O‘ahu Office
P.O. Box 1114
Kailua, Hawai‘i 96734
Ph.: (808) 262-9972
Fax: (808) 262-4950

www.culturalsurveys.com

Maui Office
1860 Main St.
Wailuku, Hawai‘i 96793
Ph.: (808) 242-9882
Fax: (808) 244-1994

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Management Summary

Reference	Archaeological Inventory Survey Report for the AES West O‘ahu Solar Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu, TMK: [1] 9-2-002:007 (por.) (Welser et al. 2020)
Date	February 2020
Project Number(s)	Cultural Surveys Hawai‘i, Inc. (CSH) Job Code: HONOULIULI 171
Investigation Permit Number	CSH completed the archaeological inventory survey (AIS) fieldwork under archaeological fieldwork permit number 19-07, issued by the Hawai‘i State Historic Preservation Division (SHPD) per Hawai‘i Administrative Rules (HAR) §13-13-282.
Agencies	SHPD; Department of Planning and Permitting (DPP); Land Use Commission (LUC)
Land Jurisdiction	State of Hawai‘i
Project Proponent	AES Distributed Energy
Project Funding	AES Distributed Energy
Project Location	The project area is on undeveloped lands located in the southeastern foothills of the Wai‘anae Range, northeast of Pu‘u Makakilo and the Makakilo subdivision and about 600 m northwest of the intersection of the H-1 freeway and the Kualaka‘i Parkway. The project area is depicted on a portion of the Ewa and Schofield Barracks 2013 U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle.
Project Description	The proposed AES West O‘ahu Solar project consists of construction and operation of an approximately 12.5 MW ground-mounted solar photovoltaic system, coupled with a 50 MWh battery energy storage system and related interconnection and ancillary facilities. Specifically, it includes the following major components: (1) solar photovoltaic system, (2) battery energy storage system, (3) substation and interconnection equipment, (4) a network of electrical wiring and collector lines, and (5) access roads and fencing. In addition to these facilities, the Project area would be made available for compatible agricultural activities. The solar photovoltaic system would consist of a series of solar modules mounted on a fixed-tilt racking system. The racking system would hold the modules at a fixed angle of 15 degrees facing toward the south and would be supported by steel posts, spaced approximately every 19 feet (5.8m) (varies). The posts would be installed using a hydraulic pile driver and/or augur for pre-drilling, with approximate depths of 6 feet (1.8m) (depending on soil conditions). In the event it is determined that the desired depth cannot be achieved, foundations would be pre-drilled and supported with concrete. Once mounted on the racking system, the highest point of the modules is expected to extend

	approximately 8.5 feet (2.6m) above the ground surface, with an average of approximately 3 feet (0.9m) of ground clearance below the modules. Electrical equipment (including inverters and transformers) and the battery units (housed in containers) would be installed on concrete equipment pads distributed throughout the Project area. A total of five concrete pads would be installed; each approximately 2,800 square feet (260.1 m^2) in area. The Project would also include a substation and associated electrical equipment to facilitate interconnection with the Hawaiian Electric grid. These facilities would be constructed immediately adjacent to the existing Hawaiian Electric ‘Ewa Nui #42 46kV sub-transmission line and would occupy a total of approximately 7,800 square feet (724.6m^2). A short overhead electrical connection (approximately 300 feet or 91.4m in length), supported by approximately three 60-foot or 18.3m tall wood poles, would also be installed. Electrical wiring and collector lines connecting the solar modules with the equipment pads and the substation would be installed underground; approximately 14,000 linear feet (4.267 km) of trenching would be required, with widths ranging between 5-10 feet (1.5m to 3.0m) and depths up to 4 feet (1.2m). Perimeter fencing and new access roads would also be installed within the Project area. Equipment to support compatible agricultural activities would include four beekeeping stations (each approximately 40 square feet or 3.7m^2) and two cattle pens (each with a small concrete slab for a water trough). In addition to construction of the facilities described above, grading would also occur in localized areas as needed to smooth the ground surface and for other civil engineering purposes (e.g., stormwater retention and management).
Project Acreage	The project area is approximately 101.62 acres (41.12 hectares).
Historic Preservation Regulatory Context	This AIS investigation fulfills the requirements of HAR §13-276. The AIS was conducted to identify, document, and assess the significance of historic properties within the project area, assess the potential for the project to adversely affect significant historic properties, and to provide agreed upon mitigation commitments to address any adverse impacts. This document is intended to support the proposed project’s historic preservation review under Hawai‘i Revised Statutes (HRS) §6E-42 and HAR §13-284, as well as the project’s environmental review under HRS §343. It is also intended to support any project-related historic preservation consultation with stakeholders such as state and county agencies and interested Native Hawaiian Organizations (NHOs) and community groups. The AIS investigation was designed in consultation with the SHPD. An *Archaeological Inventory Survey of the University of Hawai‘i West O‘ahu Campus, District of ‘Ewa, Island of O‘ahu, Hawai‘i (TMKs: 9-2-02:01, 03, and 05)* (Dega et al. 1998) that included the entirety of the

	present project area was previously accepted by SHPD on 3 February 1999 (LOG NO. 22959, DOC. NO. 9901EJ28; Appendix A). Due to the passage of time and given that the present project is different than that addressed by the 1998 report, it was agreed in consultation with Dr. Susan Lebo on 12 February 2019 that it would be appropriate to move forward with an AIS specific to this project.
Fieldwork Effort	CSH archaeologists Scott Belluomini, B.A., Alison Welser, M.A., Tyler Turran, B.A., Chris Konen, B.A., and David W. Shideler, M.A., conducted fieldwork between 4 and 6 February 2019 under the general supervision of Hallett H. Hammatt, Ph.D., Principal Investigator. This work required approximately 11 person-days to complete. Following the initial pedestrian inspection, the project area boundaries were altered slightly, extending to the north and the west, as well as south to encompass the existing access roads to be used for the project. Additional pedestrian inspection was conducted for these areas on 12 December 2019.
Historic Properties Identified and Historic Property Significance	The AIS further documented two previously identified historic properties within the project area: State Inventory of Historic Places (SIHP) # 50-80-08-5593 consists of an historic irrigation system and plantation infrastructure, including a mill building and pump station (“Pump Station 12”), bridges, troughs, transport ditches, culvert, pipes, culvert and sluice gate, and various other features related to water retention and movement. SIHP # 50-80-08-5593 was previously assessed by Dega et al. (1998) as significant under Hawai‘i State historic property significance Criteria a (be associated with events that have made an important contribution to the broad patterns of our history) and d (has yielded, or may be likely to yield, information important for research on prehistory or history). The current study assesses SIHP # 50-80-08-5593 as significant under only HAR §13-284-6 Criterion d. This historic property has yielded information on land utilization and agricultural history of the ‘Ewa Plain. However, it is not associated with specific impactful events in the area, unlike the Waiahole Ditch, which immeasurably altered the entirety of the landscape. The historic property retains integrity of location, design, materials, and workmanship. SIHP # 50-80-09-2268 consists of the Waiahole Ditch System, previously assessed by various studies. The historic property is assessed as significant pursuant to HAR §13-284-6 under Criteria a (be associated with events that have made an important contribution to the broad patterns of our history), c (embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value), and d (has yielded, or is likely to yield, information important for research on prehistory or history). The

	historic property has yielded information on agricultural history of the area and contributed greatly to the development and evolution of the ‘Ewa Plain throughout its history. The historic property retains integrity of location, design, materials, and workmanship. However, within the project area, the historic property only retains sufficient integrity of location, which is also diminished in portions of the project area due to erosion and neglect. While there are some portions that retain some integrity of design, materials, and workmanship within the project area, this integrity is diminished. The overall ditch is significant, however, the remnant portion of SIHP # 50-80-09-2268 within the project area does not retain sufficient integrity to be considered significant.
Effect Recommendations	The portion of SIHP # 50-80-09-2268 within the project area does not retain sufficient integrity to be considered significant, and therefore no further work is recommended for the historic property. Sufficient information regarding the location, extent, function, and age of the portion of SIHP # 50-80-08-5593 within the project area have been generated by the current archaeological inventory survey investigation to mitigate any adverse effect caused by the proposed project. Pursuant to HAR §13-284-7, the project-specific effect determination is “no historic properties affected.”
Mitigation Recommendations	The proposed project will have no effect on significant historic properties within the project area, therefore no mitigation is required.

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Section 1 Introduction

1.1 Project Background

At the request of Tetra Tech, Inc., and on behalf of AES Distributed Energy, Cultural Surveys Hawai‘i, Inc. (CSH) has prepared this archaeological inventory survey report (AISR) for the AES West O‘ahu Solar project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu, TMK: [1] 9-2-002:007 (por). The project area is 101.62 acres (41.12 hectares) of undeveloped lands in the southeastern foothills of the Wai‘anae Range, northeast of Pu‘u Makakilo and the Makakilo subdivision, and 600 m northwest of the intersection of the H-1 Freeway and the Kualaka‘i Parkway. The project area is depicted on a portion of the 2013 Ewa and Schofield Barracks U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle (Figure 1), a tax map plat (Figure 2), and a 2018 aerial photograph (Figure 3).

1.2 Proposed Project Description

The proposed AES West O‘ahu Solar project consists of construction and operation of an approximately 12.5 MW ground-mounted solar photovoltaic system, coupled with a 50 MWh battery energy storage system and related interconnection and ancillary facilities (see Overall Site Plan, Figure 4). Specifically, it includes the following major components: (1) solar photovoltaic system, (2) battery energy storage system, (3) substation and interconnection equipment, (4) a network of electrical wiring and collector lines, and (5) access roads and fencing. In addition to these facilities, the Project area would be made available for compatible agricultural activities.

The solar photovoltaic system would consist of a series of solar modules mounted on a fixed-tilt racking system. The racking system would hold the modules at a fixed angle of 15 degrees facing toward the south and would be supported by steel posts, spaced approximately every 19 feet (5.8m) (varies). The posts would be installed using a hydraulic pile driver and/or augur for pre-drilling, with approximate depths of 6 feet (1.8m) (depending on soil conditions). In the event it is determined that the desired depth cannot be achieved, foundations would be pre-drilled and supported with concrete. Once mounted on the racking system, the highest point of the modules is expected to extend approximately 8.5 feet (2.6m) above the ground surface, with an average of approximately 3 feet (0.9m) of ground clearance below the modules. Electrical equipment (including inverters and transformers) and the battery units (housed in containers) would be installed on concrete equipment pads distributed throughout the Project area. A total of five concrete pads would be installed; each approximately 2,800 square feet (260.1 m^2) in area. The Project would also include a substation and associated electrical equipment to facilitate interconnection with the Hawaiian Electric grid. These facilities would be constructed immediately adjacent to the existing Hawaiian Electric ‘Ewa Nui #42 46kV sub-transmission line and would occupy a total of approximately 7,800 square feet (724.6m^2). A short overhead electrical connection (approximately 300 feet or 91.4m in length), supported by approximately three 60-foot or 18.3m tall wood poles, would also be installed. Electrical wiring and collector lines connecting the solar modules with the equipment pads and the substation would be installed underground; approximately 14,000 linear feet (4.267 km) of trenching would be required, with widths ranging between 5-10 feet (1.5m to 3.0m) and depths up to 4 feet (1.2m). Perimeter fencing and new access roads would also be installed within the Project area. Equipment to support compatible agricultural

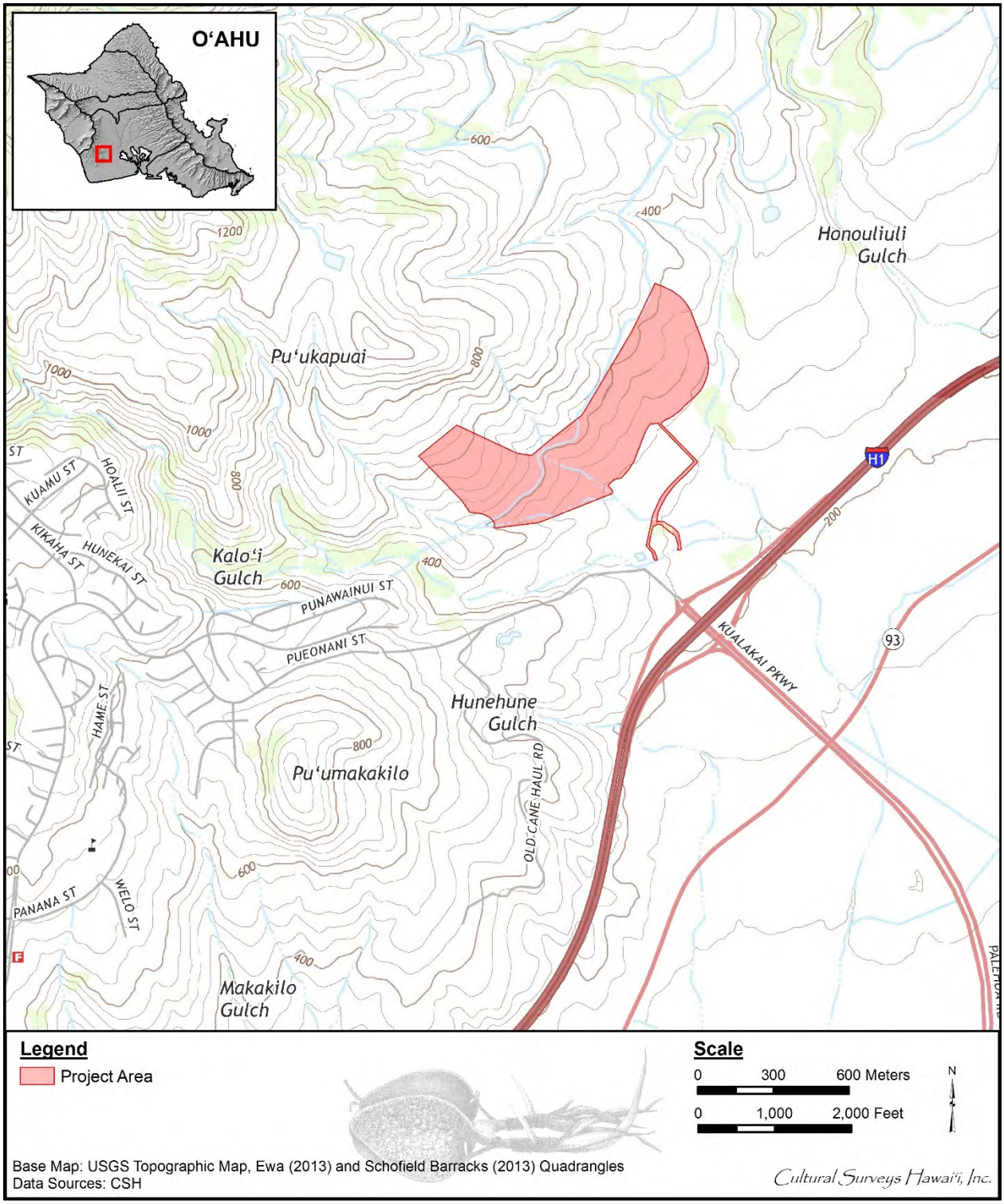

Figure 1. Portion of the 2013 Ewa and Schofield Barracks USGS 7.5-minute topographic quadrangles showing the location of the project area

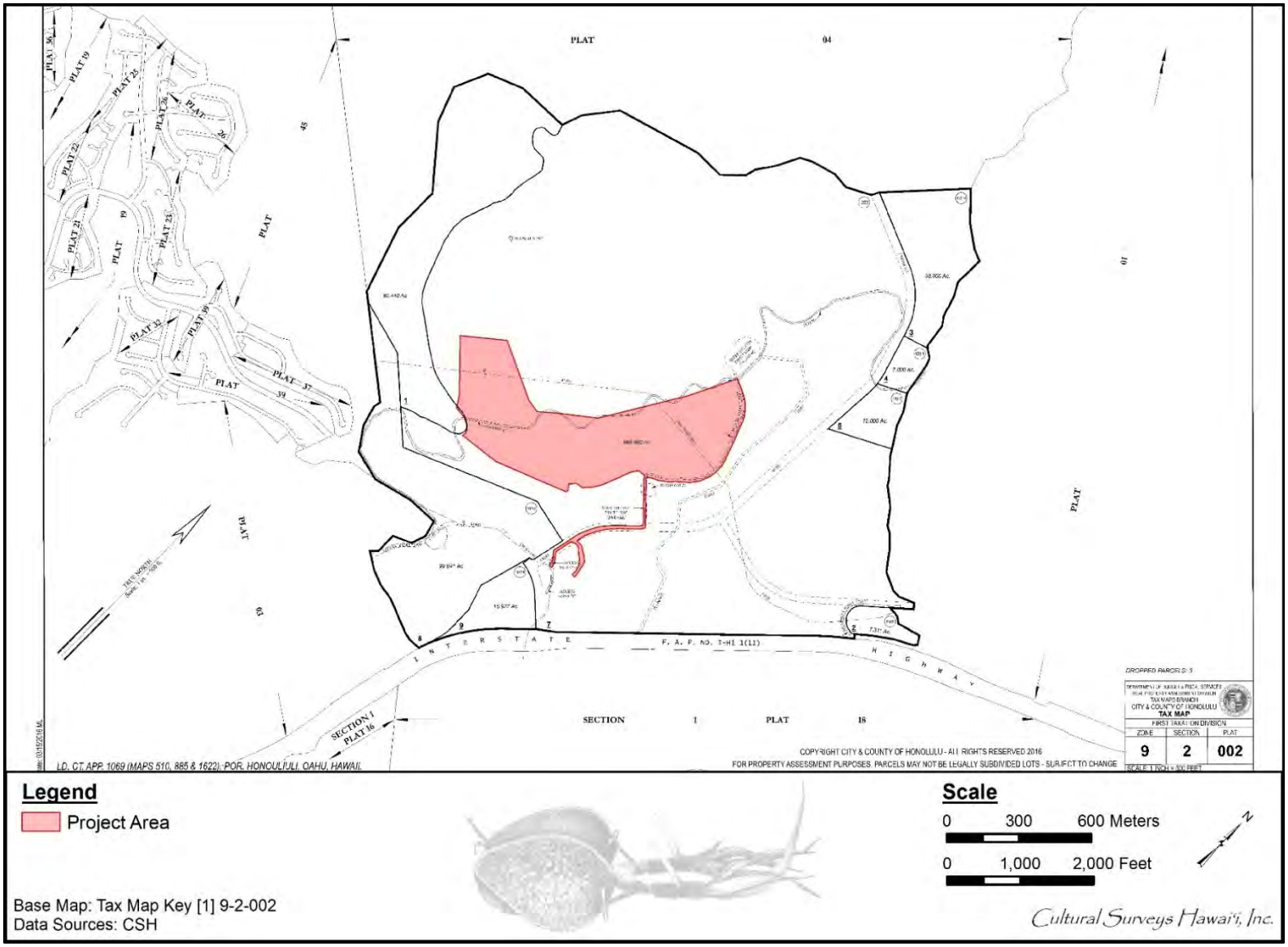

Figure 2. Tax Map Key (TMK) [1] 9-2-002 showing the location of the project area (Hawai‘i TMK Service 2014)

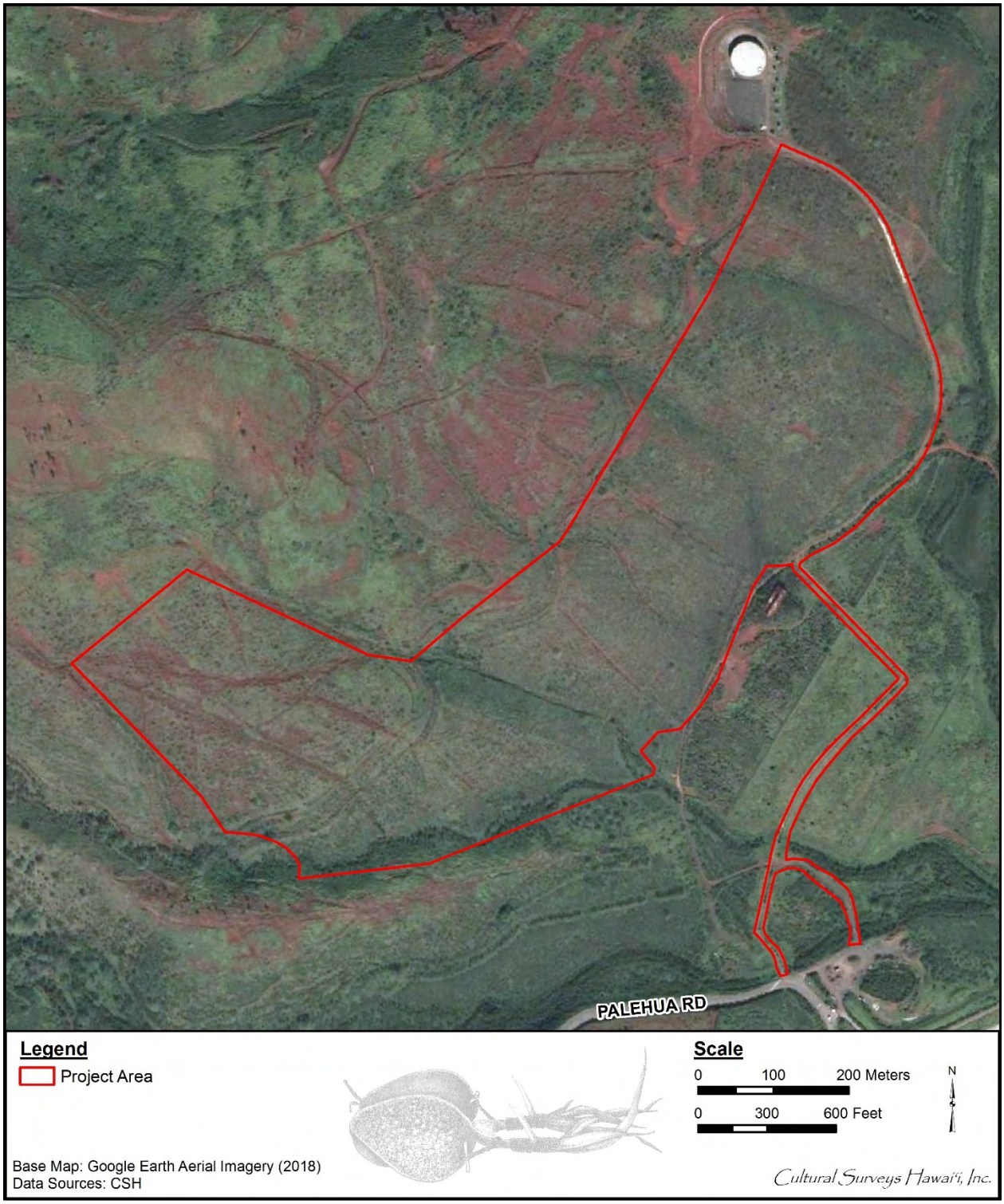

Figure 3. Aerial photograph of the project area (Google Earth 2018)

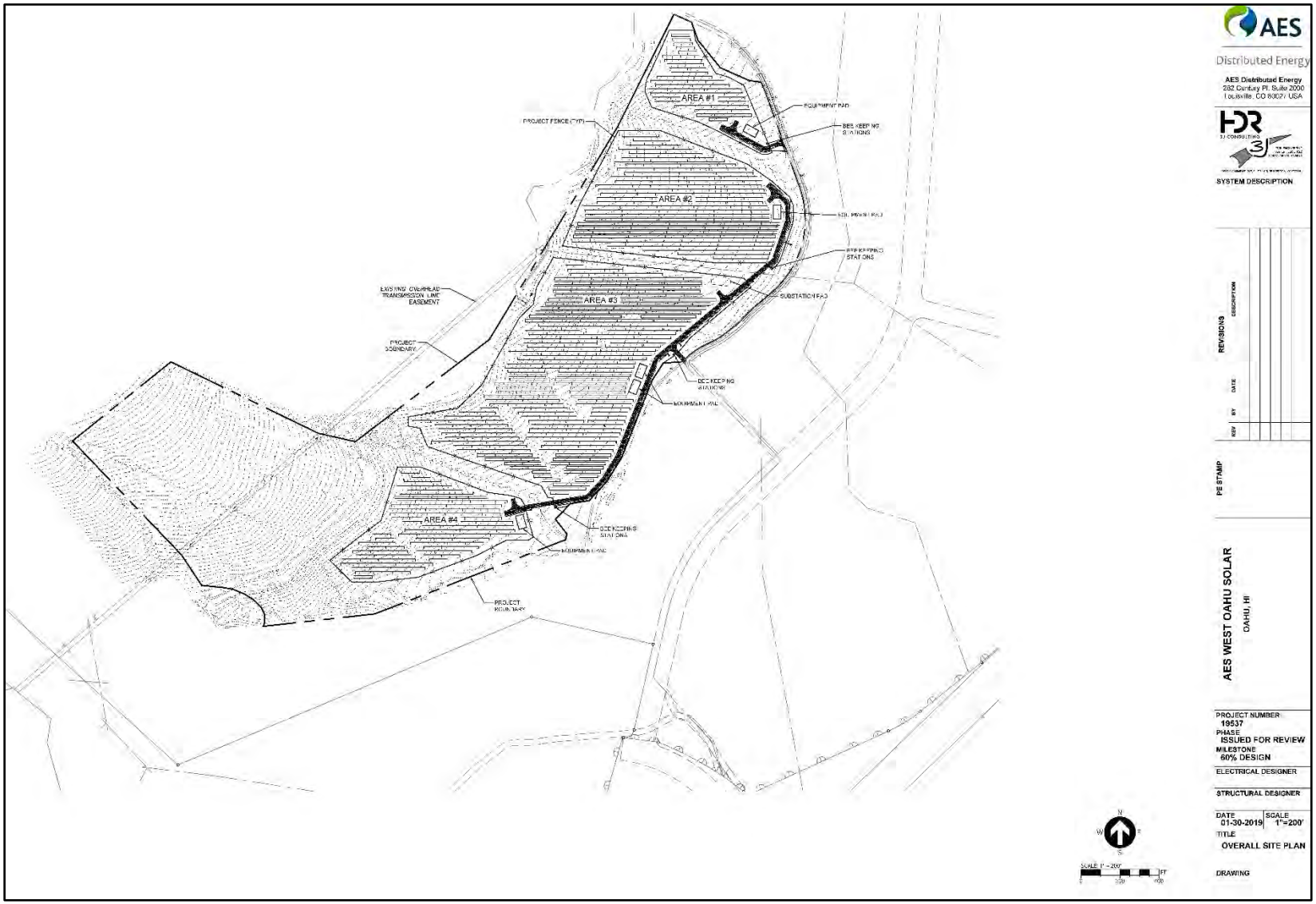

Figure 4 AES West Oahu Overall Site Plan (supplied by client, dated 1/30/2019)

activities would include four beekeeping stations (each approximately 40 square feet or 3.7m^2) and two cattle pens (each with a small concrete slab for a water trough). In addition to construction of the facilities described above, grading would also occur in localized areas as needed to smooth the ground surface and for other civil engineering purposes (e.g., stormwater retention and management).

1.1 Historic Preservation Regulatory Context and Document Purpose

The entire AES West O‘ahu Solar project area was previously addressed within an *Archaeological Inventory Survey of the University of Hawai‘i West O‘ahu Campus, District of ‘Ewa, Island of O‘ahu, Hawai‘i (TMK 9-2-02:01, 9-2-02:03, 9-2-02:05)* (Dega et al. 1998), which was accepted by the State Historic Preservation Division (SHPD) on 3 February 1999 (LOG NO. 22959, DOC. NO. 9901EJ28; Appendix A). Due to the passage of time and given that the present project is different than that addressed by the 1998 report, it was agreed in consultation with Dr. Susan Lebo on 12 February 2019 that it would be appropriate to move forward with an AIS specific to this project.

This AIS investigation fulfills the requirements of Hawai‘i Administrative Rules (HAR) §13-13-276. The AIS was conducted to identify, document, and assess the significance of historic properties within the project area, assess the potential for the project to adversely affect significant historic properties, and to provide agreed upon mitigation commitments to address any adverse impacts. This document is intended to support the proposed project’s historic preservation review under Hawai‘i Revised Statutes (HRS) §6E-42 and HAR §13-284, as well as the project’s environmental review under HRS §343. It is also intended to support any project-related historic preservation consultation with stakeholders such as state and county agencies and interested Native Hawaiian Organizations (NHOs) and community groups. The AIS investigation was designed in consultation with the SHPD.

1.2 Environmental Setting

1.2.1 Natural Environment

The project area is in the southeast Wai‘anae Range at an elevation of approximately 280 to 640 feet (ft) above mean sea level. The Wai‘anae Range comprises the eroded remnant of a great shield volcano, dating back in origin to approximately 2.2 to 3.8 million years ago, now in the form of a long narrow ridge shaped by erosion (Macdonald et al. 1983:420, 303). Pu‘u Kapua‘i is 0.5 km to the northwest and Pu‘u Makakilo is 1.2 km to the southwest. These are understood as “very late cones [of the Wai‘anae volcano] […] composed of a varied mixture of cinder, spatter and lava flows” (Macdonald et al. 1983:429).

Topography of the area is moderately sloping. In terms of hydrology, the area is drained by two deeply dissected gulches, Kalo‘i Gulch 300 m to the southwest and Honouliuli Gulch 700 m to the northeast. These gulches at a comparable elevation are believed to rarely run with water. Historic maps indicate a spring located approximately 2.2 km to the north. Such infrequent springs may have been key to the early human activity on the southeast Wai‘anae slope. The project area is relatively dry with a mean annual rainfall at the neighboring Station Field 105 of 703 mm or 27.7 inches (Giambelluca et al. 2013). This rainfall would be marginal for non-irrigated agriculture. Average annual temperatures range from 38° to 75° Fahrenheit (Giambelluca et al. 2014).

According to the U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) database (2001) and soil survey data gathered by Foote et al. (1972), the project area's soils consist of Kawaihapai clay loam (KIB), 2 to 6% slopes (KIaB), Mahana silt clay loam, 6 to 12% slopes, eroded (McC2), Mahana silt clay loam, 12 to 20% slopes, eroded (McD2), Mahana silt clay loam, 20 to 35% slopes, eroded (McE2), Molokai silty clay loam, 7 to 15% slopes (MUC) and Molokai silty clay loam, 15 to 25% slopes (MUD) soils (Figure 5).

Kawaihapai series soils are described as follows:

> This series consists of well-drained soils in drainageways and on alluvial fans on the coastal plains on the islands of Oahu and Molokai. These soils formed in alluvium derived from basic igneous rock in humid uplands. They are nearly level to moderately sloping. Elevations range from nearly sea level to 300 feet. The annual rainfall amounts to 30 to 50 inches. […] These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of kiawe, koa haole, lantana, and bermudagrass. [Foote et al. 1972:63–64]

Further, Kawaihapai clay loam, 2 to 6% slopes soils (KIB), are described as having slow runoff and a slight erosion hazard (Foote et al. 1972).

Kawaihapai stony clay loam, 2 to 6% slopes (KIaB) is described as similar to Kawaihapai clay loam, but with "enough stones to hinder, but not prevent cultivation. Runoff is slow, and the erosion hazard is slight" (Foote et al. 1972:64).

Mahana series soils are described as follows:

> This series consists of well-drained soils on uplands on the islands of Kauai and Oahu. These soils developed in volcanic ash. They are gently sloping to very steep. Elevations range from 1,000 to 3,000 feet. The annual rainfall amounts to 30 to 45 inches. […] These soils are used for pasture, woodland, wildlife habitat, irrigated sugarcane, and water supply. The natural vegetation consists of puakeawe, aalii, ricegrass, molassesgrass, silver oak, yellow foxtail, lantana, joee, Japanese tea, passion flower, and associated plants. [Foote et al. 1972:85]

Mahana silt clay loam, 6 to 12% slopes, eroded (McC2) soils are described as follows:

> This soil occurs on ridgetops and moderately sloping uplands […] Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. […] In places roots penetrate to a depth of 5 feet or more. […] This soil is used for pasture, woodland, wildlife habitat, pineapple, and sugarcane. [Foote et al. 1972:85–86]

Mahana silt clay loam, 12 to 20% slopes, eroded (McD2) soils, are described as having medium runoff and a moderate erosion hazard, used for pasture, woodland, wildlife habitat, and sugarcane (Foote et al. 1972).

Mahana silty clay loam, 20 to 35% slopes, eroded (McE2) soils are further described as follows:

> Most of the surface layer has been removed by erosion. Runoff is very rapid, and the erosion hazard is very severe. Included in mapping were areas where all of the surface layer and part of the subsoil have been removed by erosion. Also included were small, stony areas and reddish-colored upland soils that are underlain by a

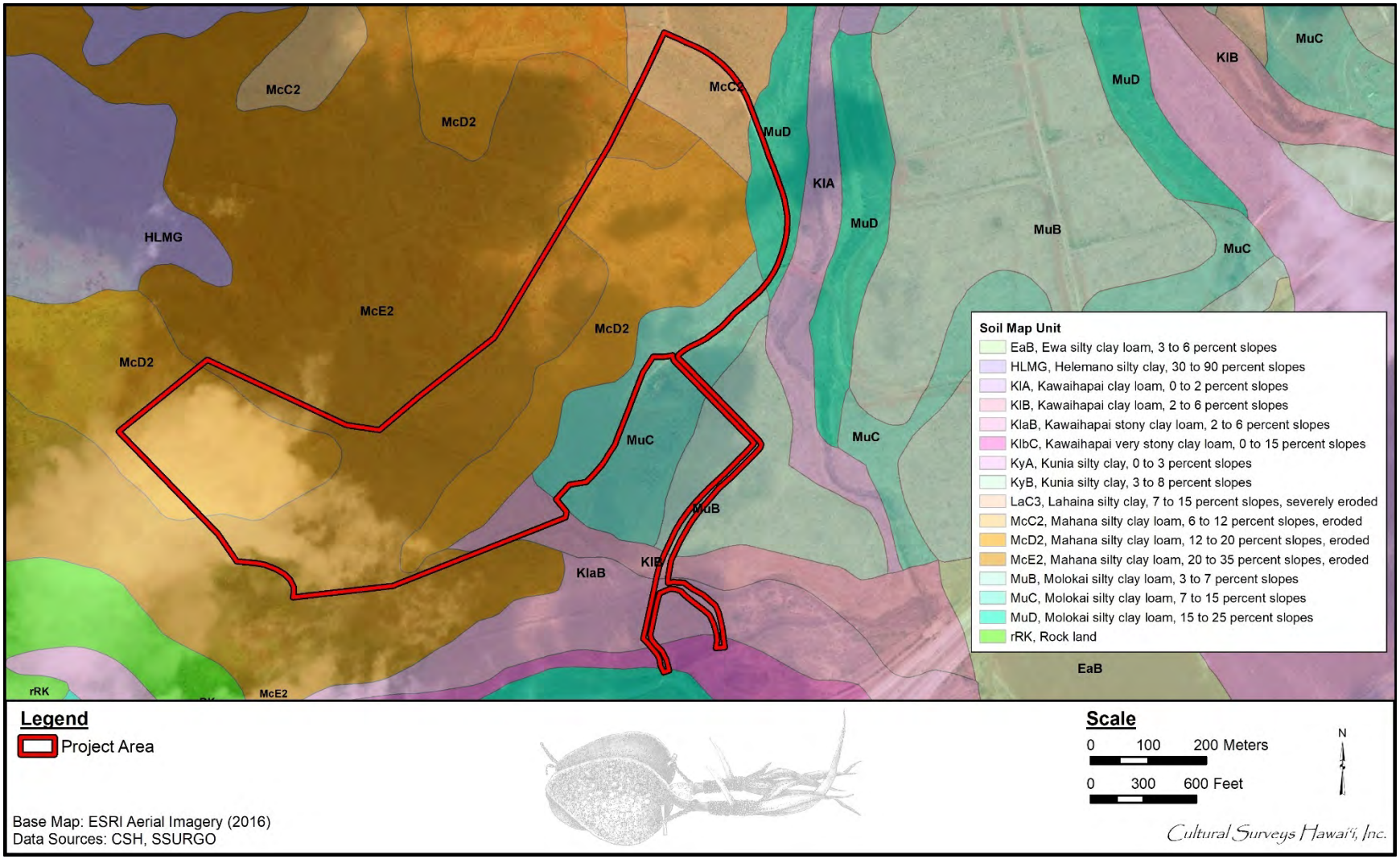

Figure 5. ESRI Aerial Imagery (2016) with overlay of *Soil Survey of the State of Hawaii* (Foote et al. 1972; USDA SSURGO 2001), indicating soil types within and surrounding the project area

> panlike layer at a depth of 15 to 50 inches. This soil is used for pasture, pineapple, and irrigated sugarcane. [Foote et al. 1972:86]

Molokai series soils are described as follows:

> This series consists of well-drained soils on uplands on the islands of Maui, Lanai, Molokai, and Oahu. These soils formed in material weathered from basic igneous rock. They are nearly level to moderately steep. Elevations range mainly from nearly sea level to 1,000 feet but are as much as 1,500 feet on Lanai. The annual rainfall amounts to 20 to 25 inches, most of which occurs between November and April […] These soils are used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. The natural vegetation consists of kiawe, ilima, uhaloa, feather fingergrass, and buffelgrass. [Foote et al. 1972:96]

Molokai silty clay loam, 3 to 7% slopes (MuB) are further described as having slight to moderate erosion hazard with slow to medium runoff.

Molokai silty clay loam, 7 to 15% slopes (MUC) soils, are described as occurring on knoll slope breaks, with medium runoff and a moderate erosion hazard (Foote et al. 1972). This material is used for sugarcane, pineapple, pasture, wildlife habitat, and home sites (Foote et al. 1972).

Molokai silty clay loam, 15 to 25% slopes (MUD) soils are further described as follows:

> This soil occurs on Oahu. In most places the slope does not exceed 20 percent. Runoff is medium, and the erosion hazard is severe. Workability is slightly difficult because of the slope. Included in mapping were small areas where boulder cores are exposed. This soil is used for sugarcane and pineapple. [Foote et al. 1972:97]

Today the project area is largely covered with *haole koa* (*Leucaena leucocephala*) and exotic grasses. *Wiliwili* (*Erythrina sandwicensis*), sweet acacia or klu (*Acacia farnesiana*), and *kiawe* (*Prosopis pallida*) were also observed within the project area.

1.2.2 Built Environment

The project area was utilized for commercial sugarcane from the early twentieth century into the late 1970s. Some of the sugarcane plantation infrastructure in the vicinity was relatively elaborate, with the Waiahole Ditch transporting irrigation water from windward O‘ahu into the foothills of the southern Wai‘anae Range. The sugarcane fields have remained fallow for decades. Some plantation infrastructure is still present in the form of cane haul roads and remnant irrigation features (see Figure 3). The project area is otherwise undeveloped. The H-1 Freeway is approximately 800 m south of the project area.

Section 2 Methods

2.1 Field Methods

Fieldwork was completed under archaeological fieldwork permit number 19-07, issued by the SHPD pursuant to HAR §13-282. CSH archaeologists Scott Belluomini, B.A., Chris Konen, B.A., Tyler Turran, B.A., and Alison Welser, M.A., conducted fieldwork between 4 and 6 February 2019 under the direction of project manager David W. Shideler, M.A., and general supervision of Hallett H. Hammatt, Ph.D., Principal Investigator. Following the initial pedestrian inspection, the project area boundaries were extended slightly to the north and the west, as well as south to encompass the existing access roads to be used for the project. Additional pedestrian inspection was conducted for these areas on 12 December 2019. This work required approximately 12 person-days to complete.

2.1.1 Pedestrian Survey

Archaeologists undertook a 100%-coverage pedestrian inspection of the project area for the purpose of historic property identification and documentation. The pedestrian survey was accomplished through systematic sweeps of four CSH archaeologists spaced approximately 10 to 15 m apart based on ground visibility. Archaeologists walked transects beginning at the north end of the project area down to the southern border, oriented southwest (Figure 6). Additionally, archaeologists walked the length of the Waiahole Ditch within the project area. Archaeologists recorded the general characteristics of the project area, including vegetation, and took general photographs of the project area. Only minimal vegetation clearance was attempted for the purpose of feature documentation and photography.

When potential historic properties were identified, archaeologists documented their locations. This included GPS data collection of the historic property and associated features. All surface features visible within the project area were photographed with a scale and generally described, which often included descriptions of dimensions, shape, materials, method of construction, integrity, general condition, and evidence of age and function of the feature. Plan maps were completed for features, as well as profiles and cross-sections when appropriate. Additionally, archaeologists documented areas of the historic properties outside the project area boundaries and photographed and noted construction methods and components of the ditch for an overall description of the historic property. Note that historic property extents were defined by a 1-m radius surrounding the documented portions of all identified features.

2.1.2 GPS Data Collection

The locations of all documented components of historic properties were recorded using a Trimble Pro XH mapping grade GPS unit with real-time differential correction. This unit provides sub-meter horizontal accuracy in the field. GPS field data was post-processed, yielding horizontal accuracy between 0.5 and 0.1 m. GPS location information was converted into GIS shape files using Trimble’s Pathfinder Office software, version 5.85, and graphically displayed using ESRI’s ArcGIS 10.6.1. CSH utilizes the NAD 83 HARN datum and UTM Zone 4N coordinate system.

In addition to feature locations, archaeologists recorded data points, which were also recorded on illustrated plan maps. For feature complexes, GPS points were taken at several data points, which were recorded on plan maps to assist in the accurate mapping of the horizontal extent of the

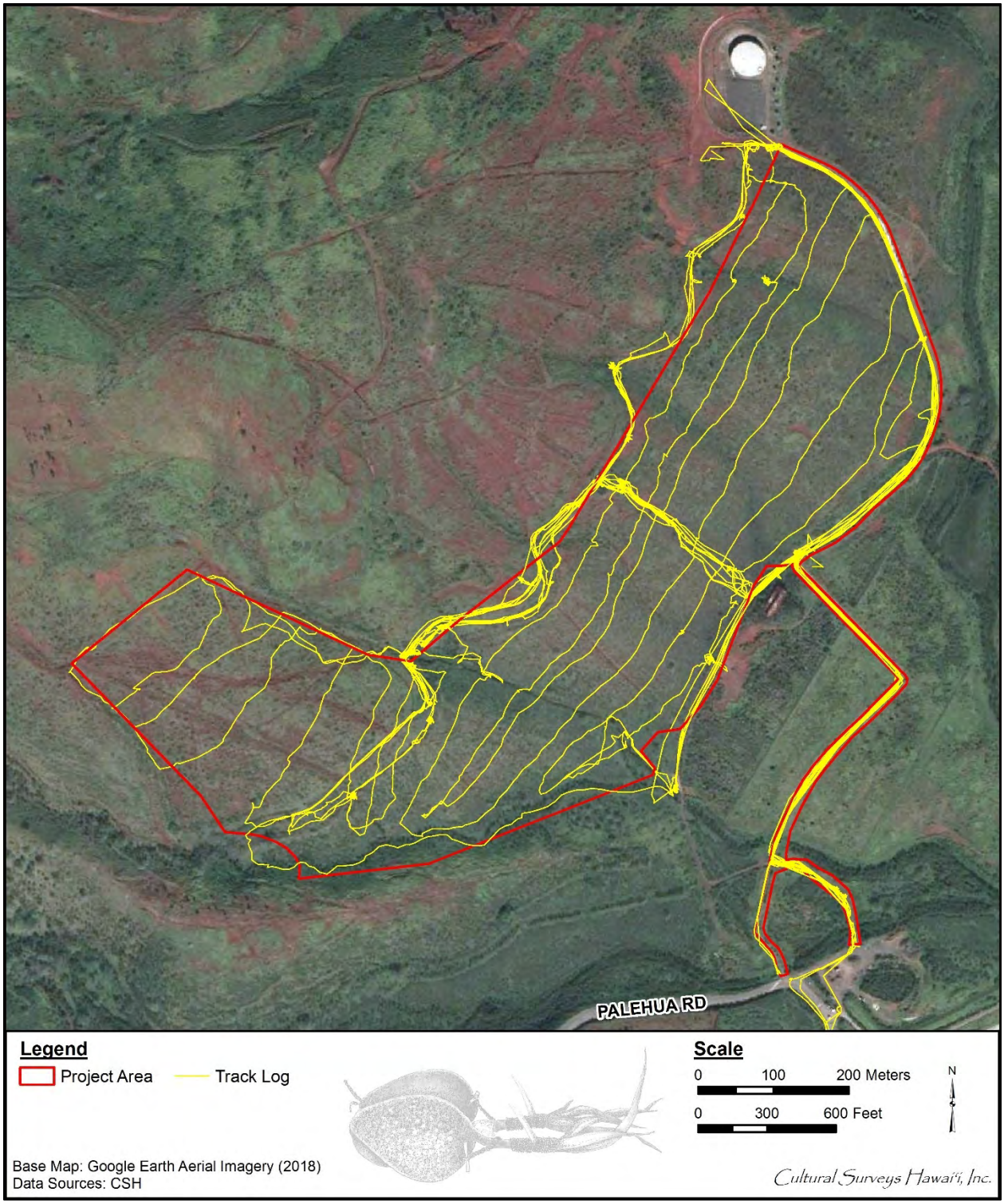

Figure 6. Aerial photograph showing the project area with overlay of two of four archaeologists' GPS track logs (Google Earth 2018)

historic property. The data points were used to geo-reference the historic properties' location using scaled illustrated maps and field notes.

2.2 Research Methods

Background research included a review of previous archaeological studies on file at the SHPD; review of documents at Hamilton Library of the University of Hawai‘i, the Hawai‘i State Archives, the Mission Houses Museum Library, the Hawai‘i Public Library, and the Bishop Museum Archives; study of historic photographs at the Hawai‘i State Archives and the Bishop Museum Archives; and study of historic maps at the Survey Office of the Department of Land and Natural Resources. Historic maps and photographs from the CSH library were also consulted. In addition, Māhele records were examined from the Waihona ‘Aina database (Waihona ‘Aina 2020). This research provided the environmental, cultural, historic, and archaeological background for the project area. The sources studied were used to formulate a predictive model regarding the expected types and locations of historic properties in the project area.

2.3 Disposition of Materials

No materials were collected during AIS fieldwork. All data generated during the course of the AIS are stored at the CSH office in Waimānalo, O‘ahu.

Section 3 Background Research

3.1 Traditional and Historical Background

The *ahupua‘a* (traditional land division) of Honouliuli is the largest, in total land area, *ahupua‘a* on the island of O‘ahu. It stretches across 16,446.4 hectares (40,640 acres) from the summit of the Wai‘anae Range in the northwest, to the west shore of Pearl Harbor in the east. It is separated from the Pearl Harbor entrance channel and the ocean by Pu‘uloa Ahupua‘a on its southeast side.

Honouliuli Ahupua‘a, as a traditional land unit, had tremendous and varied resources available for exploitation by early Hawaiians. Within Honouliuli Ahupua‘a, not only is there a long coastline fronting the normally calm waters of leeward O‘ahu, but there are also 4 miles of waterfront along the west side of the West Loch of Pearl Harbor. The “karstic desert” and marginal characterization of the limestone plain, which is the most readily visible terrain, does not do justice to the *ahupua‘a* as a whole. Although the *ahupua‘a* was rich in resources in many locations, the upper-middle portion of the Honouliuli Ahupua‘a, where the project area is located, has little recorded traditional use.

Traditional sources, the earliest maps, and early archaeological studies do not display much land use in this portion of Honouliuli Ahupua‘a. Kalo‘i Gulch, which courses just south of the project area, and Pu‘u Kapua‘i just to the northwest are the only Hawaiian-named land forms in the vicinity of the project area that have been documented (Figure 7). Pukui et al. (1974:77) translate the name “Ka-lo‘i” to mean “the taro patch” and Sterling and Summers (1978:35) relate a number of vignettes regarding the “Waihuna” or “Punahuna” hidden spring associated with Kalo‘i Gulch. Ida E.K. von Holt (in Sterling and Summers 1978:35) relates in the account of “two old Hawaiians” that the hidden spring “had been one of the principal sources of water for all that country, which was quite heavily populated before the smallpox epidemic of 1840.” “Pu‘u Kapua‘i” is translated as “footprint hill” (Pukui et al. 1974:199) but the association with that name is unclear.

The political and cultural center of the *ahupua‘a* is understood to have been the relatively dense settlement and rich lands for irrigated taro cultivation at the *‘ili* (land division smaller than an *ahupua‘a*) of Honouliuli, located where Honouliuli Stream empties into the north portion of West Loch (east of the current project area). The name of the *ahupua‘a*, translated as “dark bay” (Pukui et al. 1974:51), may refer to the nature of the waters of West Loch at the mouth of Honouliuli Stream. Early accounts and maps indicate a large settlement at the *‘ili* of Honouliuli. It is possible the political power of this village was so great it was able to extend its jurisdiction well to the northwest, into an area which might have been anticipated to fall under the dominion of the Wai‘anae ruling chiefs.

3.1.1 Mythological and Traditional Accounts

The traditions of Honouliuli Ahupua‘a have been compiled and summarized in studies by Sterling and Summers (1978), Hammatt and Folk (1981), Kelly (1991), Charvet-Pond and Davis (1992), and Maly and Rosendahl (1993). Some of the themes of these traditions include connections with Kahiki (the traditional homeland of Hawaiians, probably in reference to central Polynesia) and the special character and relationship of the places known as Pu‘u ‘o Kapolei and Kualaka‘i.

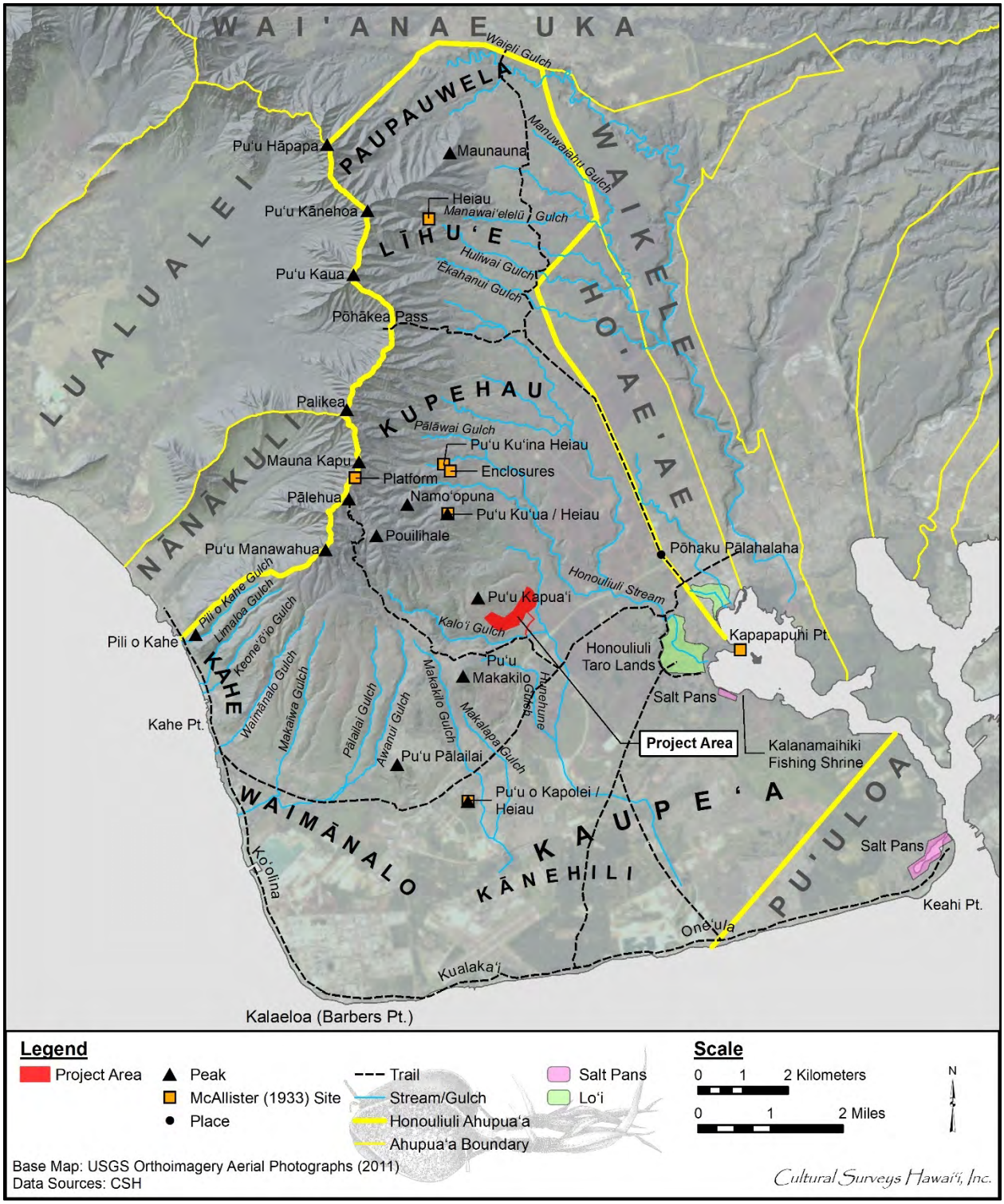

Figure 7. Portion of a USGS Orthoimagery aerial photograph (2011) showing place names, trails and streams of Honouliuli Ahupua‘a with the location of the project area

Connections with Kahiki are found in numerous place names, traditional events, and in the beings associated with Honouliuli. There are several versions of Kaha‘i leaving from Kalaeloa for a trip to Kahiki to bring breadfruit back to ‘Ewa (Kamakau 1991:110). There are several stories that associate places in the region with Kamapua‘a and the Hina family, as well as with Pele’s sisters, all of whom have strong connections with Kahiki (Kamakau 1961:111; Pukui et al. 1974:200).

Pu‘u ‘o Kapolei (approximately 4 km southwest of the project area) was one of the more sacred places in Honouliuli (cf. Sterling and Summers 1978:33). Pu‘u ‘o Kapolei is connected with Kahiki, as the hill is noted as the home of Kamapua‘a’s grandmother, Kamaunuaniho, the Kahiki ancestor to the people of O‘ahu (Fornander 1916:5:318; Kahiolo 1978:81, 107). By name, Kapolei is associated with the goddess Kapo, another connection with the Pele and Kamapua‘a stories (Kamakau 1976:14).

McAllister (1933:108) records that a *heiau* (pre-Christian place of worship) was once located on Pu‘u ‘o Kapolei, but was destroyed before his survey of 1930. The *heiau* may have been associated with the sun, as the hill was used as a point of solar reference or as a place where such observations were made (Fornander 1916:3:292). Pu‘u ‘o Kapolei might have been understood as the gate of the setting sun. It is notable that the rising sun at the eastern gate of Kumukahi in Puna is associated with the Hawaiian goddess Kapo (Emerson 1978:41). There is little specific information for Pu‘u ‘o Kapolei, but the place name itself (“hill of beloved Kapo”) is hard to ignore. It is mentioned in some cosmologies that Kū was the god of the rising sun, and Hina should be associated with the setting sun (Hina is the mother of Kamapua‘a). Fornander (1916:3:292) states, Pu‘u ‘o Kapolei may have been a jumping off place (also connected with the setting sun) and associated with the dead who roamed the adjacent Plain of Kaupe‘a.

Pu‘u ‘o Kapolei was the primary landmark for travelers between Pearl Harbor and the west O‘ahu coast, with a main trail running inland of it (‘Ī‘ī 1959:27, 29). Pu‘u ‘o Kapolei was probably the most common name used as a reference for the area of the ‘Ewa Plain in traditional Hawai‘i (Fornander 1916:2:318; Nakuina 1992:54; E.M. Nakuina 1904 in Sterling and Summers 1978:34).

3.1.2 Early Historic Period

Early historical accounts indicate the *ahupua‘a* of Honouliuli was once widely inhabited by pre-Contact Hawaiian populations, including the Hawaiian *ali‘i* (chiefly class). This substantial population can largely be attributed to the plentiful marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations were located. Other attractive subsistence-related features of the *ahupua‘a* included irrigated lowlands suitable for wet land taro cultivation (Hammatt and Shideler 1990), as well as the lower forest area of the mountain slopes for the procurement of forest goods.

Exploitation of the forest resources along the slopes of the Wai‘anae Range—as suggested by E.S. and E.G. Handy—probably acted as a viable subsistence alternative during times of famine:

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

These upper valley slopes may have also been a significant resource for opportunistic quarrying of basalt for the manufacturing of stone tools. This is evidenced in part by the existence of a probable quarrying site (State Inventory of Historic Places [SIHP] # 50-80-12-4322) in Makaīwa Gulch at 152 m (500 ft) above mean sea level, west of the current project area (Hammatt et al. 1991).

The Hawaiian *ali‘i* were also attracted to the region. One historical account of particular interest refers to an *ali‘i* residing in Ko Olina, southwest of the current project area:

> Ko Olina is in Waimanalo near the boundary of Ewa and Waianae. This was a vacationing place for chief Kakuhihewa and the priest Napuaikamao was the caretaker of the place. Remember reader, this Ko Olina is not situated in the Waimanalo on the Koolau side of the island but the Waimanalo in Ewa. It is a lovely and delightful place and the chief, Kakuhihewa loved this home of his. [Sterling and Summers 1978:41]

John Papa ‘Ī‘ī describes a network of Leeward O‘ahu trails (Figure 8 through Figure 10) which in later historic times encircled and crossed the Wai‘anae Range. These trails allowed passage from West Loch to the Honouliuli lowlands, past Pu‘u ‘o Kapolei and Waimānalo Gulch to the Wai‘anae coast and onward circumscribing the shoreline of O‘ahu (‘Ī‘ī 1959:96–98). The main trail along the south shore of O‘ahu would have been approximately 1.5 km to the southeast. A main trail extending up the central valley of O‘ahu would have been approximately 3 km to the east. The 1825 Malden map (see Figure 9) shows a trail extending from the main trail along the south shore of O‘ahu into the uplands in the Pālehua area, passing just a couple hundred meters to the southwest of the project area. The 1873 Alexander map (see Figure 10), one of the earliest detailed maps of the vicinity, shows no development near the project area.

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

Subsequent to Western Contact in the area, the landscape of the ‘Ewa Plain and Wai‘anae slopes was adversely affected by the removal of the sandalwood and other trees, and the introduction of domesticated animals and new vegetation. Goats, sheep, and cattle were brought to the Hawaiian Islands by Vancouver in the early 1790s and allowed to graze freely about the land for some time after. L.A. Henke reports the existence of a longhorn cattle ranch in Wai‘anae by at least 1840 (Frierson 1972:10). During this time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. The following dates for the introduction of exotic vegetation are given by R. Smith and outlined by Frierson (1972:10–11):

1. ‘early,’ c. 1790: for the establishment of Prickly pear cactus, (*Opuntia tuna), Haole koa, (Leucaena leucocephala)* and Guava (*Psidium guajava)*
2. 1835-1840: Burmuda [*sic*] grass (*Cynodon dactylon)* and Wire grass (*Eleusine indica)*
3. 1858: Lantana (*Lantana camara)*

The *kiawe* tree (*Prosopis pallida*) was also introduced during this period, either in 1828 or 1837 (Frierson 1972:11).

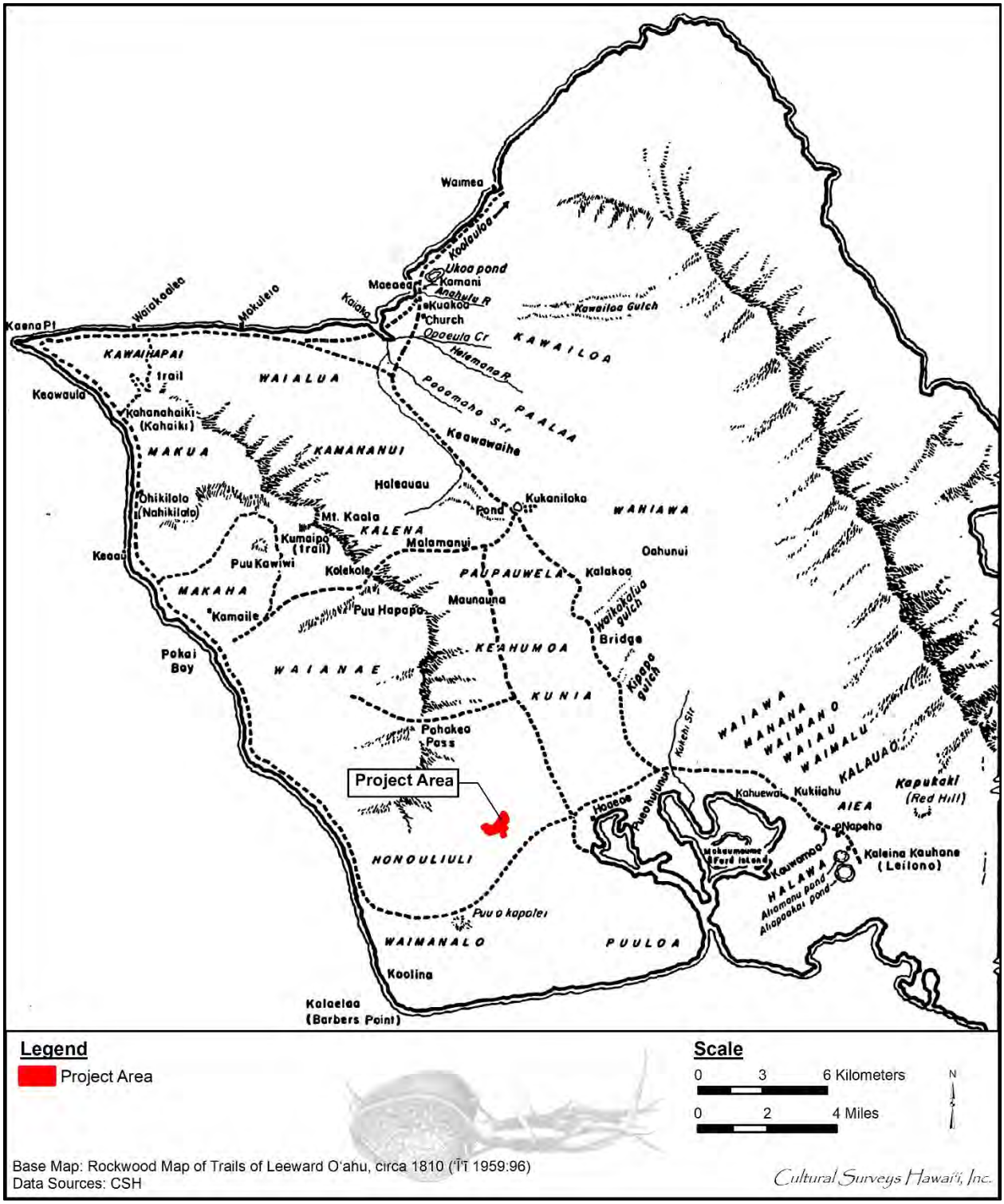

Figure 8. Portion of the 1810 Rockwood map of trails of Leeward O‘ahu with overlay of project area (Ī‘ī 1959:96)

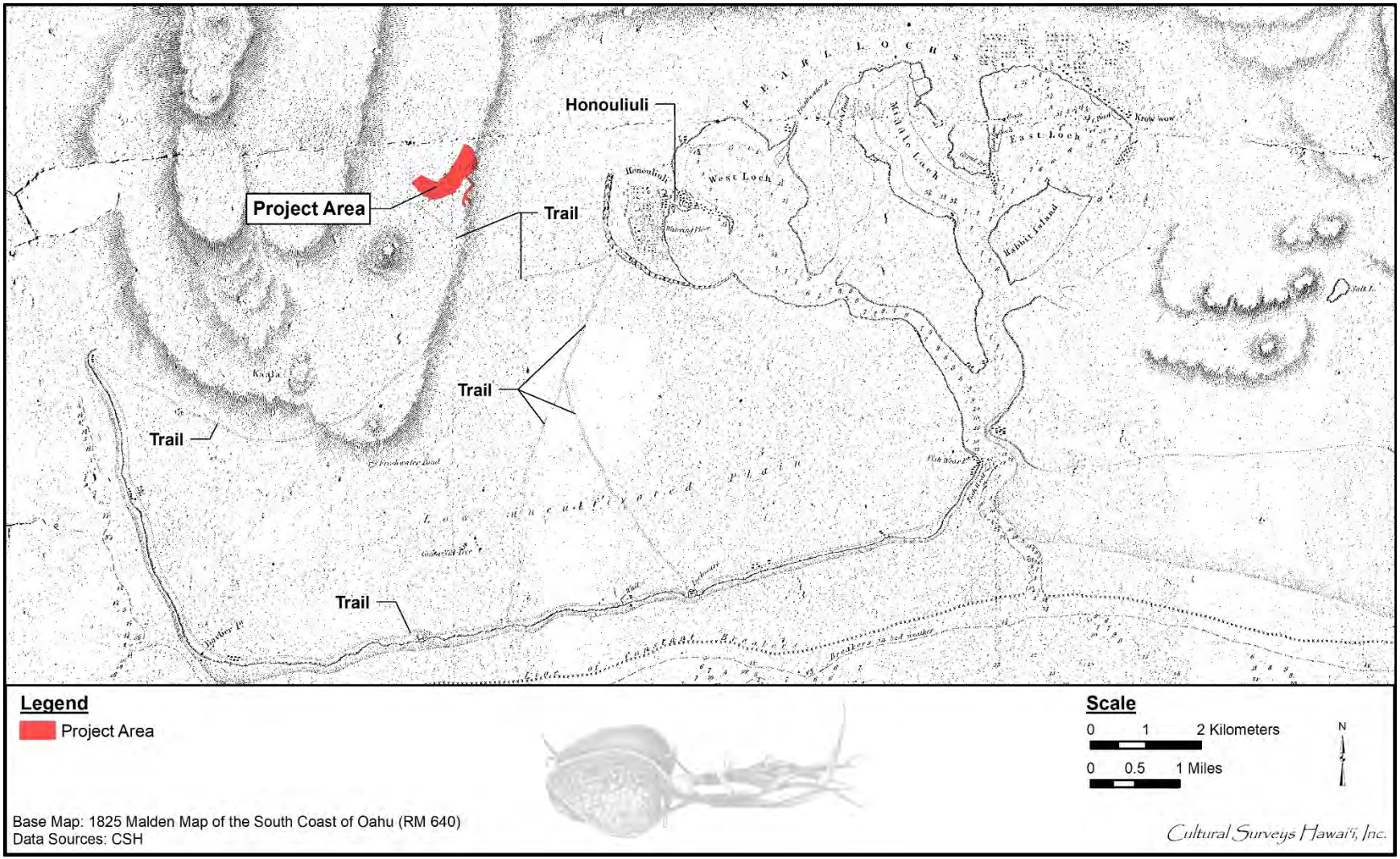

Figure 9. Portion of 1825 Malden map of the South Coast of Oahu (RM 640) showing the location of the project area

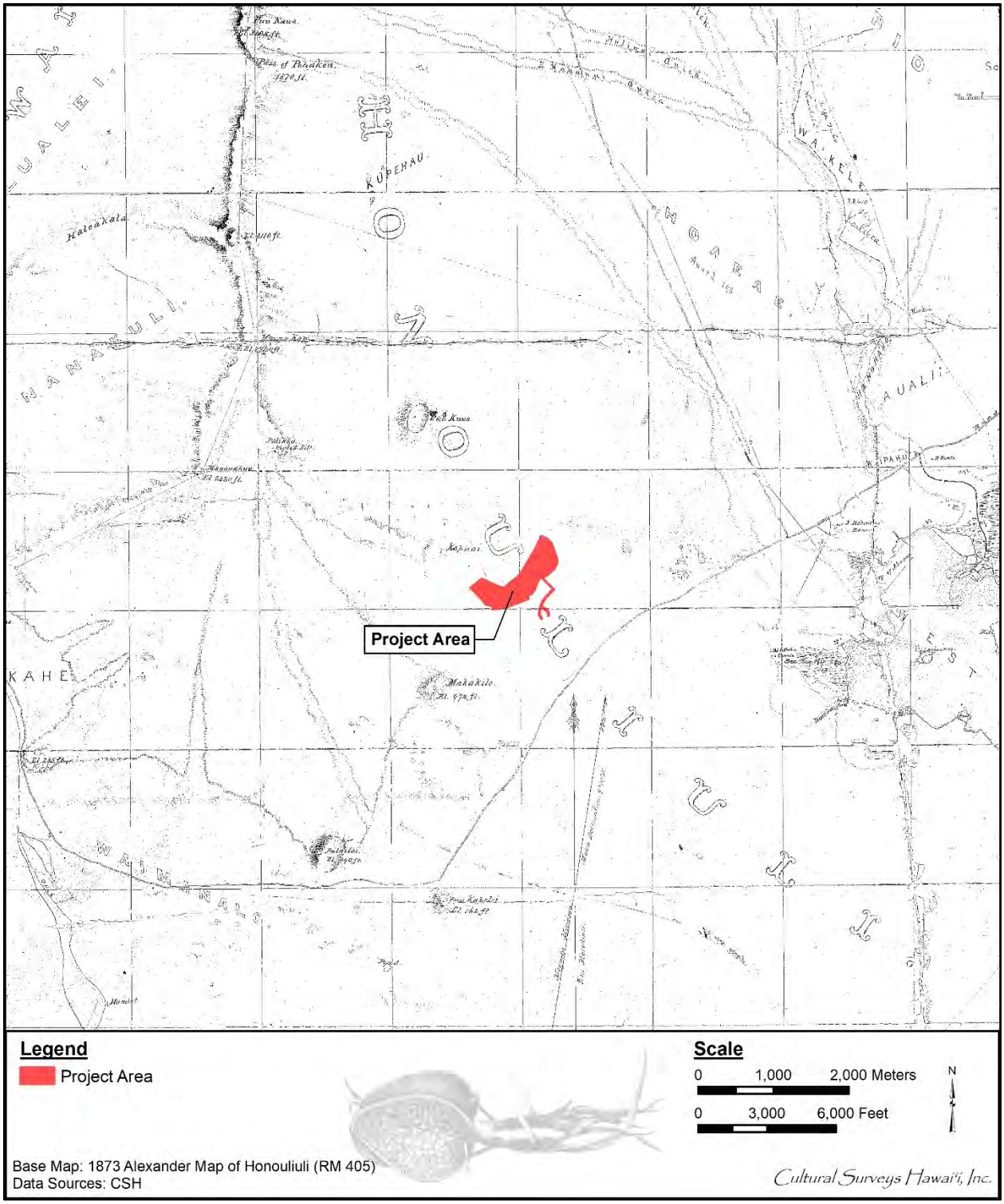

Figure 10. Portion of 1873 Alexander map of Honouliuli (RM 405) showing trail network in vicinity of project area

3.1.3 The Māhele and the Kuleana Act

During the Māhele of 1848, 99 individual land claims in the *ahupua‘a* of Honouliuli were registered and awarded by King Kamehameha III. No *kuleana* land claims were made for land within the current project area or vicinity. The vast majority of the Land Commission Awards (LCA) were located in Honouliuli near the taro lands of the *‘ili* of Pu‘uloa and the Pu‘uloa Salt Works. The largest award (Royal Patent 6071, LCA 11216, *‘Āpana* [parcel] 8) in Honouliuli Ahupua‘a was granted to Miriam Ke‘ahi-Kuni Kekau‘onohi on January 1848 (Native Register 1848). Kekau‘onohi acquired a deed to all unclaimed land within the *ahupua‘a*, including 43,250 acres encompassing the present project area.

Samuel Kamakau relates the following about Kekau‘onohi as a child:

> Kamehameha’s granddaughter, Ke-ahi-Kuni Kekau-onohi […] was also a tabu chiefess in whose presence the other chiefesses had to prostrate and uncover themselves, and Kamehameha would lie face upward while she sat on his chest. [Kamakau 1961:208–209]

Kekau‘onohi was one of Liholiho’s (Kamehameha II’s) wives, and after his death, she lived with her half-brother, Luanu‘u Kahala‘i‘a, who was governor of Kaua‘i (Kamakau 1961:20). Subsequently, Kekau‘onohi ran away with Queen Ka‘ahumanu’s stepson, Keli‘i-ahonui, and then became the wife of Chief Levi Ha‘alelea. Upon her death on 2 June 1851, all her property passed to her husband and his heirs. When Levi Ha‘alelea died, the property went to his surviving wife, who in turn leased it to James Dowsett and John Meek in 1871 for stock running and grazing.

3.1.4 Mid- to Late 1800s

In 1877, James Campbell purchased most of Honouliuli Ahupua‘a for a total of $95,000. He then drove off 32,347 head of cattle belonging to Dowsett, Meek, and James Robinson and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). In 1879, Campbell brought in a well-driller from California to search the ‘Ewa Plain for water and successfully “tapped artesian water which, from internal pressure, forced its way to the surface without being pumped” (Hitch 1992:79). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource. By 1881, the Campbell property of Honouliuli prospered as a cattle ranch with “abundant pasturage of various kinds” (Briggs in Haun and Kelly 1984:45). Within ten years of the first drilled well in ‘Ewa, the addition of a series of artesian wells throughout the island supplied most of Honolulu’s water needs (Armstrong and Bier 1983).

In 1889, Campbell leased his property to Benjamin Dillingham, who subsequently formed the Oahu Railway & Land Company (OR&L) in 1890. To attract business to his new railroad system, Dillingham subleased all land below 200 ft elevation to William Castle who in turn sublet the area to the Ewa Plantation Company for sugarcane cultivation (Frierson 1972:15). Dillingham’s Honouliuli lands above 200 ft elevation that were suitable for sugarcane cultivation were sublet to the Oahu Sugar Company.

Ewa Plantation Company was incorporated in 1890 and operated into modern times. The plantation grew quickly with the abundant artesian water. As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed

ditches running from the lower slopes of the mountain range to the lowlands, then plowed the slopes vertically just before the rainy season to induce erosion (Frierson 1972:17).

The Oahu Sugar Company was incorporated in 1897 and included lands in the foothills above the ‘Ewa Plain and Pearl Harbor. Prior to commercial sugar cultivation, the lands occupied by the Oahu Sugar Company were described as being “of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project” (Condé and Best 1973:313). The Oahu Sugar Company took control of the Ewa Plantation lands in 1970 and continued operations into the 1990s.

Dillingham’s *mauka* (inland, toward the mountains) lands in western Honouliuli that were unsuitable for commercial sugar production remained pasture for grazing livestock. From 1890 to 1892, the Ranch Department of the OR&L Company desperately sought water for their herds of cattle, tapping plantation flumes and searching for alternative sources of water. Ida von Holt shared the following account of her husband Harry’s (Superintendent of the OR&L Ranch Department) search for water in the foothills of the Wai‘anae Range:

> One of those places is on the old trail to Pālehua, and had evidently been a place of which the Hawaiians had known, for its name is Kalo‘i (the taro patch), and even in dry weather water would be standing in the holes made by the cattle, as they tried to get a drop or two. [von Holt 1985:136]

It is believed that the spring depicted in this account may have been identified during an inventory survey for the adjacent Pālehua East B project (Tulchin and Hammatt 2005). The spring was located along the upper slopes of the southern face of Kalo‘i Gulch. A second account is given of the discovery of spring water in an area over the ridge on the north side of Kalo‘i Gulch:

> Shouting to the men to come over with their picks and shovels, he [Harry von Holt] soon got them busy clearing away lots of small stones and earth. Almost at once they could see that there were evidences of a paved well, and at about three feet down they came upon a huge flat rock, as large around as two men could span with their arms. Digging the rock loose and lifting it to one side, what was their astonishment to find a clear bubbling spring! [von Holt 1985:138]

Following the discovery, two old Hawaiians began to ask Von Holt about the spring:

> Finally he [Harry von Holt] got them to explain that the spring, called ‘Waihuna’ (Hidden Spring) had been one of the principal sources of water for all that country, which was quite heavily populated before the smallpox epidemic of 1840 […] A powerful Kahuna living at the spring had hidden it before he died of the smallpox, and had put a curse on the one who disturbed the stone, that he or she would surely die before a year was out. [von Holt 1985:138–140]

3.1.5 1900s

In 1913, the Waiahole Water Company, a subsidiary of the Oahu Sugar Company, began a project to transport irrigation water from the well-watered windward side of O‘ahu, through the Ko‘olau Range, to the fields and mill of the Oahu Sugar Company in ‘Ewa. The water system, named the Waiahole Ditch System, was declared “an engineering feat of epic proportion for those times” (Condé and Best 1973:37). The original system, when completed, collected water from

stream intakes and water tunnels from Kahana Valley in the north to Waiāhole Valley in the south. The main tunnel extended through Waiāhole Valley to Waiawa, and water was then transported by ditch westward to Honouliuli, covering approximately 22 miles (Condé and Best 1973:37). The ditch system was completed in 1916 and, with some modifications, much of the ditch is in use today. This active portion of the ditch extends from the windward side of the island into Honouliuli. Remnant, inactive portions of the system extend southwest onto the ‘Ewa Plain. The remnant portion of the Waiahole Ditch crosses through the southwestern portion of the present project area.

Much of the *mauka* lands in western Honouliuli, including ridges and deep gulches, were unsuitable for commercial sugar cultivation and remained pasture land for grazing livestock. The Donn 1906 map suggests the present project area was at the edge of sugarcane cultivation at that time (Figure 11). By 1920, however, much of the lands of Honouliuli were used for commercial sugarcane cultivation (Frierson 1972:18).

A 1919 map (Figure 12) shows ditches, reservoirs, roads, and railroad lines downslope of the project area. This map shows an unimproved road alignment just south of the project area, understood as the Pālehua Road, approximating a traditional Hawaiian footpath into the uplands. However, a 1922 map (Figure 13 and Figure 14 showing annotations), shows the called out Pālehua trail as jogging into the southwest portion of the project area. This 1922 map shows pineapple fields in at least 13 locations among the foothills of the southeast Wai‘anae Range. The nearest of these pineapple fields wrapped around Pu‘u Kapua‘i some 500 m to the northwest. At least six (typically quite small) plantation camps were scattered along the bottom of these foothills with the nearest being about 500 m to the north of the project area. The Kupihau Ranch Station is shown about 2.6 km to the north. The water troughs and tanks shown upslope of the ranch station attest to the cattle operations in the vicinity at that time.

By 1925, most of the project area is depicted as within Oahu Sugar Company plantation Field 30 (Figure 15). The extreme upslope end of the project area still appears to be outside the area of sugarcane cultivation, in keeping with the depiction on the 1906 Donn map (compare with Figure 11).

In the late 1920s, the main residential communities were at the northeast edge of the ‘Ewa Plain and the largest community was still located at Honouliuli Village. ‘Ewa was primarily a plantation town, focused around the sugar mill, with a public school as well as a Japanese school. Additional settlement, in Waipahu, centered around the Waipahu sugar mill operated by the Oahu Sugar Company. However, small plantation camps were scattered within the extensive sugarcane fields (as indicated in Figure 14).

By 1936, however, “Pump Camp 5” had been established on either side of a pipeline that bisected the present project area, as seen on a 1936 U.S. Army War Department map (Figure 16). The 1936 map indicates approximately seven houses on the northeast side of the pipeline and 17 houses on the southwest side of the pipeline within the present project area at that time. The central pipeline extended downslope from the Waiahole Ditch to a large pump house structure that still exits just southeast (outside) of the project area. The alignment of the Waiahole Ditch crossing the western portion of the project area, and a roughly parallel road just upslope, are clearly depicted. It appears a spur plantation railroad serviced Pump Camp 5 connecting to the northeast and continuing a short distance to the southeast.

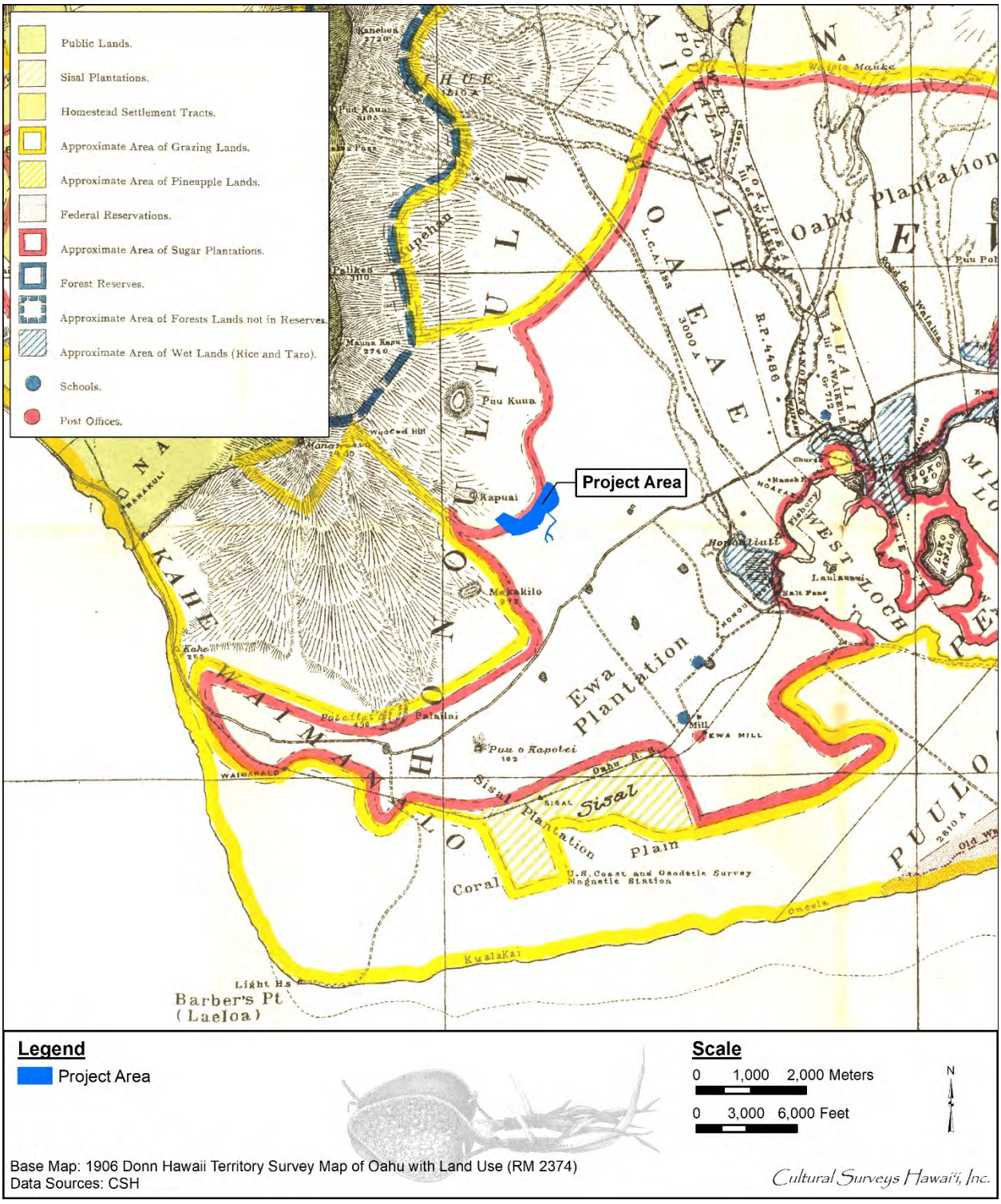

Figure 11. Portion of the 1906 Donn Hawaii Territory Survey map of Oahu with land use (RM 2374) showing breakdown of land use in southwest O‘ahu

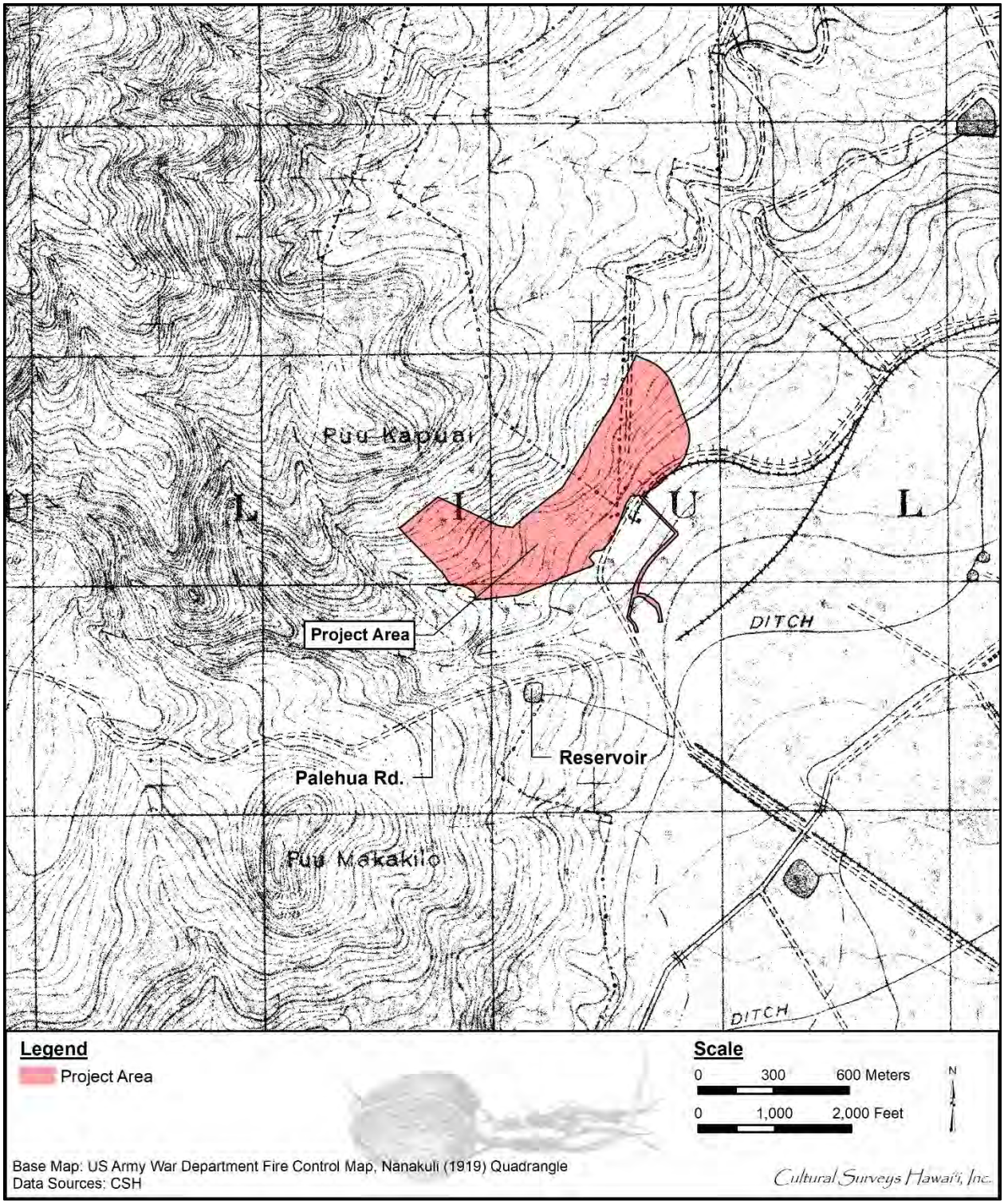

Figure 12. Portion of 1919 U.S. Army War Department fire control map, Nanakuli quadrangle showing the project area

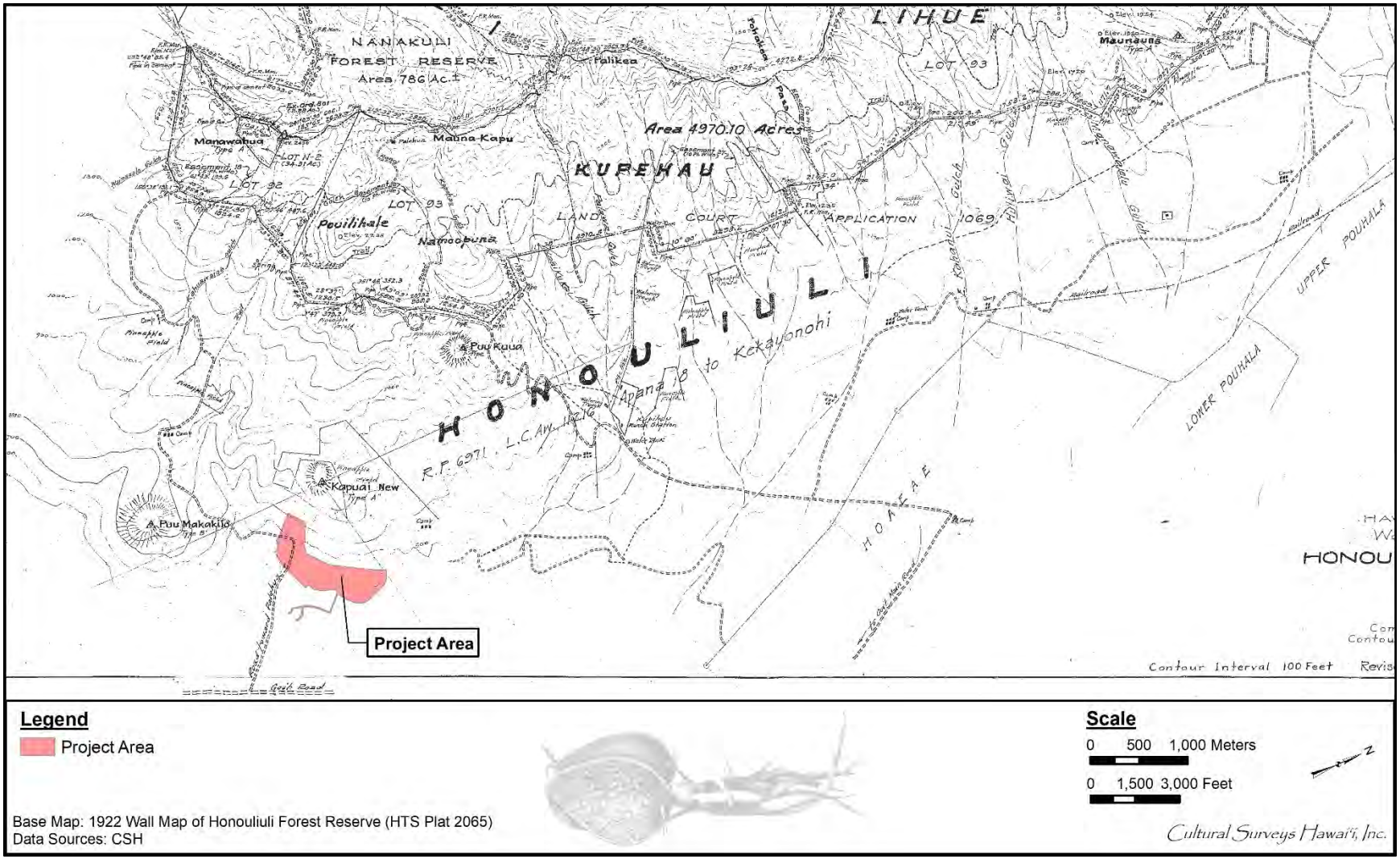

Figure 13. Portion of 1922 Wall map of Honouliuli Forest Reserve (HTS Plat 2065) showing the location of the project area

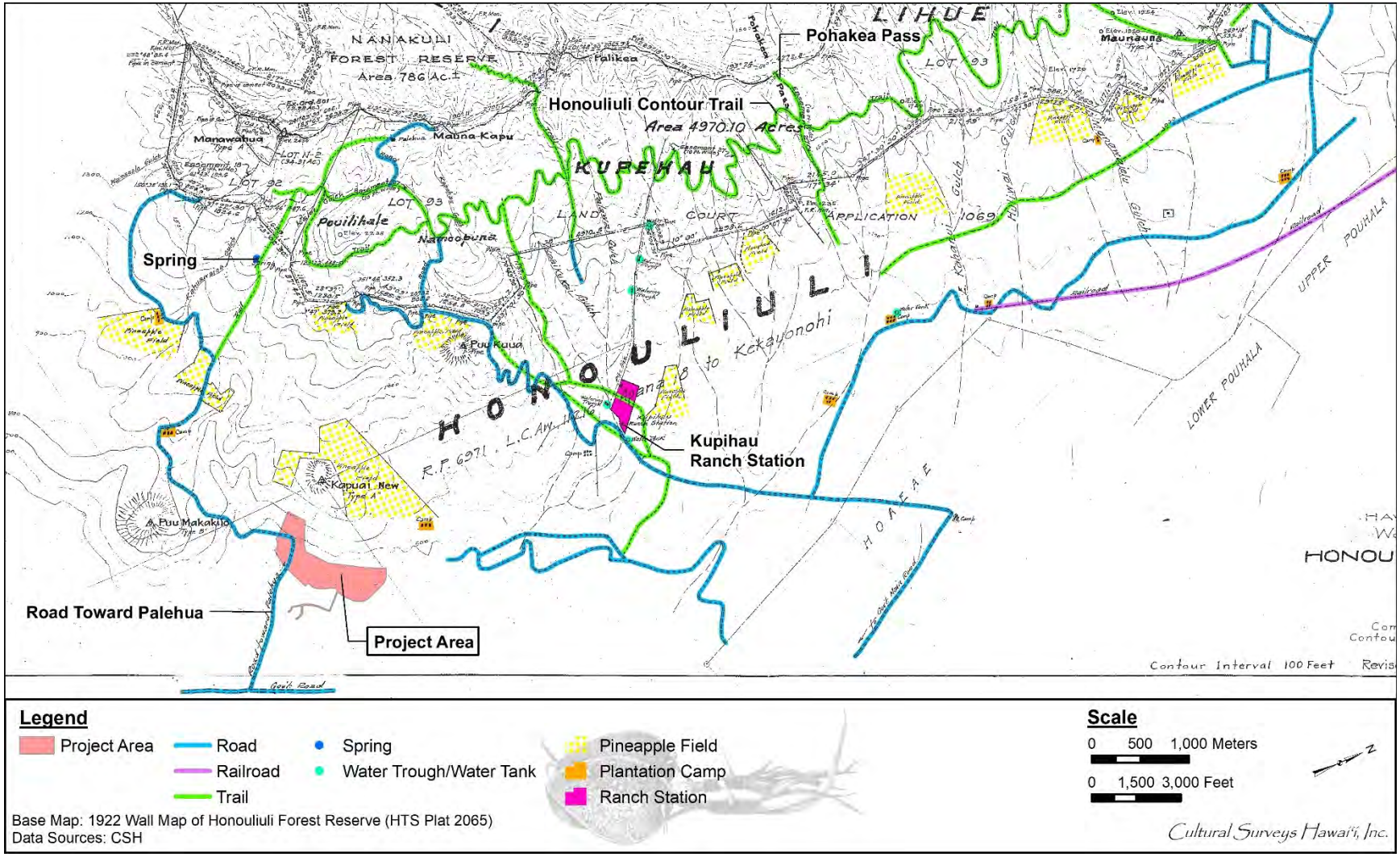

Figure 14. 1922 Wall map of Honouliuli Forest Reserve (HTS Plat 2065) showing the location of the project area with annotations

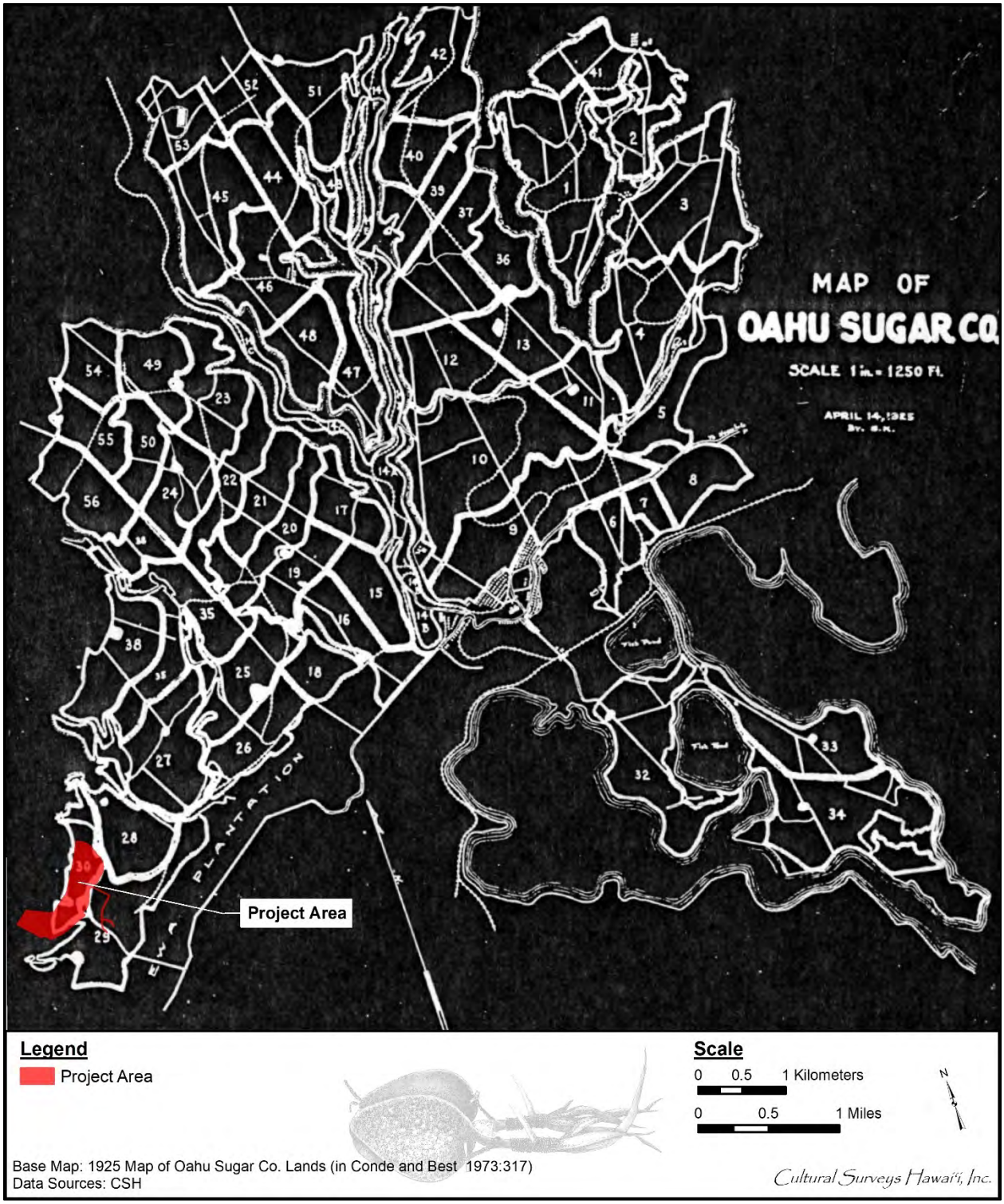

Figure 15. 1925 Oahu Sugar Company plantation map showing project area (red) as largely within former Field 30 (Condé and Best 1973:317)

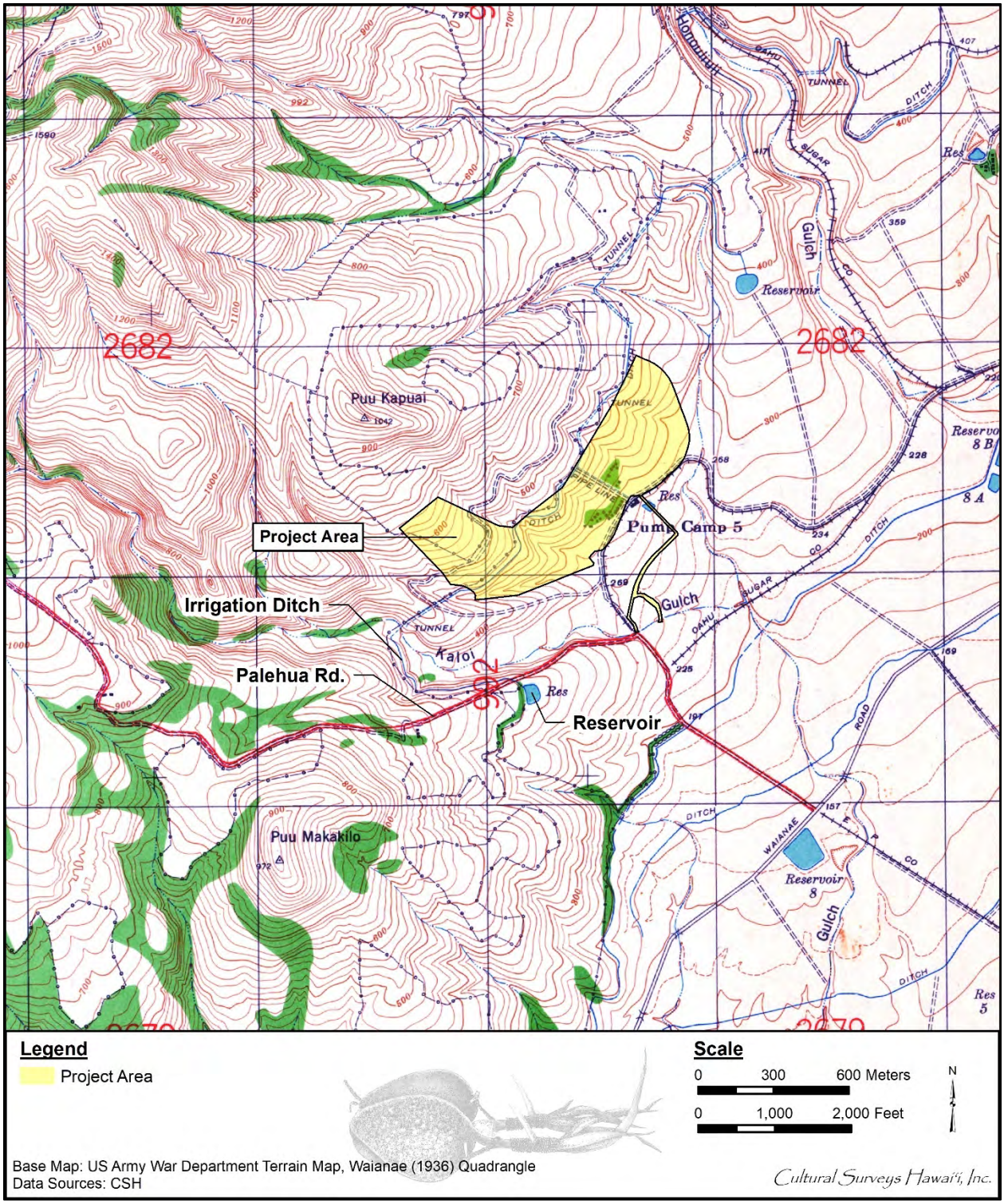

Figure 16. Portion of the 1936 U.S. Army War Department terrain map, Waianae quadrangle showing the location of the project area

A 1943 U.S. Army War Department map (Figure 17) shows much the same scene, though the unimproved road crossing the western portion of the project area now wraps around Pu‘u Kapua‘i. Additional new, unimproved roads suggest the expansion of sugarcane fields. The extensive system of fences depicted upslope indicates cattle ranching was still a significant enterprise.

Historic maps of the Makakilo area indicate a lack of any other significant development in the area into the 1940s. Major land use changes came to western Honouliuli when the U.S. Military began development in the area. Military installations were constructed near the coast as well as in the foothills and upland areas. Barbers Point Military Reservation (a.k.a. Battery Barbers Point from 1937–1944), located at Barbers Point Beach, was used beginning in 1921 as a training area for firing 155 mm guns (Payette 2003). Also in the vicinity were Camp Malakole Military Reservation (a.k.a. Honouliuli Military Reservation), used from 1939, and Gilbert Military Reservation, used from 1922–1944. Barbers Point Naval Air Station (NAS), in operation from 1942 into the 1990s, was the largest and most significant base built in the area. It housed numerous naval and defense organizations, including maritime surveillance and anti-submarine warfare aircraft squadrons, a U.S. Coast Guard Air Station, and components of the U.S. Pacific Fleet.

Fort Barrette (a.k.a. Kapolei Military Reservation and Battery Hatch), located atop Pu‘u ‘o Kapolei to the southwest, was used from 1931 to 1948 for housing four 3-inch anti-aircraft batteries (Payette 2003). In the 1950s, the site was used as a Nike missile base. Palailai Military Reservation, located atop Pu‘u Pāla‘ila‘i in Makakilo to the west, was in service from 1921, housing Battery Palailai and Fire Control Station B (Payette 2003). Fire Control Station A was located atop Pu‘u Makakilo approximately 1.4 km to the southwest of the project area. From 1942 to 1945 the Pu‘u Makakilo Training Area, including lands in and around Pu‘u Makakilo, was used for military training during World War II (Environment Hawai‘i 1992).

The 1951 aerial photograph (Figure 18) clearly shows the two neighboring housing areas of Pump Camp 5 within the central portion of the project area (just northwest and southwest of the pump house building or pumping station which remains just outside the project area). While the majority of the project area was under sugarcane cultivation, it appears the southwest portion, west or upslope of the Waiahole Ditch, was not under cultivation at that time, used instead as grazing lands. The west portion of the project area appears to have been previously cultivated but appears fallow. Extensive areas north of Pu‘u Kapua‘i appear to be under pineapple cultivation.

The 1953 USGS map (Figure 19) shows much the same landscape as the 1943 map (see Figure 17) except the railroads have now all disappeared—quickly replaced by trucking after World War II. A naval reservation is shown on the southeast base of Pu‘u Makakilo. An access road developed to service the present quarry is now depicted running up the mouth of Kalo‘i Gulch, parallel to and just north of the Kalo‘i Stream channel. The initial date of construction of an industrial quarry within Kalo‘i Gulch—depicted to the south (outside) of the current project area—is uncertain, though historic maps indicate a construction window between 1943 and 1952. In 2004, CSH conducted an archaeological inventory survey whereby the quarry was documented and designated an historic property, SIHP # 50-80-12-6680.

The 1968/1969 USGS map (Figure 20) no longer shows Pump Camp 5, which had been prominent at least as early as 1936 (see Figure 16) and lasted until at least 1953 (see Figure 19). The “Pumping Station” immediately southeast of the project area is still labeled and in general the plantation infrastructure (other than the train lines) appears active. The road up Kalo‘i Gulch,

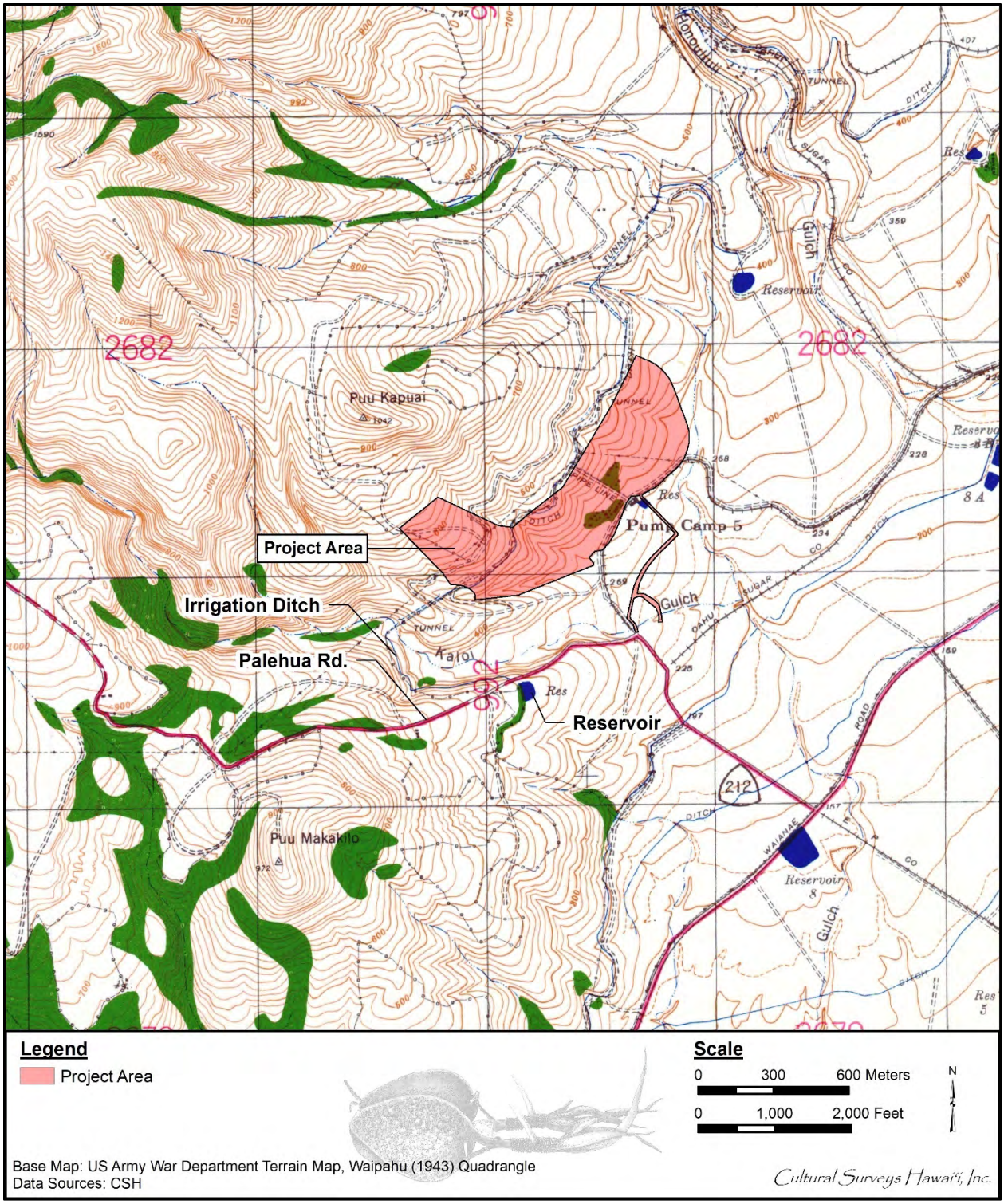

Figure 17. Portion of the 1943 U.S. Army War Department terrain map, Waipahu quadrangle showing the project area

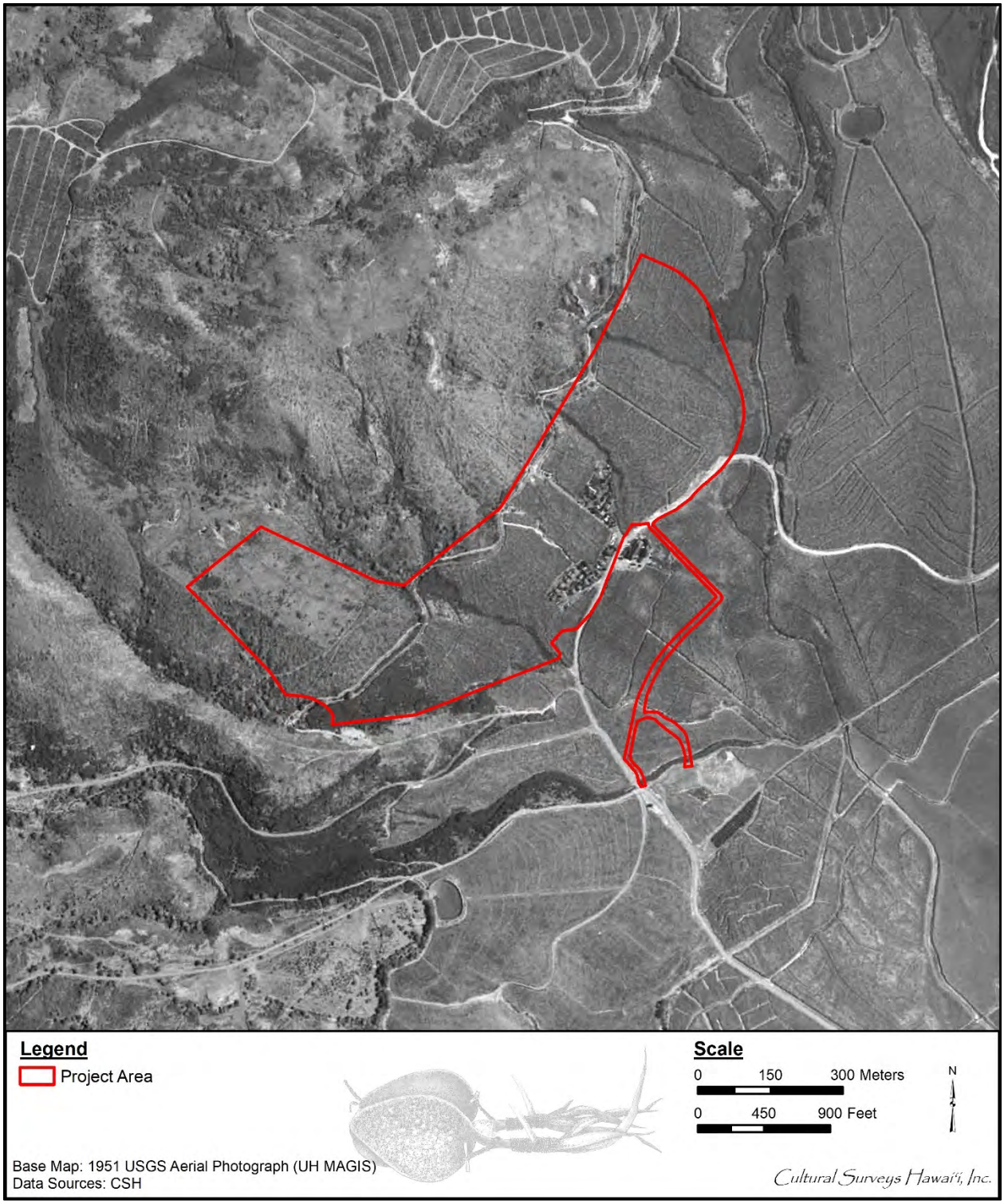

Figure 18. 1951 USGS aerial photograph (UH MAGIS) showing the project area

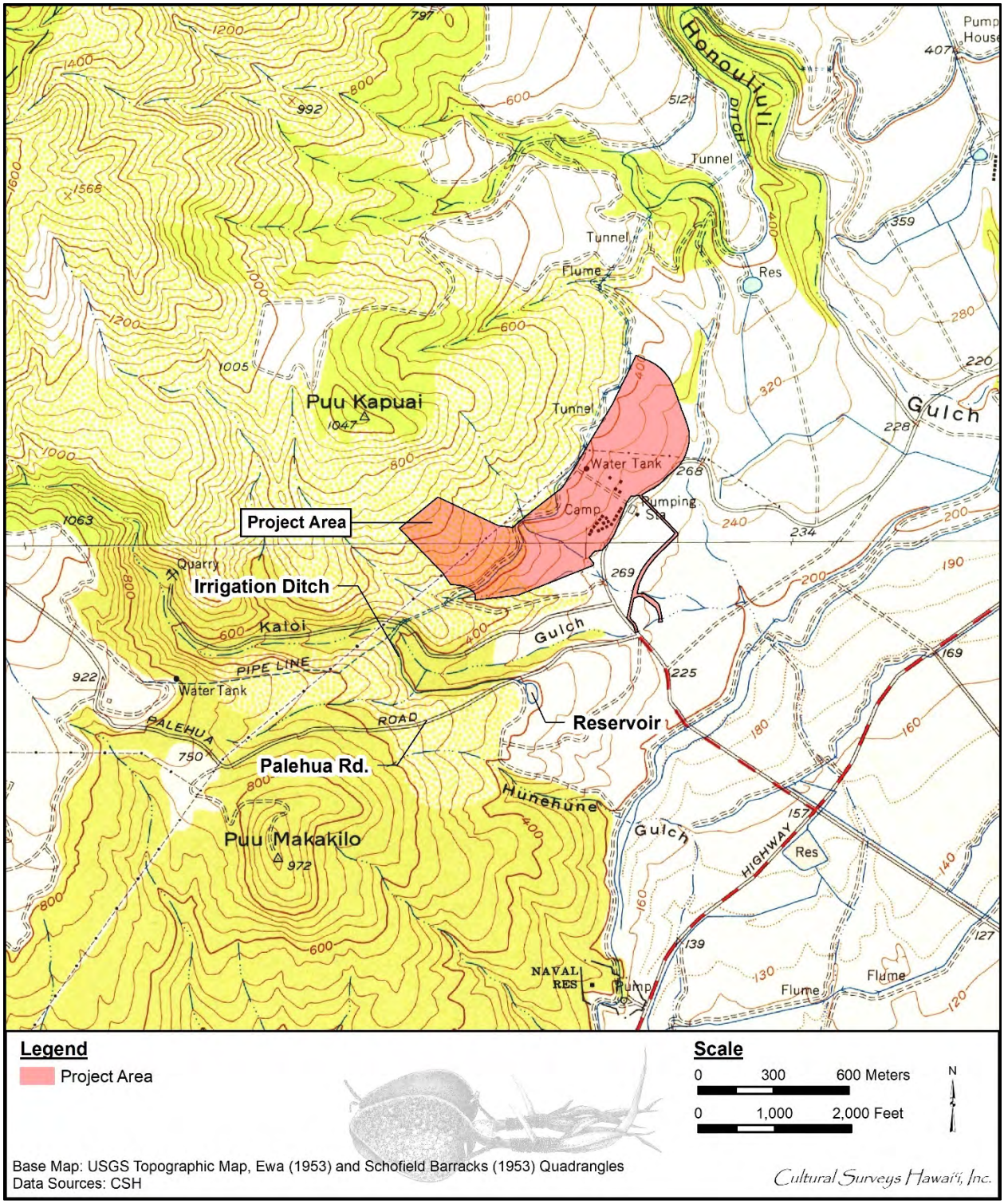

Figure 19. Portion of the 1953 Ewa and Schofield Barracks USGS topographic quadrangles showing the project area

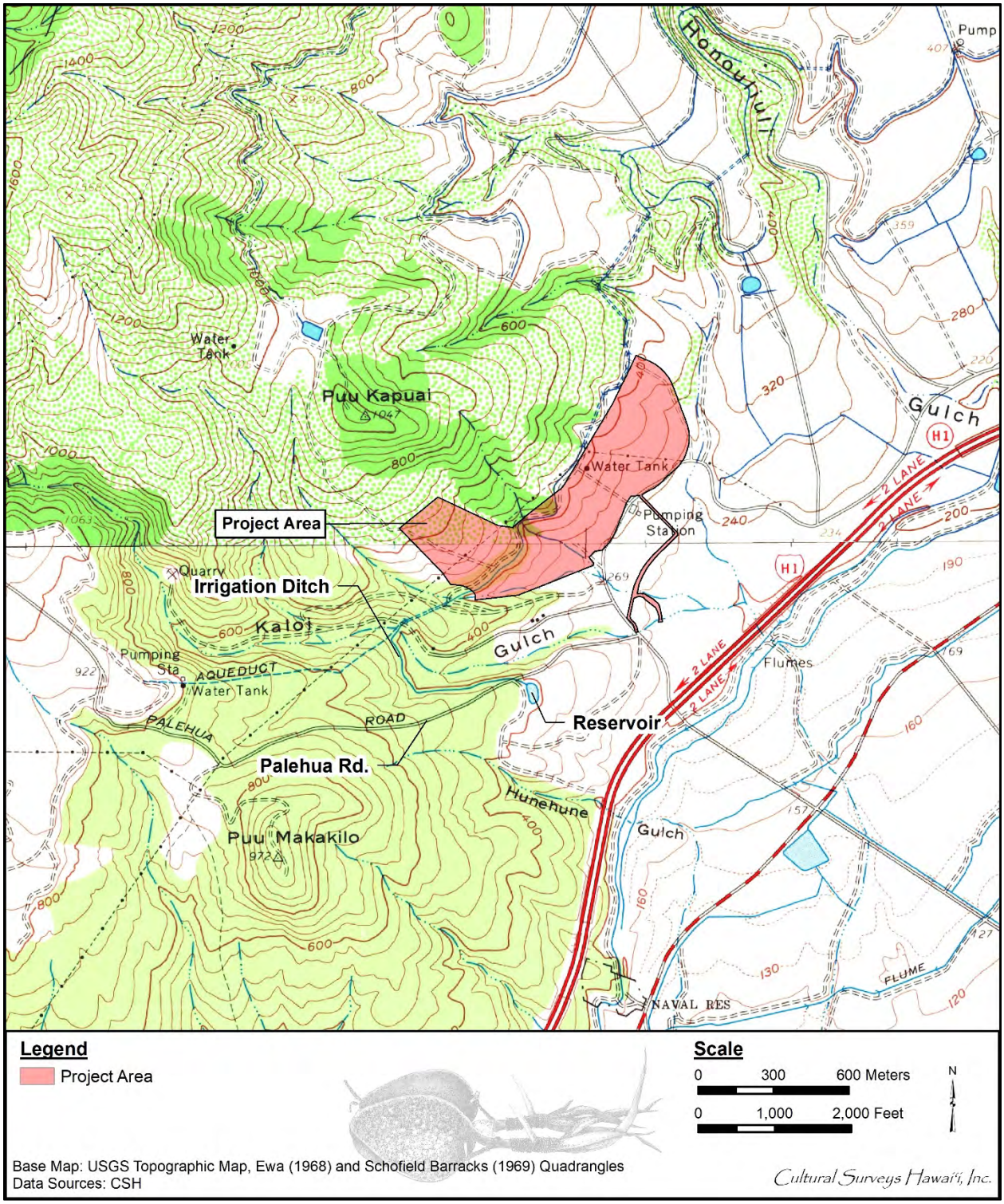

Figure 20. Portion of the 1968 Ewa and 1969 Schofield Barracks USGS topographic quadrangles showing the project area

depicted as improved in 1953, is now shown as unimproved, suggesting abandonment of some quarrying operations.

3.1.6 Contemporary Land Use

Modern maps of the Makakilo area indicate vast changes to the project area and surrounding lands, including the retreat of the sugarcane fields, the construction of the H-1 Freeway, and the partial construction of the Pu‘u Makakilo Golf Course and Grace Pacific Makakilo Quarry.

A 1968 USGS aerial photograph (Figure 21) shows virtually the entire project area still utilized for sugarcane, though there is no trace of the former Pump Camp 5 residential areas that appear to be entirely covered with cane. Many of these plantation homes are understood to have been slightly raised on “tofu-block” foundations that allowed for relatively complete demolition, leaving only the remnants of privies and trash pits. The 1968 photograph also shows new fields to the northwest (see Figure 21).

In 1969 and 1970, Pacific Concrete and Rock Company, Ltd. began subsurface drilling on the southward facing slopes of Pu‘u Makakilo for a new quarry location. The company’s previous quarry in Pu‘u Pāla‘ila‘i that had been in operation for the past 22 years was nearly exhausted. The newly proposed Makakilo Quarry would “encompass 72 acres of actual total quarry area and 188 acres of green belt buffer. Of the 72 acres of actual quarry area, only a maximum of 18 acres will be under active quarrying at any given time” (Cerny 1972:1).

A 1977 USGS aerial photograph (Figure 22) appears to display decreased sugarcane cultivation in the Wai‘anae foothills. It is not clear if the project area is in active cultivation or not. Clearly by 1993 (Figure 23) sugarcane cultivation within the project area is finished, although it remains active immediately southeast of the project area.

Sometime in the early 1990s, a group of Japanese investors poured $70 million into the development of the Pu‘u Makakilo Golf Course. The golf course’s exact date of construction is unclear; however, the proposed area was surveyed by Sinoto in 1988 (Sinoto 1988). The golf course was situated on the slopes of Pu‘u Makakilo just north of the rock quarry. During a burst bubble in the Japanese investment market the project foundered, and the course and buildings were purchased by Grace Pacific in 1994 (*Honolulu Advertiser*, May 2004:31). Construction of the golf course resulted in grading and terracing of a large area southwest of the present project area for fairway construction.

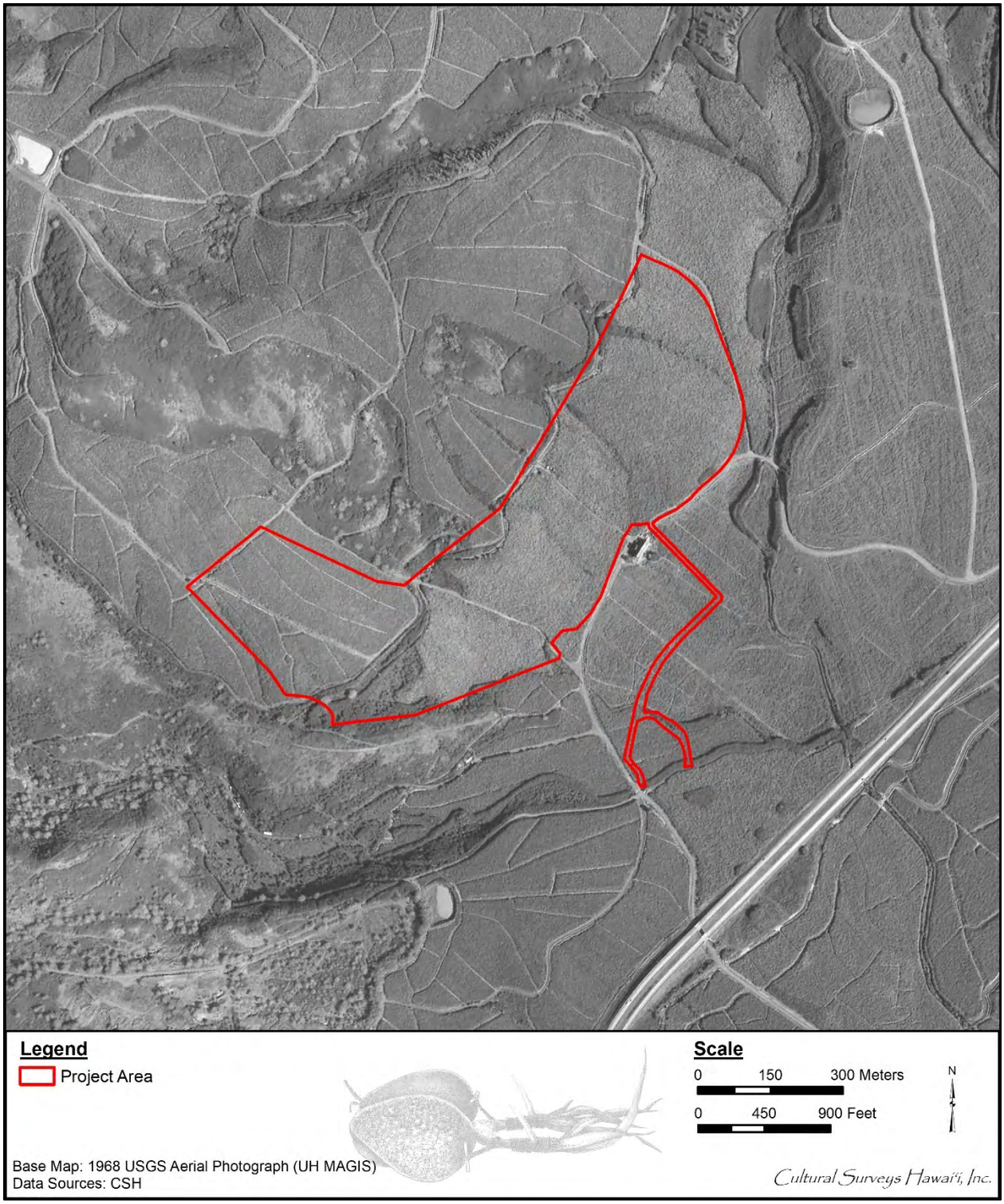

Figure 21. 1968 USGS aerial photograph (UH MAGIS) showing the project area

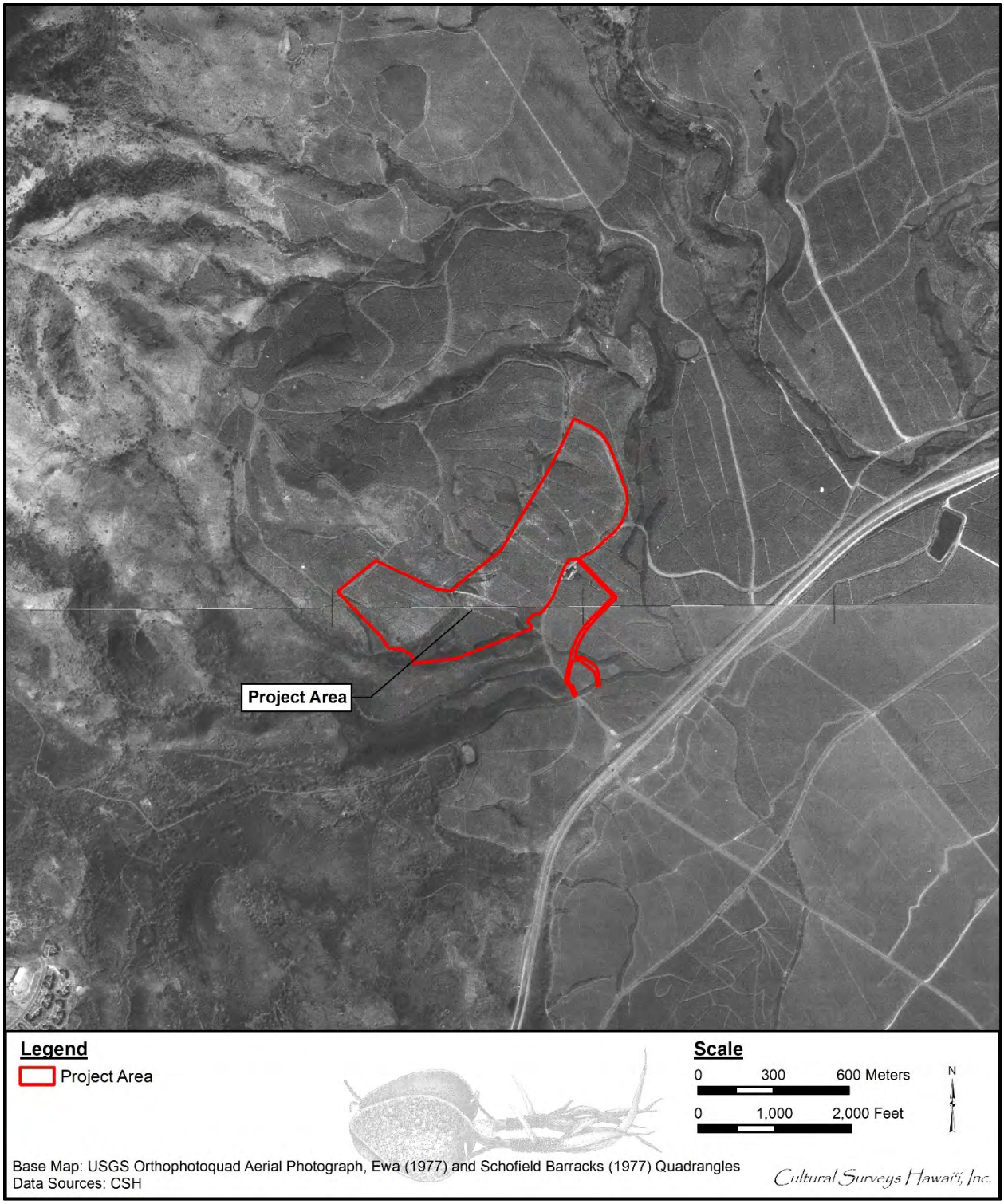

Figure 22. 1977 USGS Orthophotoquad aerial photograph, Ewa and Schofield Barracks quadrangles showing the project area

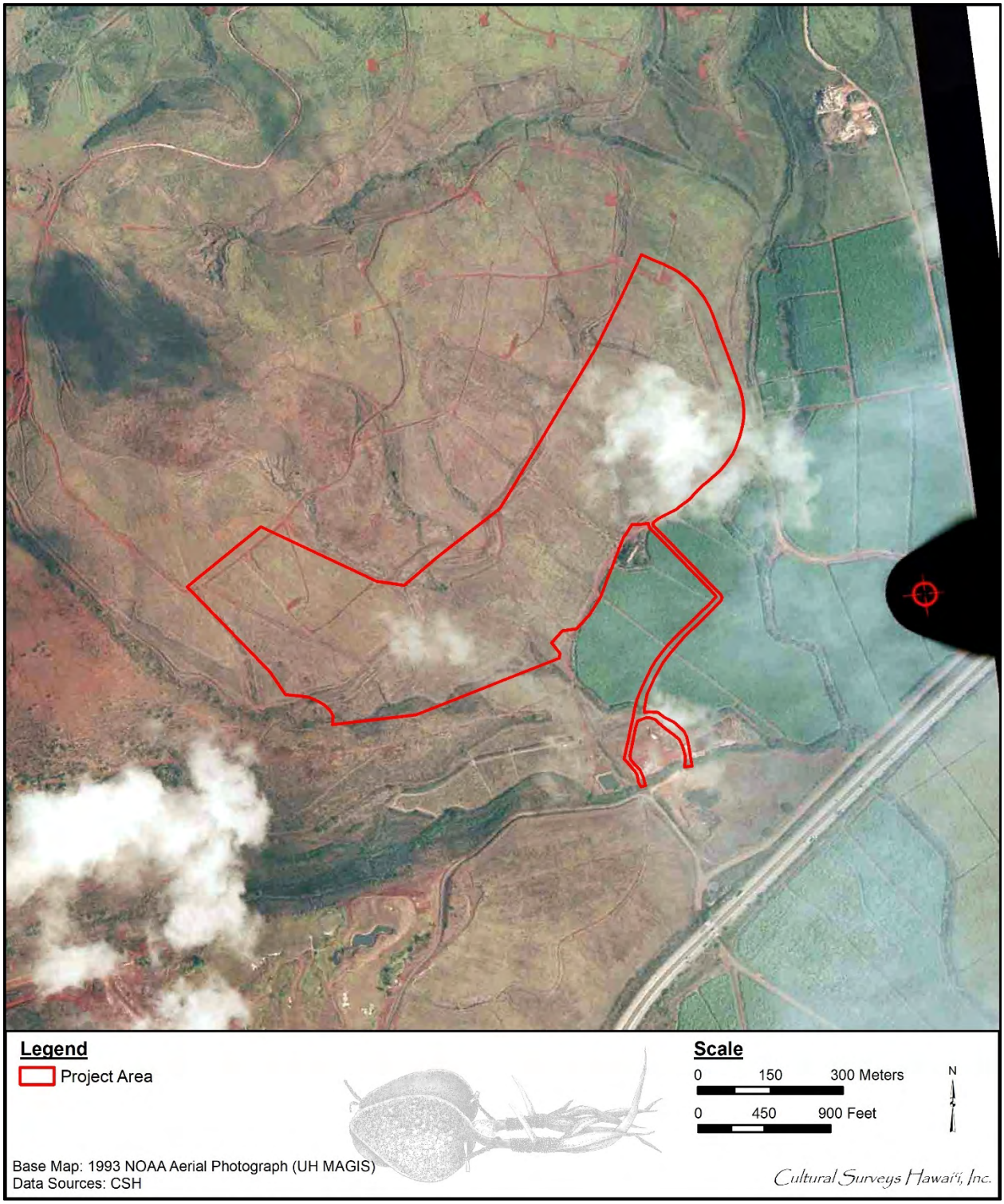

Figure 23. 1993 NOAA aerial photograph (UH MAGIS) showing the project area

3.2 Previous Archaeological Research

Previous archaeological studies in the vicinity (within approximately 1.5 km) of the current project area are shown in Figure 24 and Table 1, and a summary of these studies follows. Figure 25 and Table 2 show the locations of historic properties in the vicinity of the project area. There are no sites documented by McAllister (1933) in his early archaeological reconnaissance study of O‘ahu in the vicinity of the project area.

3.2.1 Bordner 1977

In 1977, the Archaeological Research Center Hawaii, Inc. (Bordner 1977) conducted an archaeological reconnaissance survey of a then proposed Kalo‘i Gulch landfill location, approximately 500 m west of the present project area. The study concluded the lower section of the gulch had been extensively modified through quarrying operations and cattle ranching. Foundations of both crushing and loading facilities were noted. In the upper reaches of the property, three walls of possible pre-Contact origin were documented between 1,250 and 1,300 ft elevation and designated as SIHP #s 50-80-12-2600, -2601 and -2602. These three historic properties were in the extreme, upslope end of the large property more than 1.5 km from the present project area. SIHP # 50-80-12-2600 was a low (only 0.61 m, or 2 ft high) wall of poorly stacked *pāhoehoe*, approximately 7.62 m (25 ft) long set on top of a small knoll jutting out from the slope. SIHP # 50-80-12-2601 is described as a wall built on the stream terrace cut following the course of the stream and constructed of stacked *pāhoehoe* with a total length of 67.70 m (222.1 ft), an average height of 0.91 m (3.0 ft) and incorporating in situ boulders into the wall. The wall appeared to have been constructed so as to protect a stream terrace from erosion. It also retained a terrace measuring approximately 12 m (39.4 ft) by 31 m (101.7 ft). SIHP # 50-80-12-2602 was a free-standing 18.2 m (59.7 ft) wall of stacked *pāhoehoe* that had the appearance of being a boundary wall. The historic properties were regarded as of “a marginal status” and no further archaeological work was recommended for the area covered by the reconnaissance survey.

3.2.2 Sinoto 1988

In 1988, the Bishop Museum Applied Research Group conducted a surface survey for a then proposed Makakilo Golf Course just southwest of the current project area (Sinoto 1988). The study concluded the majority of the project area had been damaged by severe erosion. No surface historic properties were documented and subsurface testing was deemed unnecessary. Just west (outside) of the golf course property, one deteriorated wall segment was documented on the northeast slope of Pu‘u Makakilo. The wall, designated SIHP # 50-80-12-1975, may have served as an “historic erosional control feature” (Sinoto 1988:1). Due to the deteriorated condition of the wall remnant, no further work was recommended.

3.2.3 Spear 1996

Scientific Consultant Services, Inc. conducted an archaeological reconnaissance survey of a large area extending from south of the H-1 freeway to the north side of Renton Road (Spear 1996). No historic properties were identified.

3.2.4 Dega et al. 1998

In 1998, Scientific Consultant Services, Inc. (SCS) conducted an archaeological inventory survey for the University of Hawai‘i, West O‘ahu Campus project area (Dega et al. 1998). The

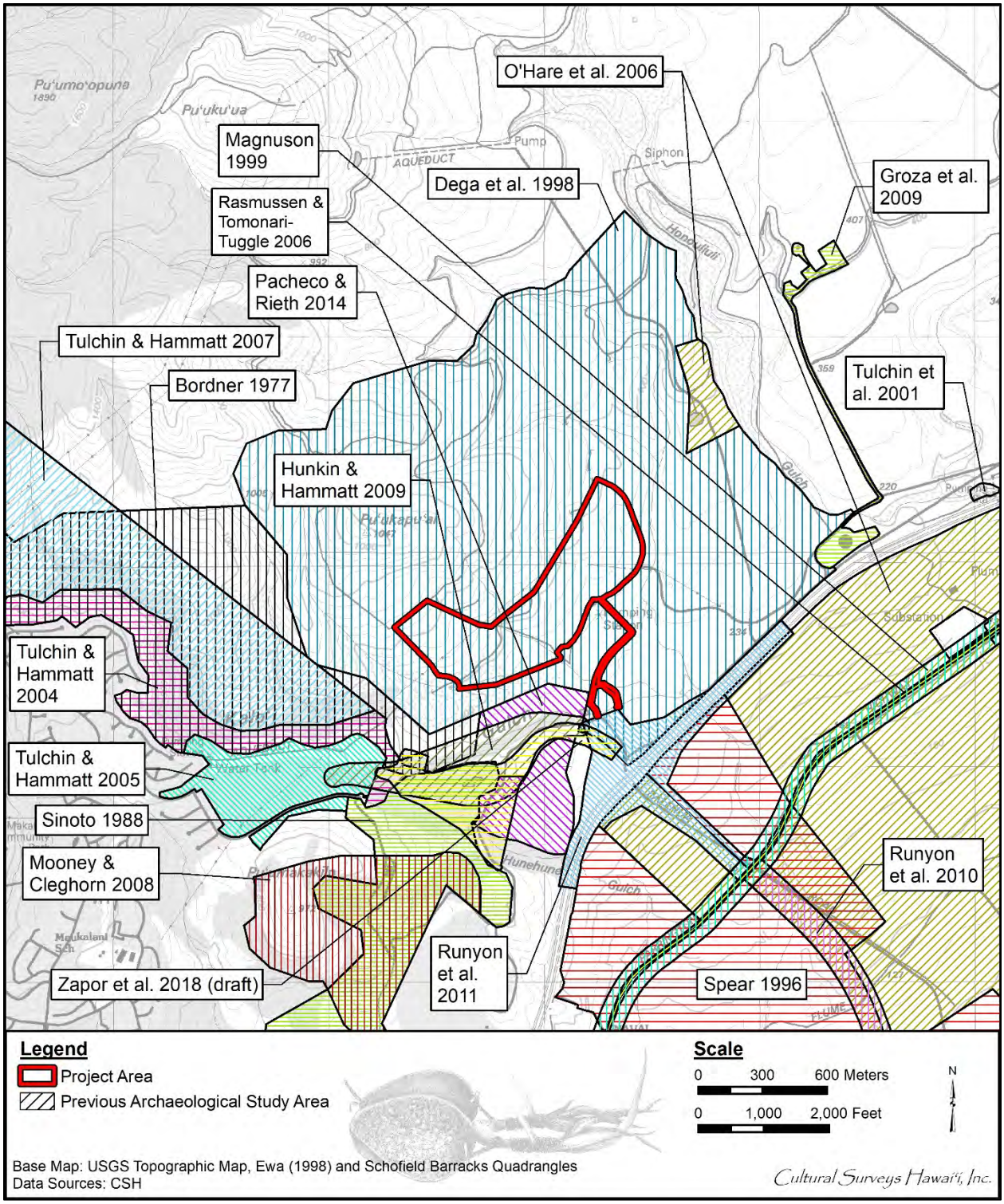

Figure 24. Portion of the 1998 Ewa and Schofield Barracks USGS topographic quadrangles showing the locations of previous archaeological studies in the vicinity (within approximately 1.5 km) of the project area

Table 1. Previous archaeological studies within the vicinity (within approximately 1.5 km) of the project area

Reference	Type of Study	Location	Results
Bordner 1977	Archaeological reconnaissance survey	Proposed Kalo‘i Gulch landfill location	Three walls designated as SIHP #s 50-80-12-2600, -2601 and -2602 in extreme west, upslope end of property, more than 1.5 km from present project area (hence not depicted in Figure 25)
Sinoto 1988	Archaeological reconnaissance survey	Makakilo Golf Course	Documented a low stacked boulder wall outside the property: SIHP # 50-80-09-1975
Spear 1996	Archaeological reconnaissance survey	East Kapolei, TMK: [1] 9-1-016:017	No historic properties identified
Dega et al. 1998	Archaeological inventory survey	UH West O‘ahu, TMK: [1] 9-2-002:001	Documented two historic property complexes: historic irrigation and plantation infrastructure system (SIHP # 50-80-08-5593) and Waiahole Ditch System (SIHP # 50-80-09-2268)
Magnuson 1999	Archaeological reconnaissance survey	‘Ewa Plain	Identified six concrete bridges, a railroad track, and a set of unidentified concrete features; no SIHP #s assigned
Tulchin et al. 2001	Archaeological inventory survey	Proposed ‘Ewa Shaft Renovation project, Honouliuli Gulch, adjacent to west-bound lanes of H-1, TMK: [1] 9-2-001	Identified one historic property: SIHP # 50-80-08-6370, stone wall alignment; also documented large pumping station and shaft building
Tulchin and Hammatt 2004	Archaeological inventory survey	86-acre proposed Pālehua Community Association, TMKs: [1] 9-2-003:078 por. and 079	Four historic properties identified: a complex of concrete and iron structures associated with industrial rock quarry operations (SIHP # 50-80-12-6680); three boulder mounds believed related to land clearing or ditch construction by Oahu Sugar Co. (SIHP # 50-80-12-6681); a small terrace believed to function as historic water diversion feature (SIHP # 50-80-12-6682); and a remnant portion of Waiahole Ditch (SIHP # 50-80-09-2268)

Reference	Type of Study	Location	Results
Tulchin and Hammatt 2005	Archaeological inventory survey	71-acre proposed Pālehua East B project, Makakilo, TMKs: [1] 9-2-003:076 and 078	Three historic properties identified: pre-Contact agricultural alignment and mound (SIHP # 50-80-12-6666), plantation-era stacked basalt boulder walls and a ditch (SIHP # 50-80-12-6667), and single alignment of upright basalt boulders and small, low terrace (SIHP # 50-80-12-6668)
O’Hare et al. 2006	Archaeological inventory survey	Ho‘opili East Kapolei	Documented six previously identified historic properties: plantation infrastructure (SIHP # 50-80-12-4344); railroad berm (SIHP # 50-80-12-4345); northern pumping station (SIHP # 50-80-12-4346); central pumping station (SIHP # 50-80-12-4347); southern pumping station (SIHP # 50-80-12-4348); and documented four newly identified features of SIHP # 50-80-12-4344: a linear wall, stone-faced berm, concrete ditch, and concrete catchment
Rasmussen and Tomonari-Tuggle 2006	Archaeological monitoring	Waiau Fuel Pipeline corridor	No historic properties identified
Tulchin and Hammatt 2007	Archaeological literature review and field inspection	Approx. 790-acre parcel, TMK: [1] 9-2-003:002 por. and 005 por.	Documented features interpreted as related to pre-Contact indigenous Hawaiian habitation (SIHP #s 50-80-08-2316 and 50-80-12-2602); historic ranching and related features (SIHP # 50-80-12-2601); and historic quarrying and related features (SIHP # 50-80-12-6680) and various pre- and post-Contact features (designated with temporary #s CSH1–CSH22)
Mooney and Cleghorn 2008	Archaeological reconnaissance survey	TMK: [1] 9-2-003:018	No historic properties identified
Groza et al. 2009	Archaeological inventory survey	TMKs: [1] 9-2-001:001 por., 004, 005, 006, 007 por.; 9-2-002:002	No historic properties identified

Reference	Type of Study	Location	Results
Hunkin and Hammatt 2009	Archaeological inventory survey	TMKs: [1] 9-2-002:006; 9-2-003:079	Documented two newly identified historic properties: irrigation ditches (SIHP #s 50-80-12-6950 and -6951); and one previously identified historic property, Waiahole Ditch (SIHP # 50-80-09-2268)
Runyon et al. 2010	Archaeological monitoring	TMKs: [1] 9-2-002:006; 9-2-003:079	No historic properties identified
Runyon et al. 2011	Archaeological monitoring	TMKs: [1] 9-1-018:001, 003, 004, 005; 9-2-002:001, 006	Documented two historic properties: a water diversion and a trash deposit (SIHP #s 50-80-12-4664 and -7128)
Pacheco and Rieth 2014	Archaeological inventory survey	East Kapolei Solar Farm, TMK: [1] 9-2-002:006 por.	Documented SIHP # 50-80-12-7433, an unpaved early twentieth century agricultural (ranching and/or sugarcane cultivation) road, understood as created between 1918 and 1928
Zapor et al. 2018	Archaeological inventory survey	Makakilo Dr extension project, TMKs: [1] 9-2-002:007, 009, 009; 9-2-003:074, 092; 9-2-039:110, 114; and 9-2-045:001	Documented two historic properties: SIHP # 50-80-09-2268, remnant portion of Waiahole Ditch, and SIHP # 50-80-12-6951, irrigation ditches; identified one new feature of Waiahole Ditch, an earthen mound and stacked stone wall, interpreted as likely remnants of a reservoir (Feature D)

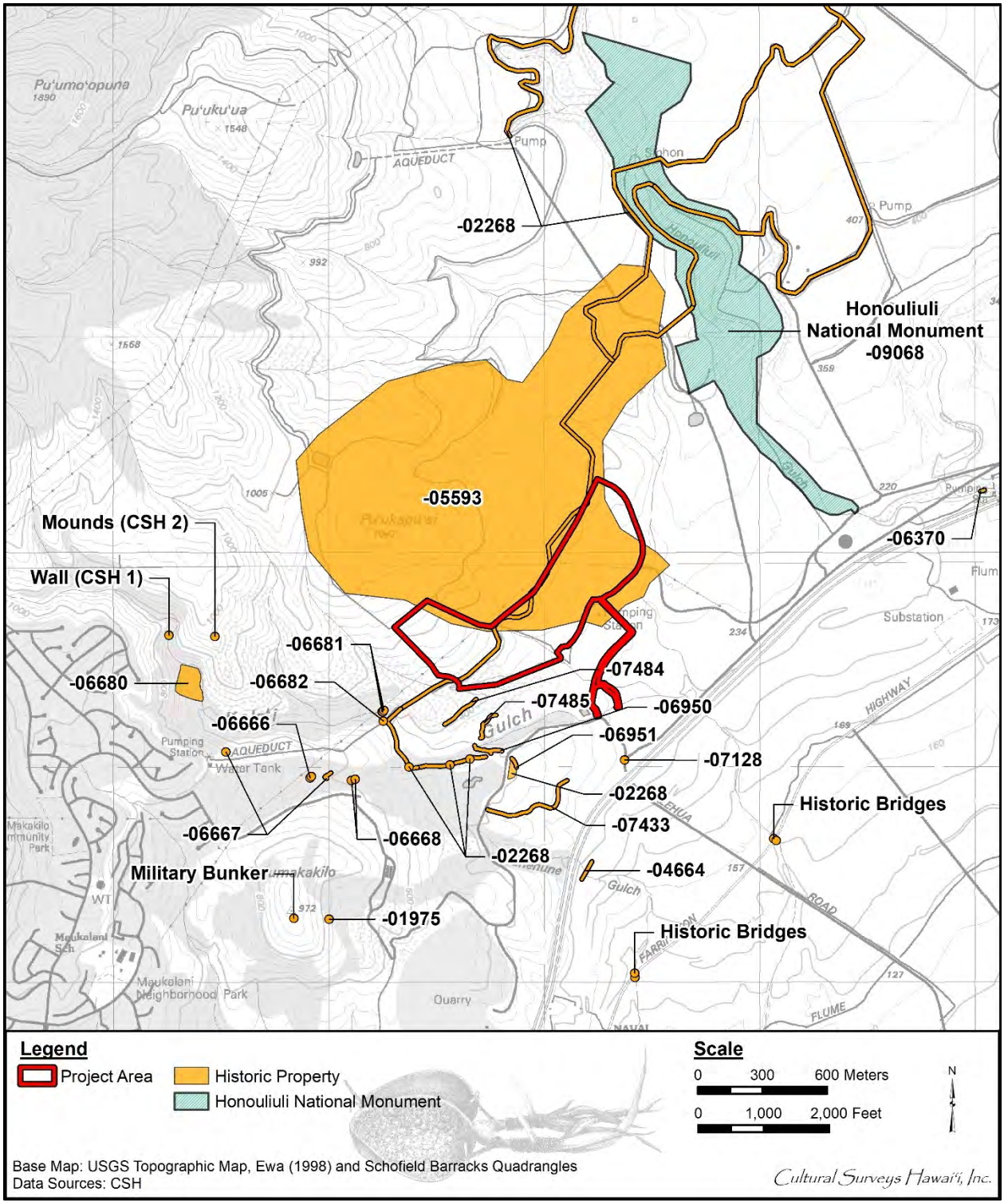

Figure 25. Portion of the 1998 Ewa and Schofield Barracks USGS topographic quadrangles showing the locations of previously identified historic properties in the immediate vicinity of the project area (note the SIHP # -5593 property boundary is defined as the Dega et al. 1998 project area and not the true extent or location of its features)

Table 2. Previously identified historic properties in the vicinity of the project area

SIHP #	Description	Reference
50-80-12-1975	Low-stacked boulder wall segment	Sinoto 1988
50-80-09-2268	Waiahole Ditch System	Goodman and Nees 1991; Hammatt et al. 1996; Dega et al. 1998; Tulchin and Hammatt 2005; Hunkin and Hammatt 2009; Zapor et al. 2018; Shideler and Hammatt 2018
50-80-12-4664	Historic water diversion structure	Nakamura et al. 1993; Runyon et al. 2011
50-80-08-5593	Plantation-era “flumes, aqueducts, ditches, pumps, and other irrigation features”	Dega et al. 1998
50-80-08-6370	Stone wall alignment, likely associated with cattle ranching or pumping station	Tulchin et al. 2001
50-80-12-6666	Alignment and mound	Tulchin and Hammatt 2005
50-80-12-6667	Two walls	Tulchin and Hammatt 2005
50-80-12-6668	Alignment and terrace	Tulchin and Hammatt 2005
50-80-12-6680	Complex of concrete and iron structures associated with industrial rock quarry operations	Tulchin and Hammatt 2005
50-80-12-6681	Three boulder mounds believed related to land clearing or ditch construction by Oahu Sugar Company	Tulchin and Hammatt 2005
50-80-12-6682	Terrace believed to function as an historic water diversion feature	Tulchin and Hammatt 2005
50-80-12-6950	Portion of a plantation-era irrigation ditch	Hunkin and Hammatt 2009
50-80-12-6951	Portion of a plantation-era irrigation ditch	Hunkin and Hammatt 2009
50-80-12-7128	Burned trash fill layer	Runyon et al. 2011

SIHP #	Description	Reference
50-80-12-7433	Unpaved early twentieth century agricultural (ranching and/or sugarcane cultivation) road, understood as created between 1918 and 1928	Pacheco and Rieth 2014
50-80-12-7484	Post-Contact irrigation ditch portion	Pacheco and Rieth 2014
50-80-12-7485	Post-Contact irrigation ditch portion	Pacheco and Rieth 2014
50-80-08-9068	Honouliuli National Monument (Internment Camp)	National Register
Historic Bridges	No SIHP #s assigned, no further documentation or mitigation recommended	Magnuson 1999
Military Bunker	WWII-era bunker	Mooney and Cleghorn 2008
CSH 1	Post-Contact wall related to historic ranching	Tulchin and Hammatt 2007
CSH 2 (Mounds)	Two basalt mounds interpreted as possible trail markers	Tulchin and Hammatt 2007

survey encompassed the entirety of the current project area. Several plantation-era “flumes, aqueducts, ditches, pumps, and other irrigation features occurring within the heavily modified landscape” were noted (Dega et al. 1998:i). The features represented an extensive complex of sugarcane irrigation features used from the 1920s through more recent times. The irrigation complex was designated SIHP # 50-80-08-5593. A portion of the Waiahole Ditch System (SIHP # 50-80-09-2268) (previously recorded by Goodman and Nees 1991) was also documented crossing through the northwest section of the subject parcel and continuing southwest through the lower agricultural fields. No artifacts were recovered from the project area. No further work was recommended for SIHP # 50-80-08-5593.

An overlay of the present project area on the Dega et al. (1998) plan map (Figure 26) indicates it lies entirely within the south/central portion of the 1998 AIS project. While the Dega et al. (1998) plan map should probably be understood as a sketch, it does indicate certain remnants of plantation infrastructure (designated as SIHP # 50-80-08-5593) were present in the property in 1998. Dega et al. (1998) defined the entire project area as the boundaries of SIHP # 50-80-08-5593. However, the identified features represent a substantially smaller area than the overall boundary.

3.2.5 Magnuson 1999

In 1999, an archaeological reconnaissance survey was completed by International Archaeological Research Institute, Inc. (IARII) for a Farrington Highway Expansion project extending along 5.3 km (3.3 miles) of Farrington Highway between Golf Course Road and Fort Weaver Road with a roughly 61-m (200-ft) wide corridor on each side (Magnuson 1999). The project identified six concrete bridges, one railroad track, and “a set of unidentified concrete features” (Magnuson 1999:17). The study concluded the following:

> The sites observed in the Farrington Highway Expansion project are neither exemplary sites of their kind nor unique. Therefore these sites have been adequately recorded during the investigations and no further work is necessary should preservation not be possible. [Magnuson 1999:25]

3.2.6 Tulchin et al. 2001

CSH archaeologists completed an archaeological inventory survey in support of a proposed ‘Ewa Shaft Renovation project. The ‘Ewa Shaft project is within Honouliuli Gulch, adjacent to the west-bound lanes of the H-1 Interstate Highway, approximately 1.7 km east of the present project area. That property included a pumping station enclosure and the surrounding area of approximately 1 acre. The survey documented one historic property, a stone wall alignment designated SIHP # 50-80-08-6370. Subsurface testing was conducted adjacent to the wall. The study interpreted the wall alignment as associated with cattle ranching or the pumping station. The study also documented a portion of the large pumping station and shaft building on the property.

3.2.7 Tulchin and Hammatt 2004

In 2004, CSH conducted an archaeological inventory survey to the west of the current project area for the Pālehua Community Association (PCA) in Makakilo (Tulchin and Hammatt 2004). Three overhang shelters were observed and tested, however, no cultural material was identified during excavation. The study documented several historic properties, including a complex of

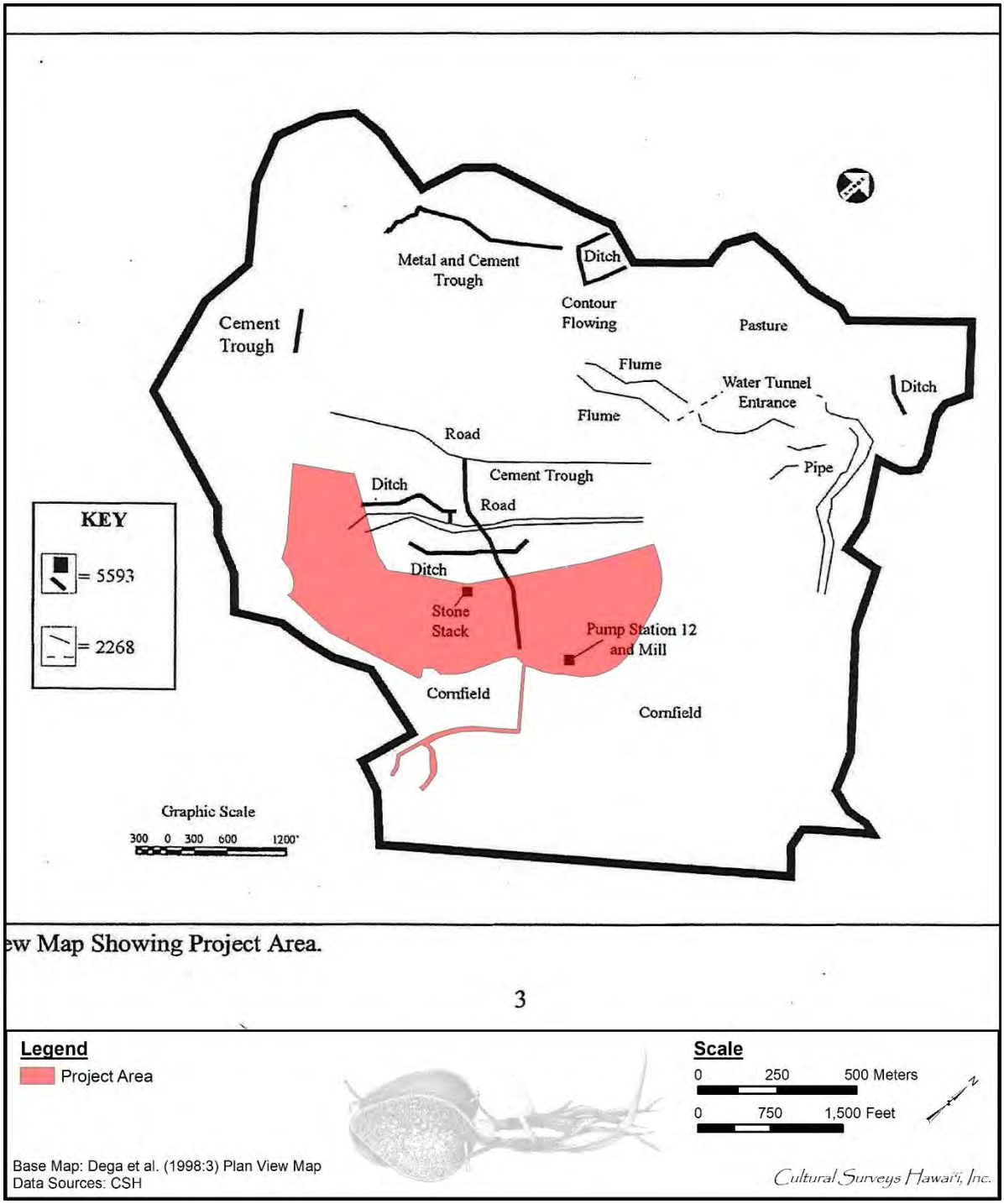

Figure 26. Plan map of the AIS for the University of Hawai‘i, West O‘ahu Campus project area showing historic properties (as of 1998) with an overlay of the current project area (adapted from Dega et al. 1998:3). This overlay suggests “Pump Station 12 and Mill” and a ditch were documented as within the present project area and another ditch and road and “Stone stack” were adjacent to the north side of the present project area (note this is a sketch and locations are approximate)

concrete and iron structures associated with industrial rock quarry operations (SIHP # 50-80-12-6680); three boulder mounds believed to be related to land clearing or ditch construction by the Oahu Sugar Company (SIHP # 50-80-12-6681); a small terrace believed to function as an historic water diversion feature (SIHP # 50-80-12-6682); and a remnant portion of the Waiahole Ditch (SIHP # 50-80-09-2268).

3.2.8 Tulchin and Hammatt 2005

In 2005, CSH conducted an archaeological inventory survey west of the current project area for the proposed Pālehua East B project in Makakilo (Tulchin and Hammatt 2005). The study identified three historic properties, including an alignment and a mound (SIHP #s 50-80-12-6666A and B), two walls (SIHP #s 50-80-12-6667A and B), and an alignment and terrace (SIHP #s 50-80-12-6668A and B). SIHP # 50-80-12-6667 is thought to contain remnants of plantation infrastructure. The historic properties were documented in an unnamed gully south of Kalo‘i Gulch.

3.2.9 O’Hare et al. 2006

In 2006, CSH conducted an archaeological inventory survey of approximately 1,600 acres for the East Kapolei project (subsequently known as the Ho‘opili project) to the southeast of the present project area (O’Hare et al. 2006). The Ho‘opili project was bounded on the east by Fort Weaver Road, *makai* (seaward) by Mango Tree Road, and *mauka* by the H-1 Freeway.

Several historic properties documented by the O’Hare et al. (2006) study were previously identified during an archaeological survey in 1990 (Hammatt and Shideler 1990). These previously identified historic properties included SIHP # 50-80-12-4344, plantation infrastructure; SIHP # 50-80-12-4345, railroad berm; SIHP # 50-80-12-4346, northern pumping station; SIHP # 50-80-12-4347, central pumping station; and SIHP # 50-80-12-4348, southern pumping station.

The survey identified four additional features of SIHP # 50-80-14-4344. These additional features include Feature D, a linear wall along the east bank of Honouliuli Stream; Feature E, a linear wall along the west bank of Honouliuli Stream; Feature F, a stone-faced berm constructed perpendicular to the orientation of the stream; and Feature G, a concrete ditch and concrete masonry catchment basement on the west bank of Honouliuli Gulch. None of the historic properties identified in the O’Hare et al. study (2006) were near the present project area.

3.2.10 Rasmussen and Tomonari-Tuggle 2006

In 2006, IARII conducted archaeological monitoring along the Waiau Fuel Pipeline corridor, extending from the Hawaiian Electric Company’s Barbers Point Tank Farm to the Waiau Generating Station (Rasmussen and Tomonari-Tuggle 2006). The Waiau Fuel Pipeline corridor follows Farrington Highway to Kunia Road, angles *makai* near Kunia Road, then continues east along the OR&L right-of-way near the Pearl Harbor coast. It appears no archaeological monitoring was conducted west of Waipi‘o Peninsula, as the corridor to the west was determined to not be archaeologically sensitive. No historic properties were identified during archaeological monitoring.

3.2.11 Tulchin and Hammatt 2007

In 2007, CSH completed an archaeological literature review and field inspection of an approximately 790-acre parcel at Pālehua, Makakilo (Tulchin and Hammatt 2007). The inspection

covered portions of Makaīwa Gulch, Awanui Gulch, and Kalo‘i Gulch. Overall, 26 historic properties were identified during the field inspection. The study included further documentation of four previously identified historic properties: SIHP # 50-80-08-2316, a *ku‘ula* stone; SIHP # 50-80-12-2601, a pre-Contact wall utilized as a water control feature; SIHP # 50-80-12-2602, a pre-Contact wall possibly utilized for agriculture; and SIHP # 50-80-12-6680, a complex of concrete and iron structures associated with industrial rock quarry operations.

Newly identified historic features (designated with temporary CSH site #s) included CSH 1, wall; CSH 2, mounds; CSH 3, large enclosure; CSH 4, platform; CSH 5, mounds; CSH 6, adze; CSH 7, platform; CSH 8, terraces; CSH 9, enclosure and two small caves; CSH 10, enclosure; CSH 11, mound; CSH 12, platform; CSH 13, enclosure; CSH 14 terrace; CSH 15, wall remnant, hearth, and military “foxhole”; CSH 16, terrace and *hau* thicket; CSH 17, level soil along ridge; CSH 18, enclosure; CSH 19, trail; CSH 20 water tunnel; CSH 21, large boulder with petroglyphs; and CSH 22, enclosure with stone uprights. These potential historic properties were not assigned SIHP #s.

Other than the previously reported SIHP # -6680 complex of structures associated with industrial rock quarry operations, none of the identified historic properties were in the vicinity of the present project area.

3.2.12 Mooney and Cleghorn 2008

In 2008, Pacific Legacy, Inc. conducted an AIS (recorded as an archaeological assessment due to lack of finds) for the proposed Makakilo Quarry expansion (Mooney and Cleghorn 2008). No historic properties were identified; however, the remnants of a modern, abandoned golf course were noted.

3.2.13 Groza et al. 2009

In 2009, CSH conducted an AIS (recorded as an archaeological assessment) for the Ho‘opili project 440-Ft Elevation Reservoir and Water Line project (Groza et al. 2009). No historic properties were identified.

3.2.14 Hunkin and Hammatt 2009

In 2009, CSH completed an archaeological inventory survey for an approximately 62-acre Makakilo Drive extension project (Hunkin and Hammatt 2009). The project documented two newly identified historic properties (SIHP #s 50-80-12-6950 and -6951). Both historic properties are portions of plantation irrigation ditches. The ditches functioned to transport water for irrigation of the sugarcane fields.

In addition to the newly identified historic properties, the project documented a portion of the previously identified SIHP # 50-80-09-2268 alignment. A meeting was held on site within the project area with CSH staff, SHPD staff, and Mr. Shad Kane on 10 February 2009 to discuss the alignment. Mr. Kane led the group along the graded alignment of SIHP # 50-80-09-2268, within the property, indicating the ditch had been constructed over the alignment of an ancient Hawaiian trail. SHPD staff observed the plantation irrigation ditch and associated infrastructure and concurred the alignment was a portion of the Waiahole Ditch System. SHPD staff also concluded the ditch was most likely constructed over the alignment of a pre-Contact Hawaiian trail. SHPD staff expressed a concern that documentation make it clear the pre-Contact Hawaiian trail function

was the dominant function of this designated site in the vicinity (which was then developed as the Waiahole Ditch in the early twentieth century). This discussion of a Hawaiian trail function was understood to apply only to that portion of the Waiahole Ditch System at Kalo‘i Gulch.

Two new features (SIHP # 50-80-09-2268 Features B and C) associated with the main ditch were also documented. These features are drainage-related, with the function of preventing storm water and sediment from entering the main Waiahole Ditch.

3.2.15 Runyon et al. 2010

In 2010, CSH conducted archaeological monitoring for Phase 1B of the North-South Road project (Runyon et al. 2010). No historic properties were identified.

3.2.16 Runyon et al. 2011

In 2011, CSH completed archaeological monitoring for phase 1C of the North-South Road project (Runyon et al. 2011). Two historic properties were identified. A previously identified historic water diversion structure (SIHP # 50-80-12-4664), originally documented by Nakamura et al. (1993), was observed on the southwest edge of Ramp C. A newly identified burnt trash fill layer (SIHP # 50-80-12-7128) was documented directly under Pālehua Road on the west edge of Ramp A.

3.2.17 Pacheco and Rieth 2014

In 2014, IARII conducted an archaeological inventory survey (Pacheco and Rieth 2014) for an East Kapolei Solar Farm project (on approximately 19 acres of TMK: [1] 9-2-002:006).The study documented one historic property: SIHP # 50-80-12-7433, an unpaved early twentieth century road related to ranching and/or sugarcane cultivation in the area, understood as created between 1918 and 1928.

3.2.18 Zapor et al. 2018

CSH conducted a supplemental archaeological inventory survey for the Makakilo Drive Extension project (Zapor et al. 2018). The survey identified two historic properties: remnant portions of the Waiahole Ditch (SIHP # 50-80-09-2268) and irrigation ditches (SIHP # 50-80-12-6951). The project documented an additional feature of the Waiahole Ditch, an earthen mound and stacked stone wall, interpreted as likely remnants of a reservoir (Feature D). SIHP # 50-80-12-6951 was observed as an irrigation ditch and associated retaining wall, pipe, valve, and sluice gate remnants.

3.3 **Background Summary and Predictive Model**

Background research of Honouliuli Ahupua‘a indicated pre-Contact settlement was centered around the rich cultivated lands of Honouliuli ‘Ili for extensive wetland taro cultivation and abundant coastal resources. The extensive limestone plain also included recurrent use habitations for fishermen and gatherers, and sometimes gardeners. The upland dry forest areas were used for hunting and gathering of forest resources, but likely not for widespread permanent settlement. In the intermediate area between the limestone plain and the upland forests, in the vicinity of the current study area, indigenous Hawaiian activities would have been limited to dryland agriculture within gulches or near springs, and *mauka* to *makai* trails and associated temporary shelters.

Within the “Makaīwa Hills” area, which is southwest of the project area, pre-Contact habitation sites were found clustered in higher elevations above 1,000 ft, and in lower elevations below 500 ft (Hammatt et al. 1991). The higher elevations, where the current study is located, do not contain forest subsistence resources.

In Von Holt’s (1985) accounts of discovering spring water southwest of the study area, it is noted that Kalo‘i had “been a place of which the Hawaiians had known” and the area “had been quite heavily populated before the smallpox epidemic of 1840” (von Holt 1985:138–140). However, there was no mention of observations of any physical evidence of Hawaiian settlement, other than the paved well (Hidden Spring). It is quite possible ranching or agricultural activities destroyed any remnants of Hawaiian occupation prior to the late 1800s.

By 1920, the lands of Honouliuli were used primarily for commercial sugarcane cultivation and ranching (Frierson 1972). Much of the *mauka* lands in western Honouliuli, including ridges and deep gulches, were unsuitable for commercial sugar cultivation and remained pasture land for grazing livestock. Historic maps indicate a lack of any significant development within the study area into the 1940s. Modest constructions in the area included Pālehua Road, allowing access to the uplands of western Honouliuli, as well as plantation infrastructure within and to the south of the study area.

Previous archaeological research in the vicinity of the project area has identified pre-Contact sites including habitation structures (temporary and permanent) and agricultural features (terrace and mounds). Of particular interest are three pre-Contact historic properties located within the *mauka* reaches of Kalo‘i Gulch. All three were determined to be related to erosion control and water management and suggest that in the past water was available, at least on a seasonal basis, in the Kalo‘i Gulch area. Historic properties identified in the vicinity of the study area include plantation-era infrastructure (ditches, flumes, clearing mounds, etc.) related to the Ewa Plantation Company and Oahu Sugar Company.

Based on background research, archaeologists expected to document historic features related to sugarcane cultivation and ranching, including walls, fences, maintained springs, and water tunnels as well as irrigation infrastructure including ditches and flumes related to the Ewa Plantation Company, Oahu Sugar Company, and the Waiahole Ditch System.

Section 4 Results of Fieldwork

The project area consists of a largely undeveloped property with rolling hills and several gulch areas. In general, the sloping lands within the project area are dry, fallow lands that appear to have undergone significant erosion of topsoil. Much of the nearly 101.62-acre project area is covered in thick vegetation including California grass (*Brachiaria mutica*), *koa haole (Leucaena leucocephala*), w*iliwili* (*Erythrina sandwicensis*), sweet acacia or *klu* (*Acacia farnesiana*), and *kiawe* (*Prosopis pallida*) (Figure 27 through Figure 29). The hillside within the project area also exhibited land modification in the form of graded access roads, bulldozed clearings, a portion of the Waiahole Ditch System, and remnants of the abandoned historic irrigation system and plantation infrastructure. Modern barbed wire fences were also observed surrounding the southern border of the project area, indicative of the continued use of portions of the project area for grazing livestock. Cow paths were identified meandering throughout the project area. Various fence posts were observed in the southwest project area, determined not to be associated with those fence lines noted on historic maps of the area based on their location and alignment (Figure 30).

The 1936 U.S. Army War map (see Figure 16) shows a camp (“Pump Camp 5”) located in the central portion of the project area. The camp is last depicted on the 1953 USGS map (see Figure 19). On the 1968 USGS map (see Figure 20) the camp is no longer depicted. An effort was made to identify any remnants of the former camp during fieldwork, but no remnants were identified during the pedestrian inspection.

The pedestrian survey identified two historic properties within the project area: SIHP # 50-80-08-5593, identified as remnant structures associated with water allocation related to plantation activities, and SIHP # 50-80-09-2268, identified as a portion of the Waiahole Ditch System, which extends along the northern boundary of the project area, crossing into the southwest project area and exiting at the southern boundary. Both of these historic properties were previously identified in the immediate area by Dega et al. (1998). The current project documented two features of SIHP # 50-80-08-5593 (Features 1 through 2E), which include retention basins, drain pipes, culvert, sluice gates, and various other components related to water control and retention. Most features of SIHP # 50-80-08-5593 were identified extending northwest to southeast down a slope in the north portion of the project area, designated as a complex related to water control. The complex is related to—and in line with—the pump station and mill building at the base of the hill, just outside the southern boundary of the project area. The complex consists of various water retention components, runoff features, a remnant water tower, pipes, and concrete features likely housing additional pipes. The uppermost components in this complex of features were constructed around a portion of the Waiahole Ditch, and would have utilized water from the ditch, channeling it down the slope to the pump station and mill, where it would have been pumped out to irrigate the surrounding sugarcane fields. One additional feature was identified in the north/central project area.

A remnant portion of the Waiahole Ditch (SIHP # 50-80-09-2268) extends along the northern boundary of the project area. Toward the western portion of the project area, the Waiahole Ditch crosses through the project area and extends to the southwest. The ditch extends underground through much of the project area. Observed portions of the ditch displayed culverts, bridges, tunnels, and flumes. Composition of the ditch varied from entirely earthen portions to concrete

Figure 27. Overview of southwest portion of project area, view to southwest

Figure 28. Overview of southwest portion of project area, view to west

Figure 29. Overview of northern portion of project area, view to northeast

Figure 30. Representative photo of fence posts noted in southwest portion of project area, view to southeast

and basalt lined portions. A former road that is likely an access road for the Waiahole Ditch was noted within the northern and northeastern boundaries of the project area. Portions of the Waiahole Ditch outside the project area were photographed and briefly described, included in the description of the Waiahole Ditch in Section 5 below. The project also documented seven new features of SIHP # 50-80-09-2268 (Features E through K), including sluice gate features, a drainage flume, culverts, and bridges. The portion of the Waiahole Ditch within the project area extends along the northern boundary and northeast-southwest through the southwest project area. Along this trajectory, one of the features was documented near the southern boundary of the project area (Feature E), two toward the central project area (Features F and G), three near the northern boundary of the project area (Features H, I, and J), and one in the northeast project area (Feature K). For detailed descriptions of all features of the two historic properties identified within the project area, refer to Section 5.

Within the project area, the former roads first recorded on the 1936 U.S. Army War Department map are currently in remnant condition. Temporary water diversion remnants related to the roads, identified as portable concrete flumes, were recorded in two locations along the edge of the former roads, in the west portion of the project area. The first documented portable flume spans approximately 10.6 m long and is oriented northeast-southwest (Figure 31). The second documented portable flume spans approximately 10.5 m in length and is oriented east to west (Figure 32). These remnant sections initially consisted of connected concrete troughs used to divert water from one place to another. As these components were temporary fixtures in remnant condition, they do not retain association with any potential historic properties and are not considered features.

Following the initial pedestrian inspection, the project area boundaries were altered slightly, extending to the north and the west, as well as south to encompass the existing access roads to be used for the project. Additional pedestrian inspection was conducted for these areas. The access roads that may be impacted consist of either paved or gravel roads. It is clear that modifications and upgrades have been made to the various access roads over the years. A portion of the northeast-southwest oriented access road is lined with a concrete curb (Figure 33). Some areas of the access road appear to consist of only dirt, though it may be this is actually material deposited on the road due to rain and erosion, and there may still be paved road underneath (Figure 34). This road reaches a junction, and in one direction the pavement continues, while the other direction is gravel (Figure 35). Access manholes for water lines were noted along the paved access road (Figure 36). A modern concrete culvert was noted at the base of the gravel access road (southernmost tip of the project area, west branch), allowing water flow under the road (Figure 37).

An additional, more intact concrete flume was identified *mauka* (northwest) of SIHP # -2268 Feature H, of similar composition to those noted in the western project area. Oriented east/west, this flume extends for 21 m in length, with each segment measuring 75 cm long, 45 cm wide, and 30 cm tall (Figure 38). Each concrete segment has a square hole near the base on each side, with a metal L-shaped insert, likely used for controlling water flow out of the flume (Figure 39). Again, this flume appears to have been used for water diversion related to the access roads.

Archaeologists walked a gulch now situated within the project area from the northern boundary down to the access road (Figure 40). Metal debris from an unknown source was noted within the gulch toward the north edge of the project area (see Figure 40); no historic properties were identified.

Figure 31. Remnant water diversion flume in southern project area, view to northwest

Figure 32. Remnant water diversion flume in southern project area, view to north

Figure 33. Access road encompassed within the project area, paved and lined with concrete curb, view to southwest

Figure 34. Overview of dirt (or dirt-covered) access road, view to northeast

Figure 35. Overview of access road junction, view to south

Figure 36. Access road overview showing water manhole, view to northeast

Figure 37. Overview of modern concrete culvert at the base of the access road (junction with Palehua Road), view to northeast

Figure 38. Overview of concrete flume in central northern project area, view to southeast

Figure 39. Plan view of concrete flume in central northern project area

Figure 40. Overviews of the gulch inside the project area, view to southwest (left), view to northeast with observed metal debris (right)

Section 5 Historic Property Descriptions

Two historic properties were identified within and immediately adjacent to the current project area during this AIS (Figure 41). SIHP # 50-80-08-5593 consists of remnants of an historic irrigation system and plantation infrastructure (Figure 42), and SIHP # 50-80-09-2268 designates (a portion of) the Waiahole Ditch System (see Figure 80). These historic properties within the project area are described below.

5.1 SIHP # 50-80-08-5593

FORMAL TYPE:	Historic Irrigation System and Plantation Infrastructure
FUNCTION:	Agriculture/water control
NUMBER OF FEATURES:	15 total; two newly identified (designated here as Feature 1 and Feature 2 (2A through 2E)
AGE:	1920s and continuing through the early 1990s
SIZE:	625 sq m (designated features only)
LOCATION AND DISTRIBUTION:	Concentrated in northern portion of project area extending in a line northwest-southeast, plus one feature on the southern boundary and one in the northeast project area
TMK:	[1] 9-2-002
LAND JURISDICTION:	State of Hawai‘i
PREVIOUS DOCUMENTATION:	Dega et al. 1998

SIHP # 50-80-08-5593 consists of an historic irrigation system and components of plantation infrastructure. Most of SIHP # 50-80-08-5593 was documented extending northwest to southeast, beginning outside the north boundary of the project area through the central portion. One isolated feature was documented within the northeast project area. The boundaries of SIHP # 50-80-08-5593 extend well beyond the current project area, as features of the historic property were documented northeast of the current project area by Dega et al. (1998). Table 3 lists all features considered components of this historic property both by Dega et al. 1998 and the present study.

5.1.1 Description of SIHP # -5593 by Dega et al. 1998

A 1998 archaeological inventory survey for the (then proposed) University of Hawai‘i West O‘ahu Campus (Dega et al. 1998) addressed a 991-acre area that encompassed the entire present project area. Dega et al. (1998) documented components of a newly identified historic property, designated SIHP # 50-80-08-5593.

The study mentions the mill building and pump station (“Pump Station 12”), “adjacent to the lower agricultural fields” (see Figure 42 through Figure 44). The current study noted the mill building and pump house are presently enclosed by chain-link fencing. The authors of the 1998 study also mention other features including flumes, dikes, dams, and pumps, but do not include documentation of such features. The provided site location map from the 1998 study (Figure 43)

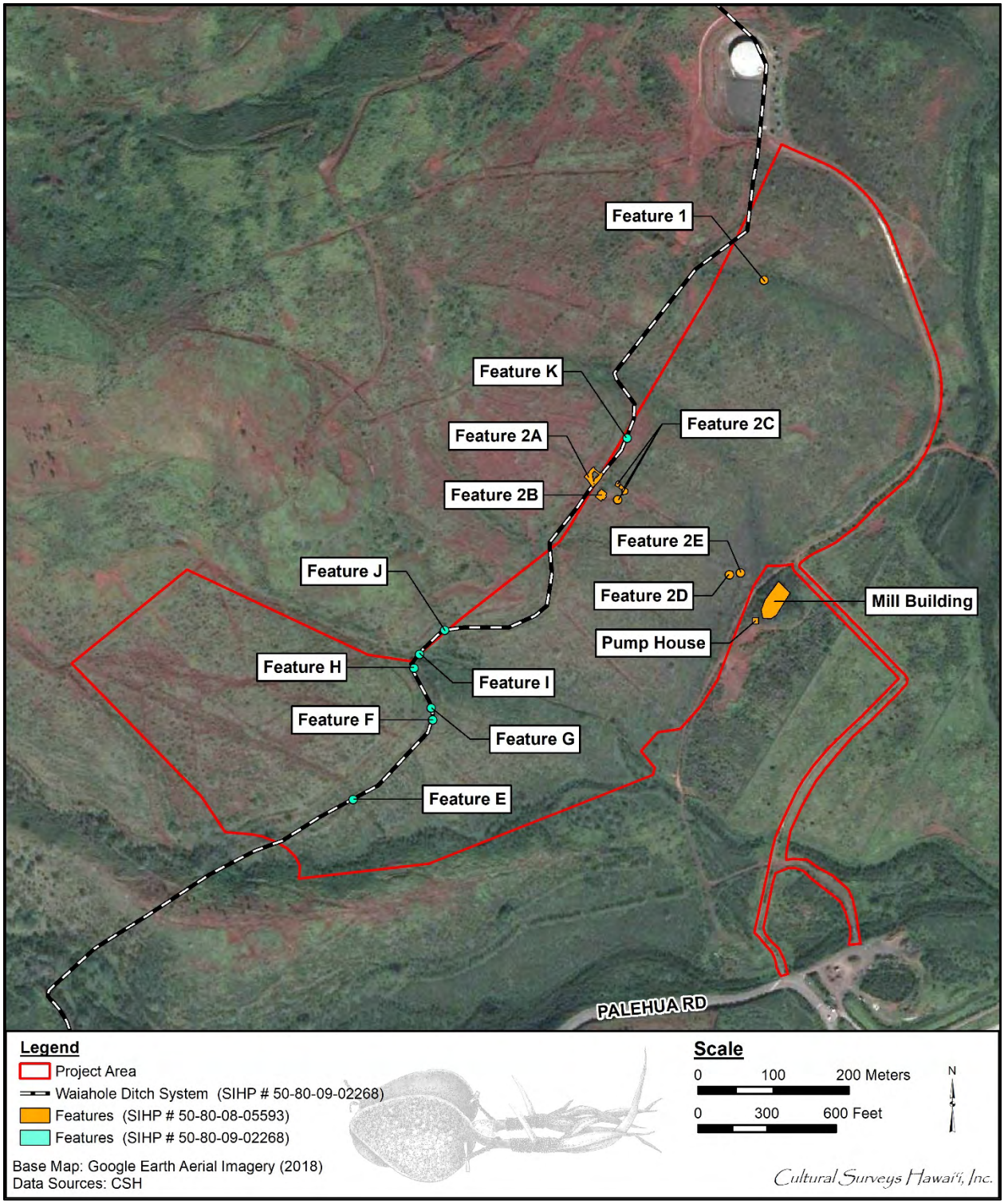

Figure 41. Aerial photograph showing the historic properties identified during the AIS: SIHP # 50-80-08-2268 Feature E through Feature K (shown in green) and SIHP # 50-80-08-5593 Feature 1 and Features 2A through 2E (shown in orange) (Google Earth 2018)

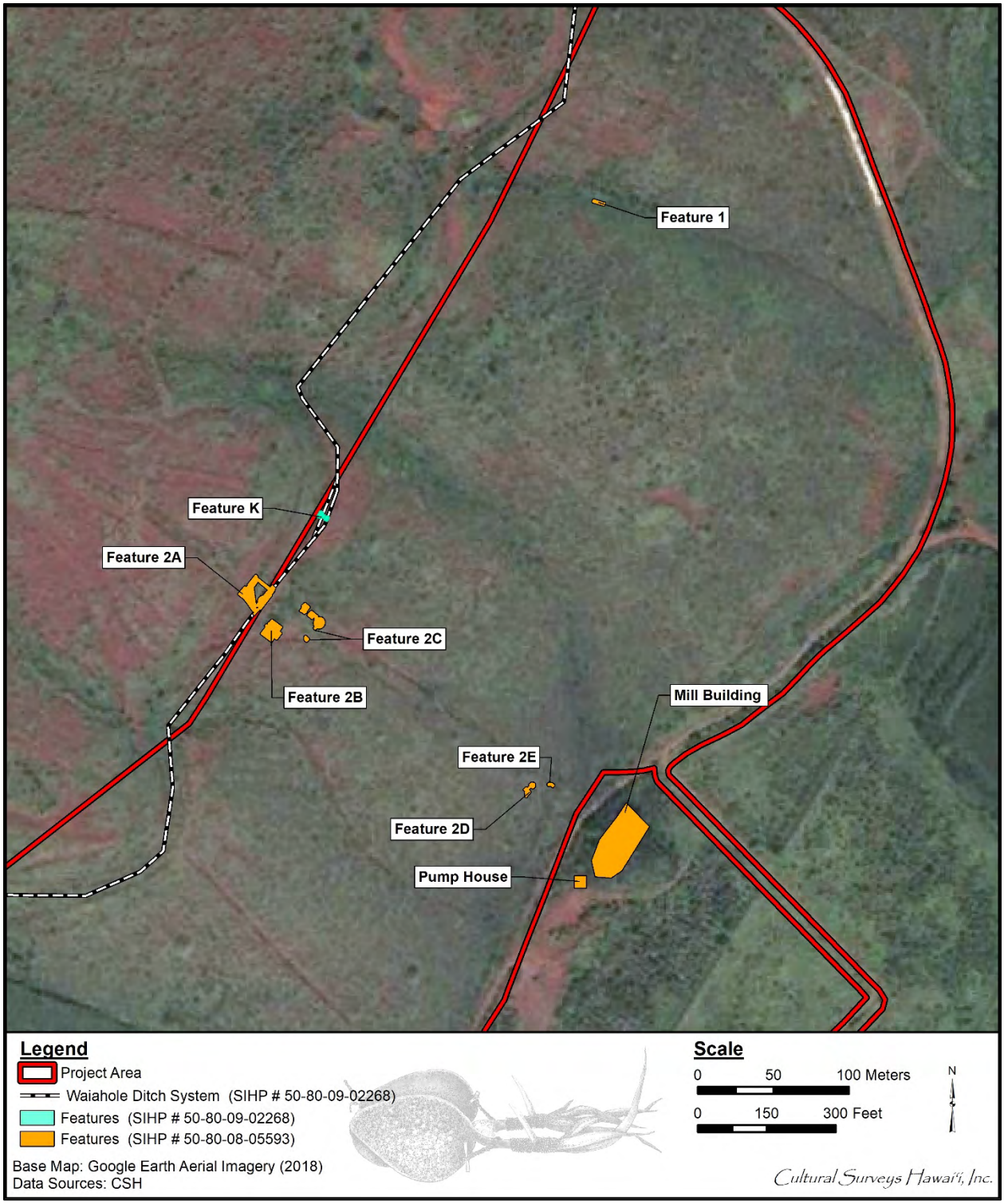

Figure 42. Aerial photograph (Google Earth 2018) depicting the distribution of features of SIHP # 50-80-08-5593 (Feature 1 and Features 2A through 2E) within the project area

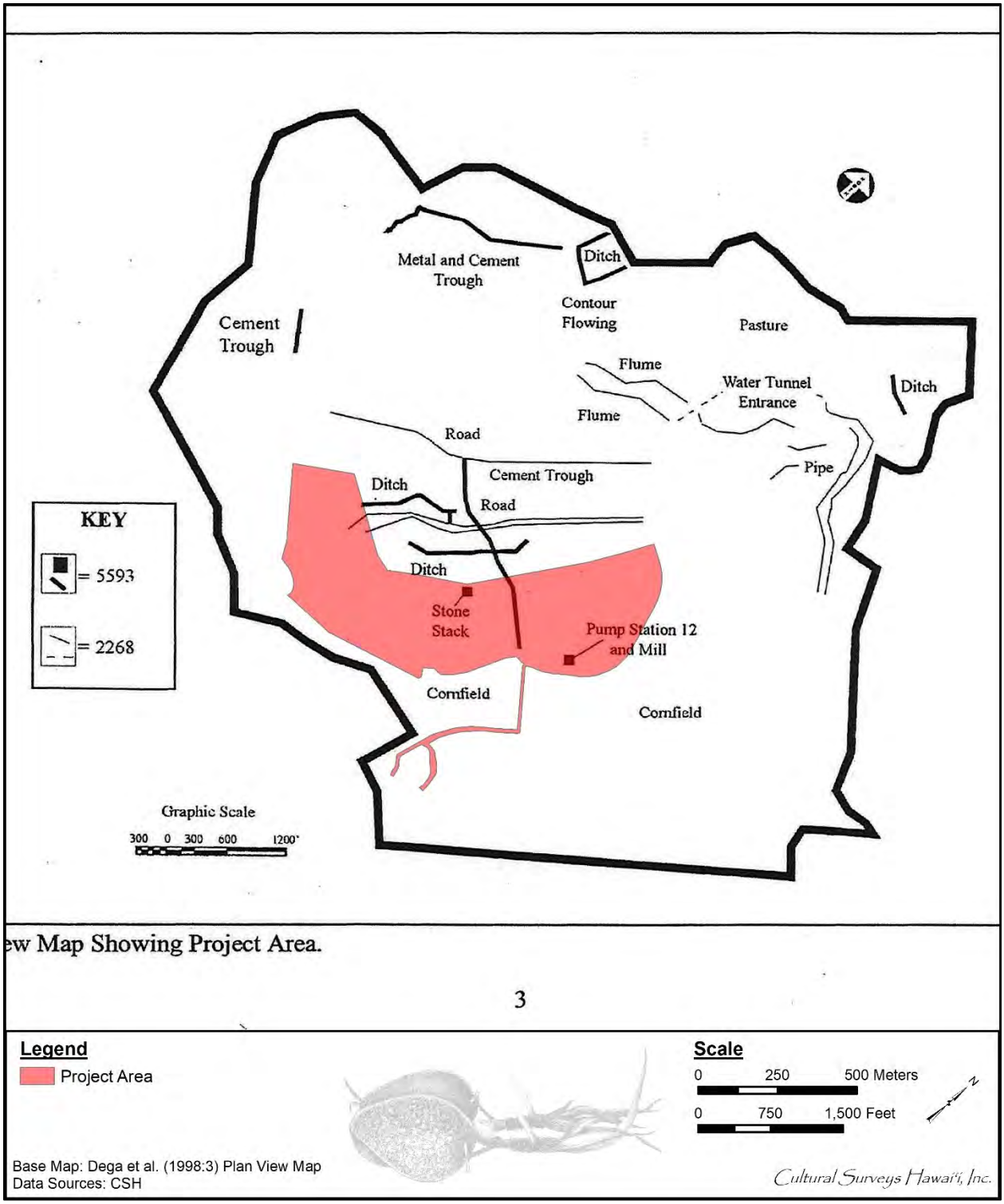

Figure 43. Figure from Dega et al. (1998) showing identified features of two historic properties (Dega et al. 1998:3), with overlay of current project area

Table 3. SIHP # 50-80-08-5593 (Dega et al. 1998 did not designate feature numbers)

Feature #	Brief Description	Reference
—	Mill building containing pumping machinery	Dega et al. 1998
—	Pump House 12	Dega et al. 1998
—	Water pump feature (concrete, wood, and pumping mechanism)	Dega et al. 1998
—	Irrigation system bridge (basalt and mortar, inscribed date of 1928)	Dega et al. 1998
—	Stone stack (not described, plotted on figure)	Dega et al. 1998
—	Two concrete and metal troughs	
—	Four earth-lined water transport ditches	Dega et al. 1998
—	Two concrete troughs, 45 cm wide and 45 cm high	Dega et al. 1998
1	Concrete and metal drain pipes	Current study
2A–2E	Complex including formal portion of the Waiahole Ditch, water catchment/retention features, flumes, and associated pumping mechanisms	Current study

Figure 3: Pump House No. 12. View to Northwest.

Figure 4: Water Pump in Sugarcane Field. View to West.

Figure 44. Features of SIHP # 50-80-08-5593 documented by Dega et al. (1998:15)

calls out a “Stone Stack,” two “Flumes,” a “Water Tunnel Entrance,” and a “Pipe” (or pipes) that appear to have no textual discussion. The study includes a photo that depicts what appears to be a rather elaborate “Irrigation system bridge” dated 1928—understood as relating to at least one of the “Flume” annotations on the plan map (Figure 45) and as outside the present project area.

According to the authors, the study documented various distinct features: two metal and concrete troughs, four small earth-lined water transport ditches, and two concrete ditches or troughs. No feature numbers were designated in the Dega et al. (1998) study. The 1998 study describes the documented components of the historic property as follows:

> Also found on the subject parcel are the remnants of a system which appears to have been designed to gather and transport water for local use. This sites [*sic*] includes a network of small concrete troughs c. 45 cm wide and 45 cm high. These were observed along the summit ridgeline to the northeast of Pu‘u Kapua‘i, from where it entered a ditch system on the lower slopes. Remnant sections of these troughs were also found on the western and southern slopes of Pu‘u Kapua‘i and within the 38 acre parcel which forms the northeastern corner of the project area. Smaller earthen ditches are found throughout the project area, particularly on the east-facing slope at the northern area of the project. Connections of this system with the Waiahole Ditch system were not observed. Water collected and transported through this system was probably used for local ranch operations, extensive sugarcane cultivation, and small-scale agriculture. Because of the leeward location of this parcel, water would flow into this system almost exclusively during Kona or southerly storms. Thus, a total of eight features comprise Site 5593: metal and cement troughs (2), small earth-lined water transport ditches (4), solely cement constructed ditches or troughs (2) and an area containing large clearing mounds adjacent to the lower agricultural fields (1) [The plan view map in their report is referenced].
>
> Of additional interest is a large wooden building (part of Site 5593), presumably constructed in the late 1920’s and utilized through the 1950’s, that occurred on the southern flank of Pu‘u Kapua‘i’s base. This structure and associated pumping system, designated as Pump 12 by Wilcox (1996:106), contained steam engine driven pumps. The preponderance of coal within the building and mechanisms observed through the structure allow for the inference that this indeed was a steam-driven pumping station. These steam pumps were likely needed for transport of water to fields as gravity alone was not enough to propel the water into lower ‘Ewa Plain sugarcane fields. Steam-driven pumps allowed cultivators to propel water into these lower reaches. [Dega et al. 1998:19]

5.1.2 Description of SIHP # -5593 within and adjacent to the Current Project Area

Features documented during the current AIS consist of concrete and metal drain pipes (Feature 1) and a complex of water control features (Features 2A through 2E) associated with the previously documented pump house and mill building (Figure 46 and Figure 47) just southeast (outside) of the present project area. It is likely that subsurface remnants, such as pipes, are present between Feature 2A and the mill building.

Figure 5: Pumping Machinery at Mill Adjacent to Pump House No. 12. View to North.

Figure 6: Irrigation System Bridge. Note Date of 1928 in Center of Bridge. View to Southeast.

Figure 45. Features of SIHP # 50-80-08-5593 documented by Dega et al. (1998:16)

Figure 46. Mill building immediately southeast of the project area boundary (downslope of Feature 2A complex), view to east

Figure 47. Pump House No. 12, southeast of the project area (mill building to the left), view to southeast

SIHP # 50-80-08-5593 Feature 1 consists of plantation-era drain pipes located within a ditch in the northeast portion of the project area (see Figure 42 for location). It is possible this feature was identified during the Dega et al. (1998) study, however, this could not be definitively discerned based on that documentation. The upper/west end of this feature consists of a single observable concrete pipe approximately 35 cm in diameter (the second pipe is likely obscured by collapsed earth) with overlying concrete rubble and stacked basalt, three stones wide and two to three courses high (Figure 48). This upper portion measures 82 cm tall and 90 cm wide. The east/lower end of Feature 1 consists of two steel pipes (Figure 49 and Figure 50), each approximately 35 cm in diameter, and the exposed portions approximately 40 cm tall. The function of this feature is related to agriculture and water control. Feature 1 is in fair condition, as much of the area is overgrown and heavily eroded.

SIHP # 50-80-08-5593 Feature 2 is a complex encompassing six structures (Features 2A through 2F) associated with the mill building and Pump House 12 (see Figure 42 for location, and Figure 51 through Figure 62). The Feature 2 complex begins at the northern boundary of the project area and extends southeast through the central portion of the project area down the natural slope. The complex is made up of six structures designed to move water from the Waiahole Ditch down the hillside to the pump house and mill building. According to Dega et al. (1998), steam engine pumps would disperse the water to sugarcane fields, likely those situated both above and below the pump house and mill. The entire complex measures approximately 240 m in length.

SIHP # 50-80-08-5593 Feature 2A, the uppermost portion of the complex, consists of various water catchment features attached to a portion of the Waiahole Ditch, related to the mill and pump house at the base of the slope (see Figure 51, Figure 52, and Figure 62). This portion is oriented northeast-southwest, and constructed of basalt, concrete, and metal pipes. The Feature 2A complex is situated on the northwest boundary of the project area. Portions of this upper complex contain modern rubbish (modern bottles and cans), as well as a cow skeleton, likely a livestock animal that fell, died, and decayed in place. The northeast portion of this section of the Waiahole Ditch consists of a concrete-lined ditch 140 cm wide and 163 cm deep. As it extends toward the Feature 2A complex, there is an overlying addition of mortared basalt three courses high, a portion of which bears the date inscription “MAR 1939” (Figure 53). The ditch then feeds into a large catchment basin measuring a maximum of 4.0 m long and 3.2 m wide, with a maximum depth of 180 cm. The basin is flanked by notches in the concrete on both sides, for former sluice gates which are no longer intact. The basin would have fed into the two drain pipes at the base of the southeast wall of the structure (Figure 54). These pipes extend down the slope to the pump house and mill. Portions of these pipes are exposed on the slope’s surface, and much of the pipes are likely intact underground.

An additional water retention component is positioned directly northwest of this basin. This portion consists of a rectangular mortared basalt catchment area measuring 5.1 m long by 3.8 m wide (Figure 55), feeding into an oval catchment area measuring 6.3 m long and 2.6 m wide (Figure 56), with notches for a sluice gate feature in between (gate not intact). It is possible these catchment areas are gravel traps, which would have served to trap silt and clay (Reeves 1954). This function is suggested based on the complex shape of the structure, which is somewhat similar to a gravel trap from the Iao-Maniania Ditch pictured in a publication on plantation ditches (Figure 57; Wilcox 1996). Three flumes feed from the upper catchment areas into the Waiahole Ditch (Figure 58 and Figure 59). The flumes are oriented north-south and northwest-southeast. The eastern flume

Figure 48. Upper portion of SIHP # 50-80-08-5593 Feature 1 showing concrete pipes, view to east (collapse to the southwest, at right, may have covered the second pipe)

Figure 49. Lower portion of SIHP # 50-80-08-5593 Feature 1 showing metal pipes, view to northwest

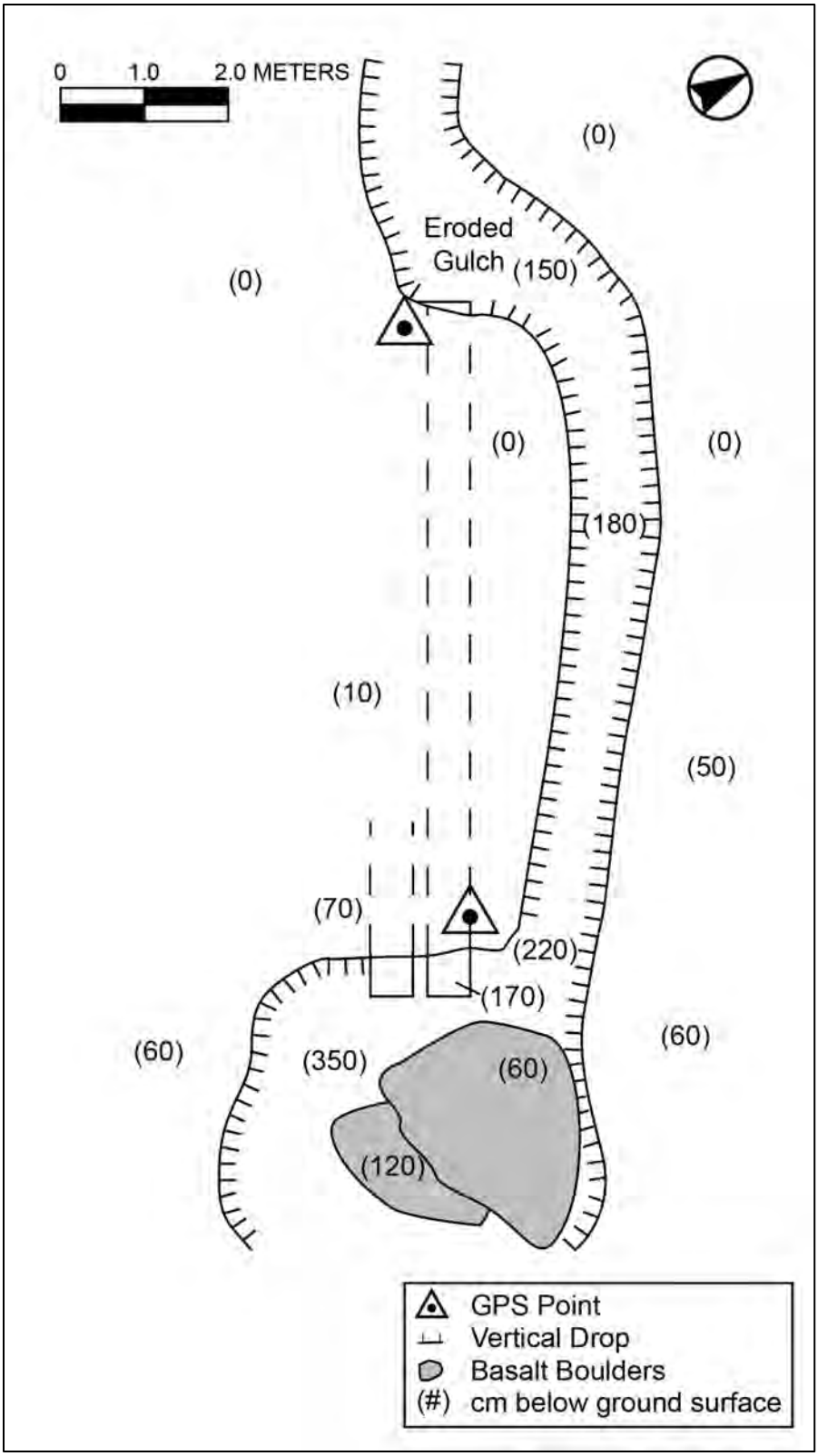

Figure 50. SIHP # 50-80-08-5593 Feature 1 plan map

Figure 51. Overview of SIHP # 50-80-09-2268 Waiahole Ditch portion, and SIHP # 50-80-08-5593 Feature 2A complex, with the pump house and mill building at the base of the slope, view to southeast

Figure 52. Overview of SIHP # 50-80-09-2268 Waiahole Ditch portion, and SIHP # 50-80-08-5593 Feature 2A complex, view to north

Figure 53. Plan view showing inscription in SIHP # 50-80-08-5593 Feature 2A complex

Figure 54. Overview of SIHP # 50-80-08-5593 Feature 2A and SIHP # 50-80-09-2268 Waiahole Ditch portion, with catchment basin (foreground) and drain pipes, view to east

Figure 55. Upper water retention area of SIHP # 50-80-08-5593 Feature 2A complex, view to west

Figure 56. Upper water retention areas (eastern portion) of SIHP # 50-80-08-5593 Feature 2A complex, view to northeast

Water is collected in this gravel trap before being sent on its way in the Iao-Maniania Ditch. (Photo: D. Franzen.)

Figure 57. Figure showing an example of a gravel trap on the Iao-Maniania ditch system on Maui (from Wilcox 1996:125)

Figure 58. Center flume of SIHP # 50-80-08-5593 Feature 2A complex extending from upper catchment area into SIHP # 50-80-09-2268 Waiahole Ditch, view to west

Figure 59. Overview of SIHP # 50-80-08-5593 Feature 2A complex with eastern flume (right), extending into SIHP # 50-80-09-2268 Waiahole Ditch, view to northwest

Figure 60. Water retention component of SIHP # 50-80-09-5593 Feature 2A complex, view to west

Figure 61. Plan view of SIHP # 50-80-09-5593 Feature 2A complex, water retention component, view to northwest

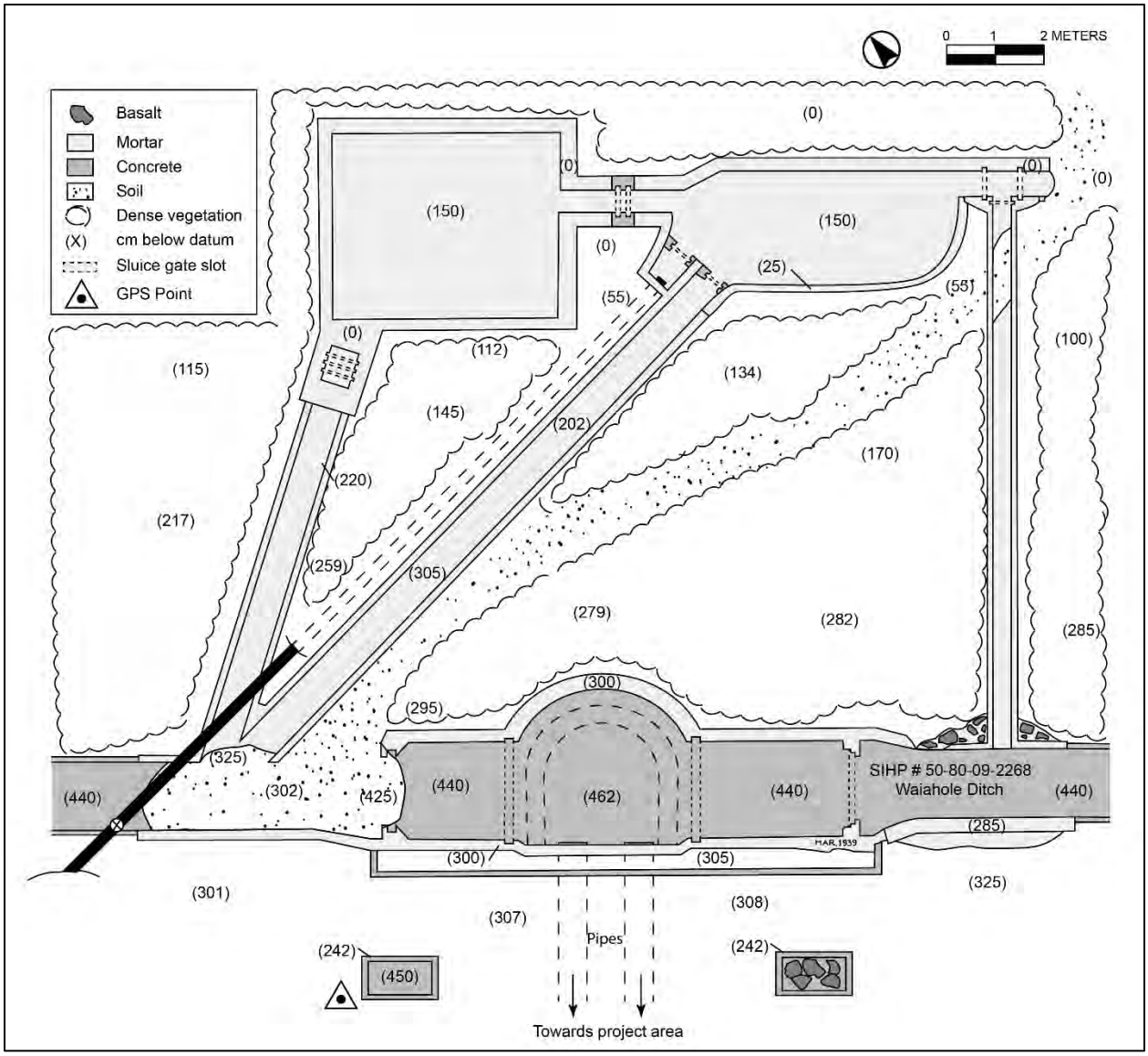

Figure 62. Plan map of SIHP # 50-80-08-5593 Feature 2A water diversion complex (just northwest of project area)

measures 11.0 m long and 0.6 m wide, the center flume measures 12.8 m long and 0.6 m wide, and the western flume measures 7.1 m long and 0.6 m wide.

The final components of the Feature 2A complex are two small rectangular water retention features, each measuring 152 cm long, 90 cm wide, and 118 cm deep, with 16-cm thick walls (see Figure 60). The south wall of the southwest retention feature contains a slit in the concrete that has a wood insert with an attached steel measuring rod (see Figure 61). The wood and steel components no longer exist in the northeast retention feature, but the slit in the concrete remains on the south wall of this component.

Descending the hillside from Feature 2A are various structures related to moving water down to the mill and pump house, including water retention areas, and concrete pads and boxes that housed pumps and pipes.

SIHP # 50-80-08-5593 Feature 2B is a rectangular water retention structure into which water from the upper Feature 2A complex/Waiahole Ditch would have been channeled (Figure 63 through Figure 66). Feature 2B measures approximately 15.2 m long, 10.6 m wide, extends 1.38 m above surface, and is a maximum depth of 3 m deep from top to bottom (see Figure 63 and Figure 64). The main structure, constructed entirely of concrete, consists of a large rectangular structure divided into two open rectangles by a concrete wall extending through the middle. The walls of the structure measure 25 cm wide, and the three northwest-southeast oriented walls have notches cut out of the surface that are 18 cm deep and range from 30 cm to 150 cm long. Two metal pipes extend out of the earth into the northeast half of the structure, at one time transporting water from the upper portion of the complex into this retention feature. Attached to the larger structure is a small rectangular portion, measuring 4.25 m long and 2.05 m wide, and containing a metal rung ladder descending into the structure and several metal pipes, which presumably continued transporting the water down the hillside (see Figure 65).

SIHP # 50-80-08-5593 Feature 2C consists of water tank remnants and related components (Figure 67 through Figure 71). The water tank was constructed of a concrete foundation with a wooden structure held together with steel cables. The wooden structure is no longer in place, leaving behind the 11 steel cables, concrete foundation, and several metal pipes (see Figure 67). The connected circular cable remnants measure a maximum 6.2 m in diameter, and the entirety of the remnants cover an area measuring 7.8 m long and 7.4 m wide. Two concrete squares measuring 80 cm by 80 cm and containing valves were documented immediately southwest of the water tower remnants (see Figure 68). A smaller related structure is 2.6 m northwest of the water tower remnants, which consists of a rectangular concrete structure measuring 3.0 m long and 2.8 m wide (see Figure 69). The northeast half of the structure is a solid concrete slab, and the southwest half of the structure is an open concrete rectangle containing metal pipes. The solid slab likely contains additional pipes related to the water control complex. Another 2.8 m northwest is an additional structure of concrete slabs and pipes, measuring 5.2 m long and 3.8 m wide. Additionally, approximately 7.4 m southwest of the water tower remnants is a damaged concrete component (see Figure 70). This concrete feature consists of three concrete walls—15 cm thick and a maximum 80 cm tall—that have broken and collapsed into a triangle shape. One metal pipe remains inside the collapsed walls. The tank is not noted on the 1943 Army War Department terrain map but appears on the 1953 Ewa and Schofield Barracks topographic quadrangles as a

Figure 63. Overview of SIHP # 50-80-08-5593 Feature 2B, showing dividing wall between two large water storage components, view to northeast

Figure 64. Overview of SIHP # 50-80-08-5593 Feature 2B, showing two large water storage compartments (background) and smaller compartment containing pipes and valves (foreground), view to northwest

Figure 65. Overview of SIHP # 50-80-08-5593 Feature 2B, smaller southeast portion, view to northeast

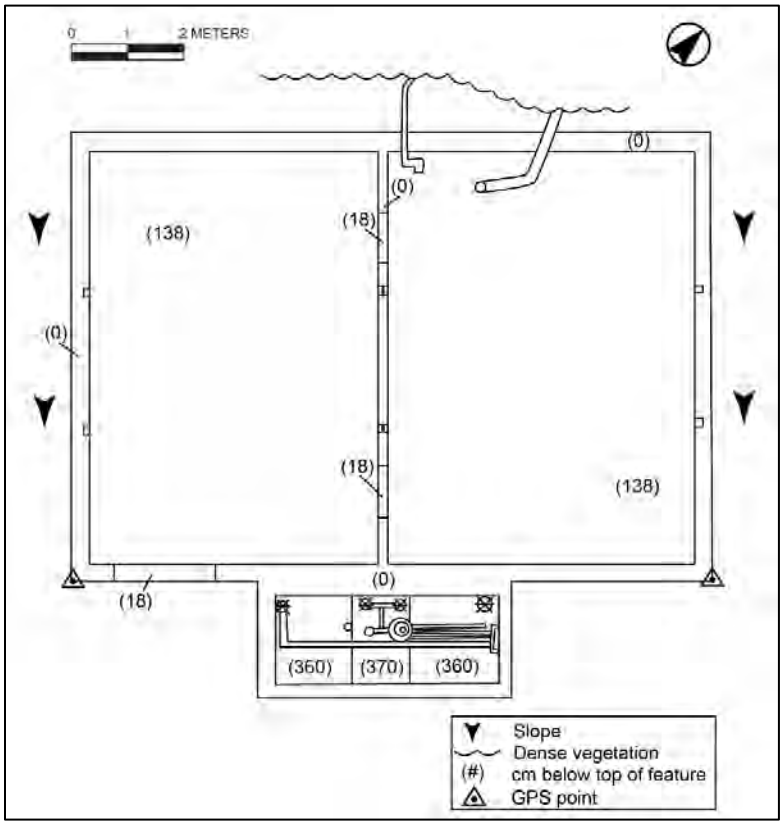

Figure 66. SIHP 3 50-80-08-5593 Feature 2B plan map

Figure 67. SIHP # 50-80-08-5593 Feature 2C, water tank and associated components, view to northeast

Figure 68. Concrete valve components of SIHP # 50-80-08-5593 Feature 2C, view to west

Figure 69. Overview of concrete foundation and pipes component of SIHP # 50-80-08-5593 Feature 2C, view to southeast

Figure 70. Collapsed walls with pipe, component of SIHP # 50-80-08-5593 Feature 2C, view to southeast

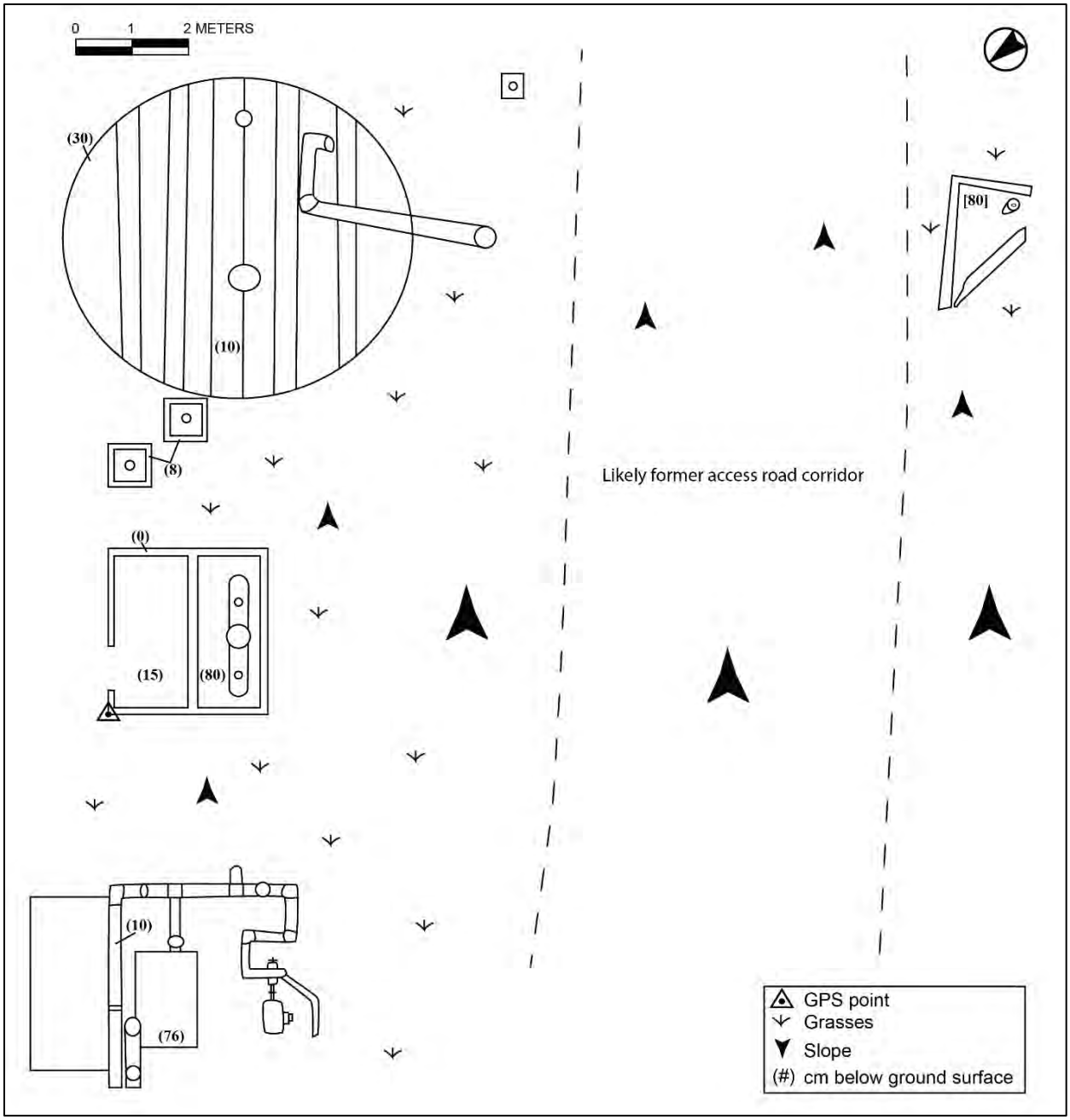

Figure 71. Plan map of SIHP # 50-80-08-5593 Feature 2C, water tank remnants and associated components

marked circular feature labeled “Water Tank” in the same location as the documented Feature 2C (see Figure 17 and Figure 19). Structures are visible in this general area as late as 1968, including an apparent circular structure, which is likely the water tank (see Figure 21; UH MAGIS 1968).

SIHP # 50-80-08-5593 Feature 2D, a rectangular-shaped likely water retention feature, is situated near the base of the slope toward the pump house and mill building (Figure 72 through Figure 76). This is constructed of concrete, metal, and wood. The feature has three components: two rectangular shafts and one concrete culvert. The first portion measures 2.4 m long and 2.0 m wide, consisting of a rectangular shaft extending to a maximum depth of 215 cm with an attached small square shaft extending to a maximum depth of 205 cm (see Figure 72). A metal pipe oriented north-south extends from inside the rectangular shaft out above ground for 3.6 m before extending downward into the shaft of the second rectangular component. The second rectangular shaft measures 2.1 m long and 1.2 m wide, extending to a maximum depth of 215 cm (see Figure 73). This second retention shaft includes notches for an intact wooden sluice gate on the east edge, which leads out into a sloped, mortared basalt channel, possibly for overflow runoff (see Figure 74 and Figure 75). The mortared basalt portion measures 3.6 m long by 1.4 m wide and is two courses high (exposed portion is 50 cm tall on average). This feature may be connected to Feature 2E, described below, as a pipe in the squared shaft on the northeast end appears to extend in the direction of Feature 2E (see Figure 75). Apparent infrastructure is observed in the vicinity of this feature in a 1951 aerial photograph (see Figure 18; UH MAGIS 1951).

SIHP # 50-80-08-5593 Feature 2E consists of a remnant concrete culvert (see Figure 76 through Figure 78). Feature 2E is in poor condition and measures 2.4 m long and 0.75 m wide. Feature 2E is in the lower portion of the project area and appears to have been used to help channel water overflow runoff. A pipe was observed in a shaft of Feature 2D extending in the direction of 2E, suggesting water overflow was channeled from the retention feature out of Feature 2E.

5.1.3 Significance

SIHP # 50-80-08-5593, historic irrigation system and plantation infrastructure, was previously assessed by Dega et al. (1998) as significant under Hawai‘i State historic property significance Criteria a (be associated with events that have made an important contribution to the broad patterns of our history) and d (has yielded, or may be likely to yield, information important for research on prehistory or history). The current study assesses SIHP # 50-80-08-5593 as significant only under Criterion d. This historic property has yielded information on land utilization and agricultural history of the ‘Ewa Plain. However, it is suggested that SIHP # 50-80-08-5593 did not make an important contribution to the broad patterns of our history, unlike the Waiahole Ditch, which immeasurably altered the entirety of the landscape. The historic property possesses integrity of location, design, materials, and workmanship.

Figure 72. Overview of SIHP # 50-80-08-5593 Feature 2D, northeast valve box, view to east

Figure 73. Overview of SIHP # 50-80-08-5593 Feature 2D, southwest valve box, view to southwest

Figure 74. SIHP # 50-80-08-5593 Feature 2D sluice gate and possible water overflow channel, view to northeast

Figure 75. Feature 2D plan view of southern retention area with sluice gate and possible overflow channel, view to southwest

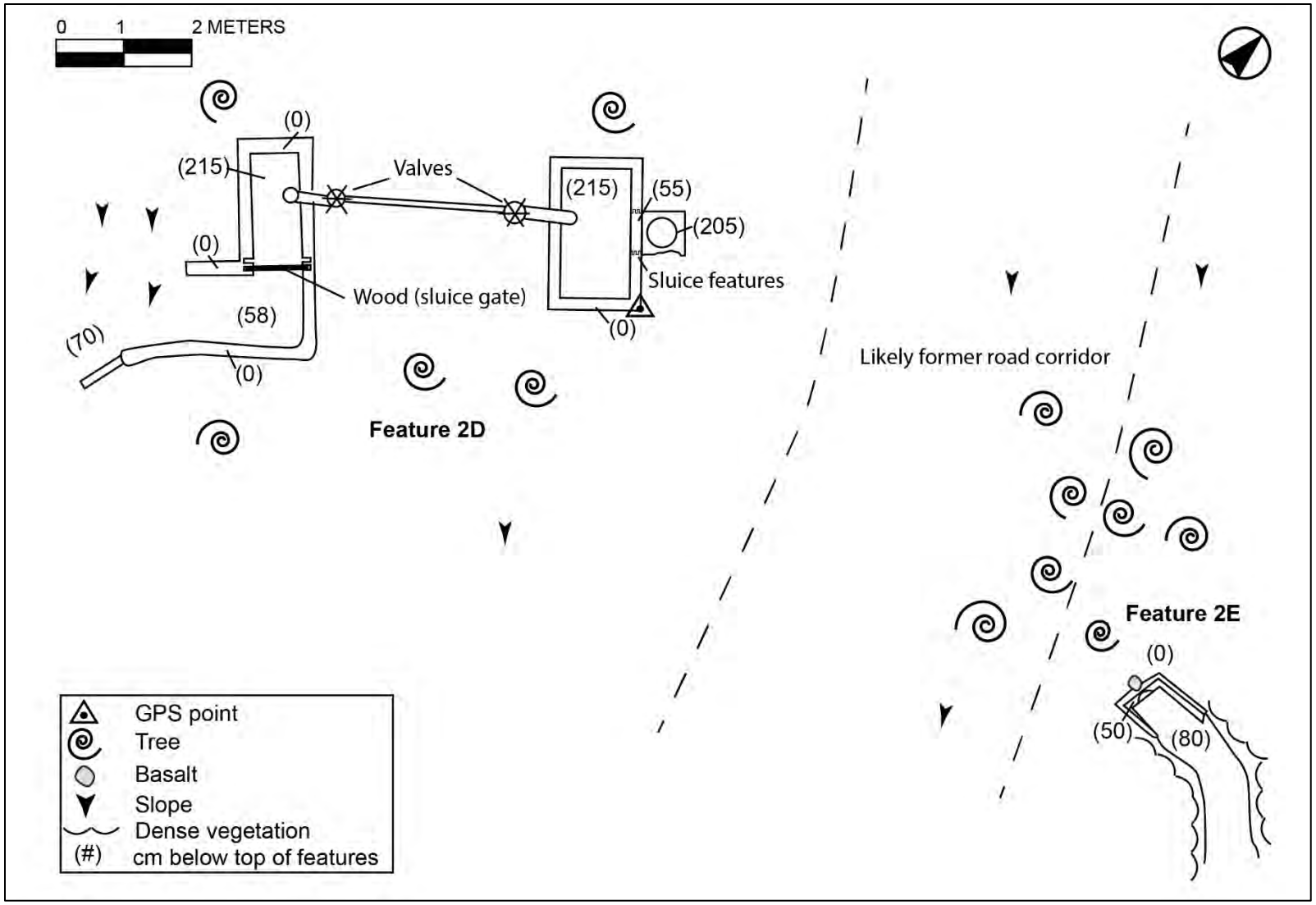

Figure 76. SIHP # 50-80-08-5593 Feature 2D, northeast and southeast valve boxes (top left), and Feature 2E runoff channel (bottom right) plan map

Figure 77. SIHP # 50-80-08-5593 Feature 2E, culvert remnants, view to northwest

Figure 78. SIHP # 50-80-08-5593 Feature 2E, close-up of culvert remnants, view to west

5.2 SIHP # 50-80-09-2268 Waiahole Ditch System/ post-Contact Irrigation Ditch

NAME:	Waiahole Ditch System
FORMAL TYPE:	Post-Contact irrigation ditch
FUNCTION:	Agricultural (plantation irrigation)
NUMBER OF FEATURES:	11; 7 newly identified (and designated as Feature E through Feature K)
AGE:	Post-Contact, irrigation ditch from 1916
SIZE:	22 miles total; approximately 380 linear m within project area
LOCATION AND DISTRIBUTION:	Extends from the windward side of the Ko‘olau Range on to the ‘Ewa Plain; within the current project area extends through the western portion
TMK:	[1] 9-2-001, 9-2-002, 9-2-003, 9-4-003, 9-4-006, 9-6-005
LAND JURISDICTION:	State of Hawai‘i
PREVIOUS DOCUMENTATION:	Hammatt and Borthwick 1988; Goodman and Nees 1991; Hammatt et al. 1996; Dega et al. 1998; Tulchin and Hammatt 2004; Hunkin and Hammatt 2009; Tulchin et al. 2009; Groza et al. 2014; Zapor et al. 2018

SIHP # 50-80-09-2268 consists of the entire Waiahole Ditch System, a post-Contact irrigation ditch dating from 1916. The historic property spans approximately 22 miles (Figure 79) transporting water from the windward side of the Ko‘olau Range through the Ko‘olau Range by a system of tunnels, across central O‘ahu and on to the ‘Ewa Plain (Condé and Best 1973). Approximately 380 linear m of the Waiahole Ditch was identified in the northern and western portions of the project area. The ditch extends along the northern boundary, crossing the central project area as it extends southwest down the natural sloping landscape, exiting the southern boundary and continuing to extend southwest away from the project area (Figure 80).

5.2.1 Overview

Currently, a portion of the Waiahole Ditch remains active (see Figure 79). This active portion begins on the windward side of the island and terminates at Reservoir 155 in Honouliuli. Various features associated with the active portions of the Waiahole Ditch have been identified, including the reservoirs, flumes, sluices, and siphons (Goodman and Nees 1991; Groza et al. 2014; Hammatt and Borthwick 1988; Hammatt et al. 1996; Tulchin et al. 2009). Descriptions of the in-use stretch of the Waiahole Ditch range from a concrete-lined ditch to only a metal siphon structure crossing over gulches.

Remnant, inactive portions of the Waiahole Ditch extend beyond the reservoir. This includes a portion of the main ditch extending west of the reservoir and a portion that originates at the ditch and extends southwest from the reservoir. Several archaeological studies documented this southwest extending inactive portion of the Waiahole Ditch, including the current project (Dega et al. 1998; Hunkin and Hammatt 2009; Tulchin and Hammatt 2004; Zapor et al. 2018).

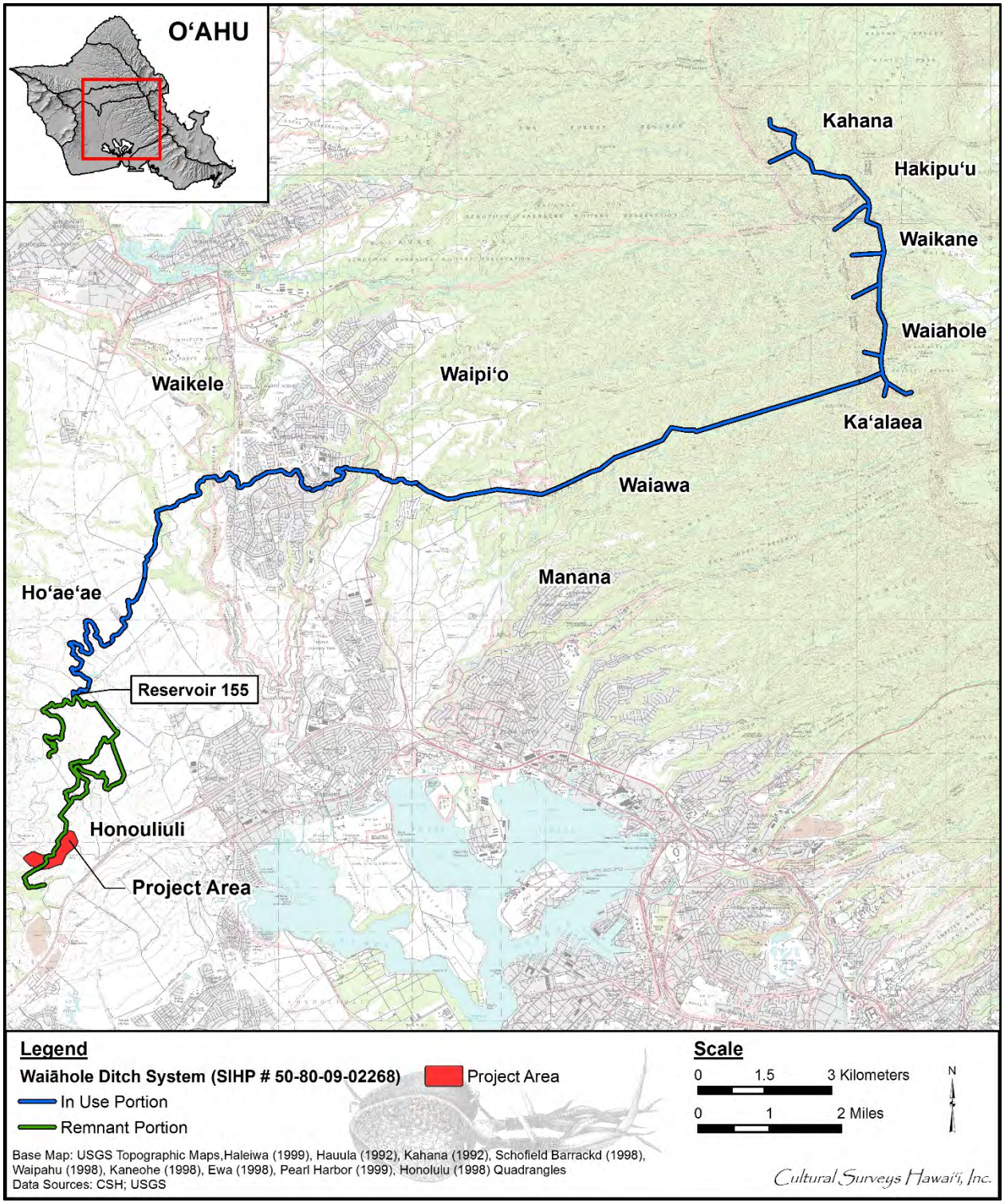

Figure 79. Route of the Waiahole Ditch System in relation to the present project area, showing in-use and remnant portions, depicted on a 1992–1999 USGS topographic quadrangle map

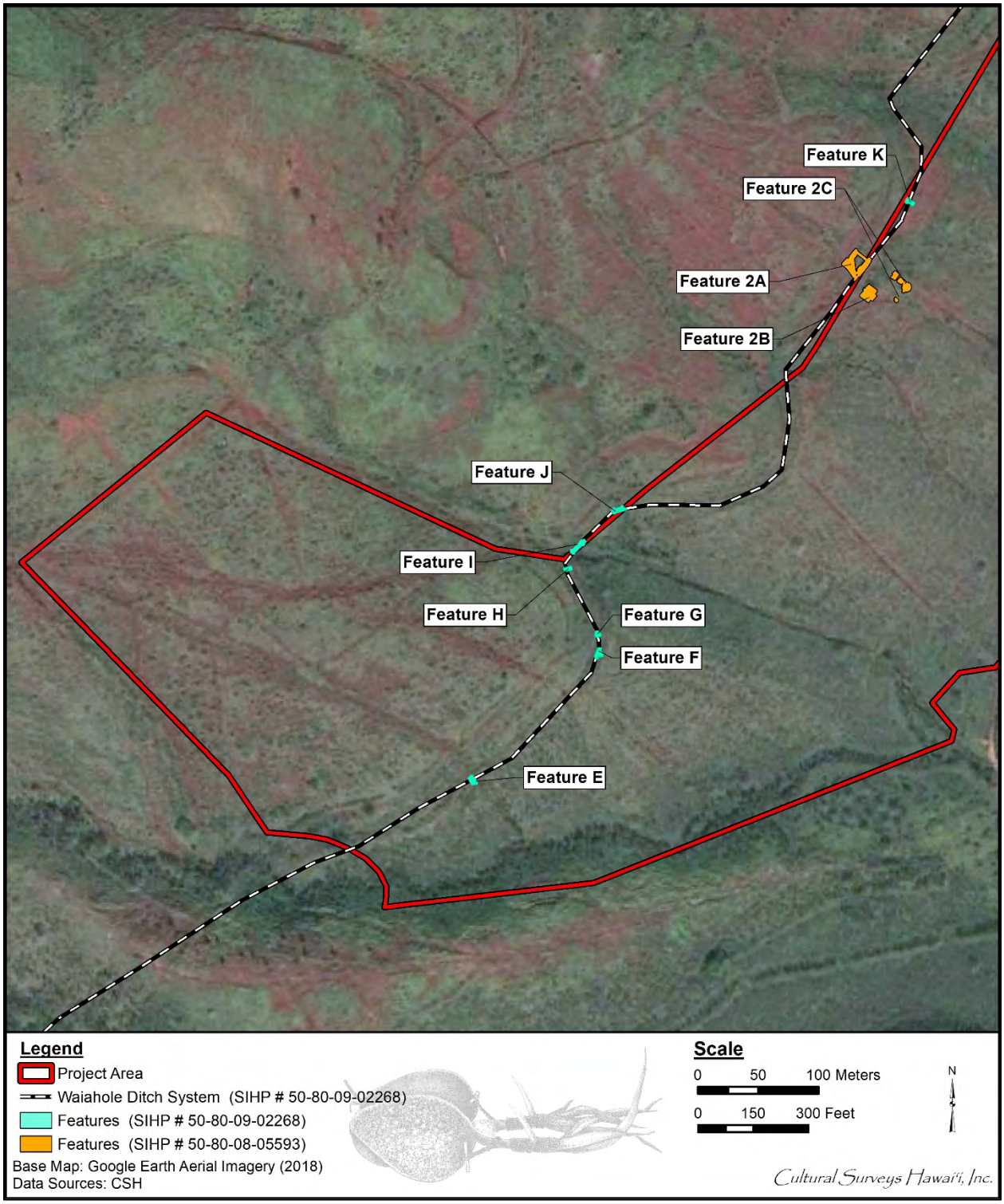

Figure 80. Aerial photograph depicting the distribution of portions of SIHP # 50-80-09-2268 Feature E through Feature K, as well as features of SIHP # 50-80-08-5593, identified within the current project area (Google Earth 2018)

Documented features related to the inactive ditch include flumes, tunnels, walls, drainage channels, sluice gates, culverts, bridges, and one earthen mound, as discussed below. Portions of the remnant portion likely no longer exist or may have been buried. The historic property description presented here focuses on the remnant portion of the Waiahole Ditch, as that is the portion documented within the current project area and immediate vicinity.

Dega et al. (1998) documented remnant portions of the Waiahole Ditch, described as follows:

> The ditch was encountered on the western slope of the westernmost gulch which trends north-south through the eastern portion of the property. The major flume crosses the bottom of the gulch through a concrete flume and enters a c. 1000 m long tunnel. A branch within this tunnel is also connected to the Waiahole Ditch System via a more northerly route. This ditch exits the tunnel, crosses the bottom of another smaller gulch through a shorter concrete flume and then enters another tunnel. The ditch follows along the 400 to 440 foot contours in this manner along the eastern and southern slopes of Pu‘u Kapua‘i and exits the property to the west near Kaloi Gulch. There are, altogether, seven tunnels of various lengths along the ditch within the project area.
>
> The flume itself is 60 cm deep and about 1 m across […] The sides of the ditches have been shored with stone masonry. The tunnels are 90 cm wide and about 140 cm high. Cement was used to support the sides and roofs of the tunnels only near the entrances. At greater depth within the tunnels cement was used only to shore up the walls. The tunnel roofs in these areas consist of bare rock.
>
> Along the south-facing slope of Pu‘u Kapua‘i there are segments of the ditch which are lined with concrete and smaller segments lined with corrosive metal. Differing channels appear to divert some of the water to the sugarcane fields which occur at and near the base of the slope. There is also a small, rectangular, concrete basin in this area measuring about 12 by 10 m and 2 m deep which perhaps served to store small quantities of water for later diversion downslope. [Dega et al. 1998:17–18]

Figure 81 shows the section of the flume feature documented by Dega et al. (1998).

5.2.2 Previously Identified Features of the Remnant Portion of SIHP # -2268 outside the Current Project Area

Tulchin and Hammatt (2004) described additional remnant portions of the ditch (outside the present project area), describing the components as follows:

> The improved ditch appeared to be constructed in a U-shaped configuration, with a flat bottom and nearly vertical sidewalls. However, heavy sedimentation within the interior of the ditch did not allow for direct observation of the base of the ditch. The main constructed portion of the ditch measured 90 cm [centimeter] wide and 1 m [meter] in height. The sidewalls were of cut basalt stone and mortar construction [present Figure 82]. In areas where the ditch was cut deeply into the slope, loosely stacked basalt boulder and cobble retaining walls were constructed along the top edges of the ditch as necessary. The stones composing the retaining wall appeared to be flaked, likely during the fashioning of cut basalt blocks. [Tulchin and Hammatt 2004:52]

Figure 7: Site 2268, a Section of Water Flume. View to Northeast.

Figure 81. Portion of SIHP # 50-80-09-2268 documented by Dega et al. (1998:18)

Figure 82. SIHP # 50-80-09-2268 showing the dressed basalt boulder and mortar Waiahole Ditch (top), and stacked basalt boulder and cobble retaining wall (below) (Tulchin and Hammatt 2004:53)

SIHP # 50-80-09-2268 Feature A, a flume bridge documented by Tulchin and Hammatt (2004), is described as follows:

> Near the easternmost point of the project area, the ditch crosses an unnamed drainage gully which empties into Kalo‘i Gulch. In order to cross the gully, foundations were constructed at each edge of the gully to support a metal flume section spanning the approximately 4.8 m gap. At the time of the inventory survey, the metal flume was not intact, though remnants were observed in the brush in the immediate vicinity of the structure. Each foundation consisted of a central portion constructed of cut basalt boulders and mortar, measuring 2.8 m wide and a maximum height of 1.8 m [Figure 84 and Figure 83]. In addition to the central stone and mortar constructed portion, additional stacked basalt boulder and cobble retaining walls were constructed along the edges of the gully both up and down slope of the main ditch foundation. The retaining walls extended approximately 7.2 m upslope and 3.4 m down slope of the main ditch foundation. The stones were stacked a maximum of 7-8 courses high, with a maximum height of 2.2 m. The retaining walls were generally constructed of loosely stacked stones, though mortar was observed at the interface between the retaining wall and the ditch foundation, as well as at the down slope terminus of the retaining wall. Wooden fence posts with attached barbed wire were observed to run along the top of the retaining walls and over the ditch foundations. [Tulchin and Hammatt 2004:52]

SIHP # 50-80-09-2268 Feature B identified by Hunkin and Hammatt (2009) is described as follows:

> Feature B is an improved drainage channel and short flume section. Feature B is located in the central portion of the project area, where the Waiāhole Ditch crosses a small drainage channel along the Kalo‘i Gulch slope. The drainage channel appears to have been improved by excavation of loose soil and stones to improve water flow. Feature B consists of a metal half-pipe flume section constructed over the Waiāhole Ditch [Figure 87 and Figure 88]. The metal flume is constructed of three (3) riveted sections of U-shaped sheets of iron. The flume is oriented perpendicular to the ditch, with the upslope end of the flume located in the center of the drainage channel. The flume is supported on the upslope end by a stone and mortar foundation and retaining walls that direct the water flow from the drainage channel into the flume [Figure 85]. The central portion of the flume is supported by wooden support beams and crossed with wooden cross beams. The down slope portion of the flume rests on the soil berm down slope of the ditch, with a stacked-stone retaining wall constructed along the berm in the vicinity of the flume. Down slope of the end of the metal flume section are remnants of a wooden flume that likely connected to the end of the metal flume [Figure 86]. Feature B functions as a drainage improvement associated with the Waiāhole Ditch. The flume collects storm water from an improved drainage channel and transports the water over the ditch and down the gulch slope, thereby reducing damage to and sedimentation of the ditch during periods of heavy rainfall. [Hunkin and Hammatt 2009:47]

Figure 83. Showing the eastern (top, view to east) and western (bottom, view to south) ends of the southern portion of SIHP # 50-80-09-2268 Feature A: flume bridge (Tulchin and Hammatt 2004:55)

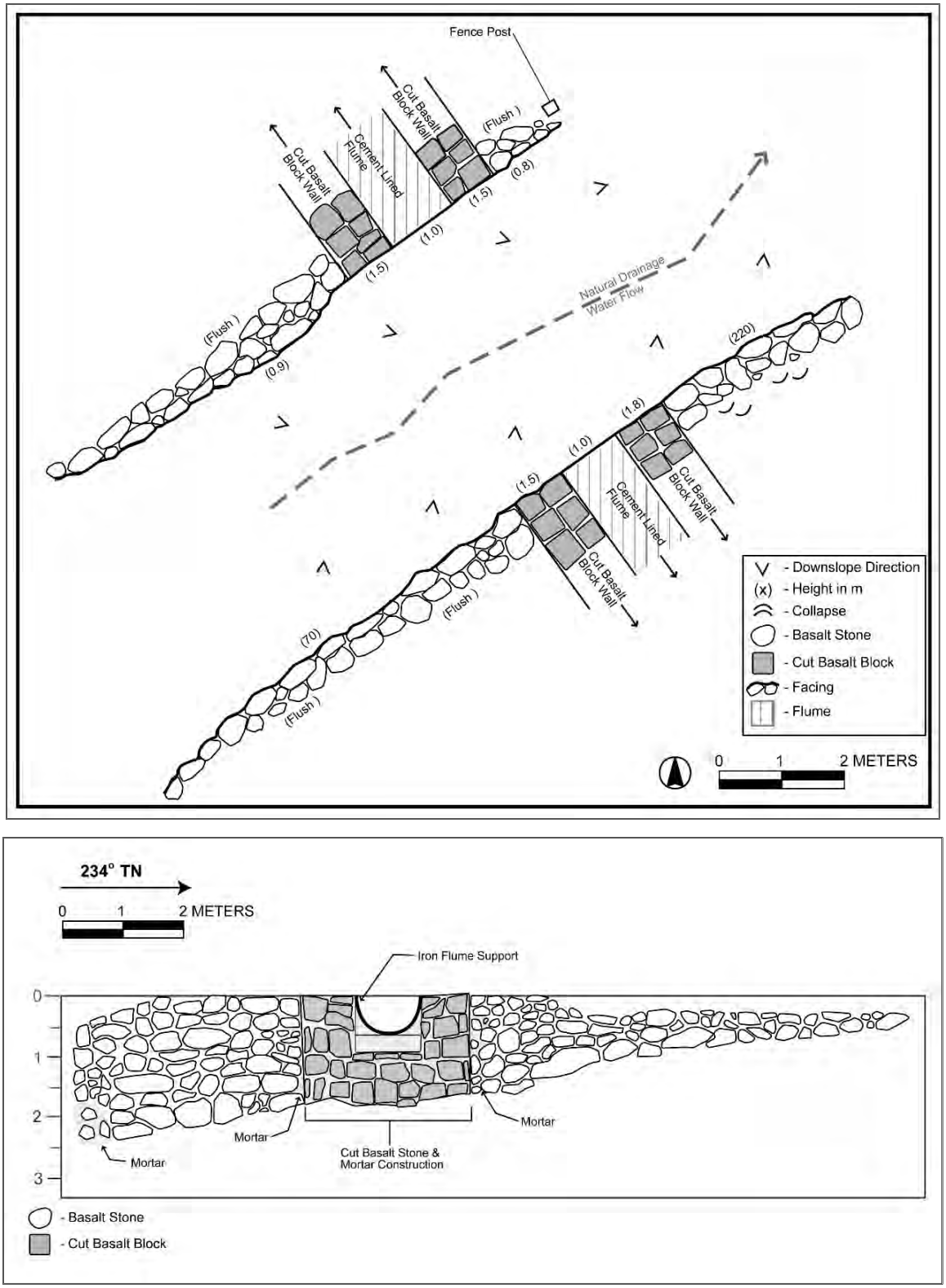

Figure 84. Plan view diagram (top) and profile (bottom) of SIHP # 50-80-09-2268 Feature A: flume bridge (Tulchin and Hammatt 2004:54)

Figure 85. SIHP # 50-80-09-2268 Feature B, showing stone and mortar flume support foundation, view to north (Hunkin and Hammatt 2009:50)

Figure 86. SIHP # 50-80-09-2268 Feature B flume, showing wooden flume extension (Hunkin and Hammatt 2009:50), view to southeast

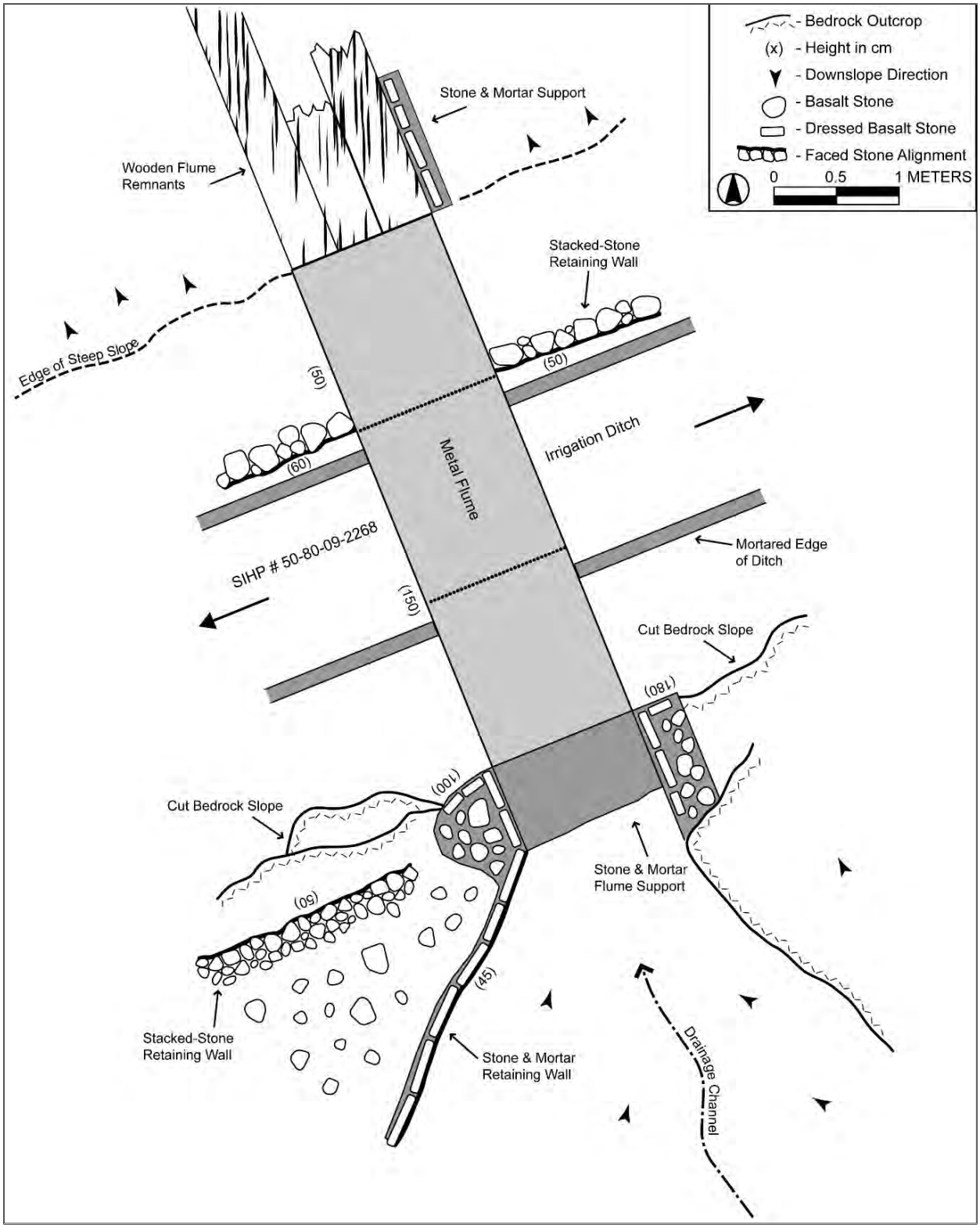

Figure 87. Plan view of SIHP # 50-80-09-2268 Feature B (Hunkin and Hammatt 2009:48)

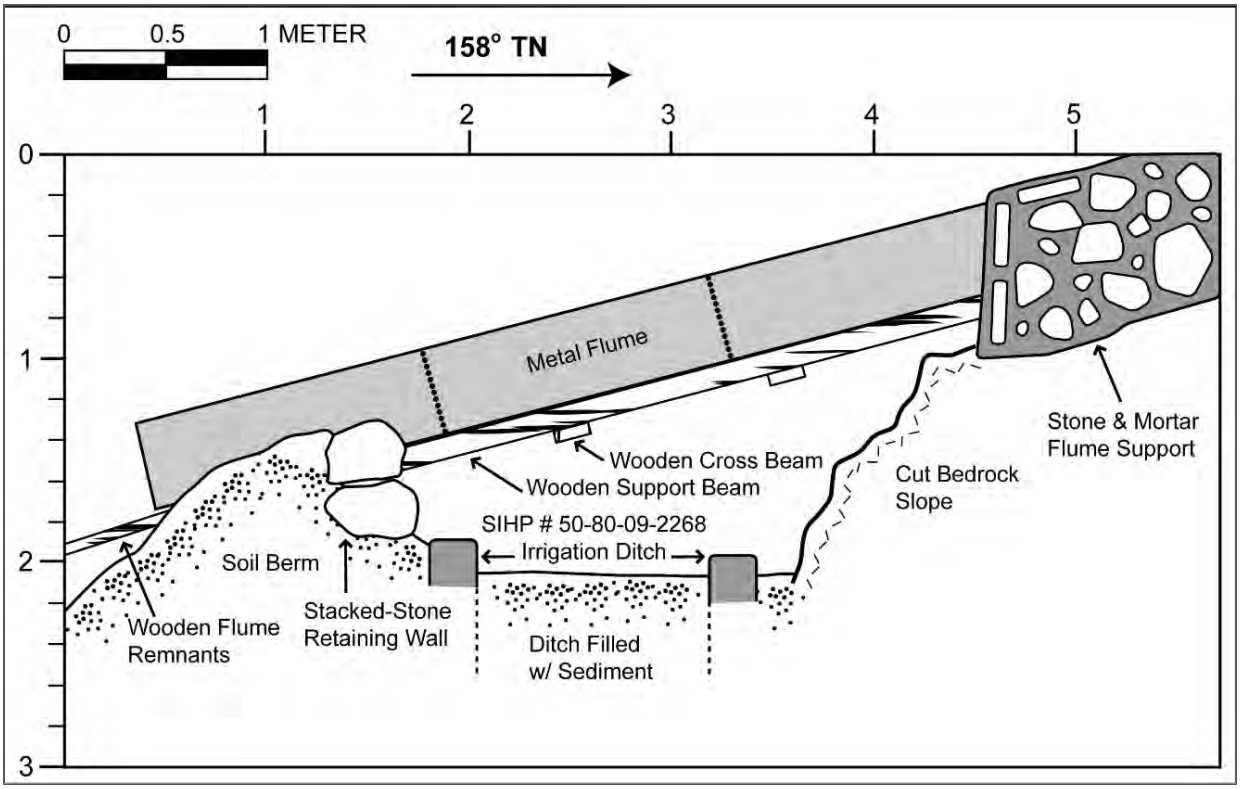

Figure 88. Photograph (top, view to east) and cross-section map (bottom) of SIHP # 50-80-09-2268 Feature B flume (Hunkin and Hammatt 2009:49)

SIHP # 50-80-09-2268 Feature C, also identified by Hunkin and Hammatt (2009), is described as follows:

> Feature C is an improved drainage channel and short flume section, similar to Feature B. Feature C is located where the Waiahole Ditch crosses a small drainage channel, approximately 100 m east of Feature B. The drainage channel appears to have been improved by excavation of loose soil and stones to improve water flow. Feature C consists of a wooden U-shaped flume section constructed over the Waiahole Ditch (Figure 91 through Figure 90). The flume is oriented perpendicular to the ditch, with the upslope end of the flume located in the center of the drainage channel. The flume is supported on the upslope end by a stone and mortar foundation and retaining walls that direct the water flow from the drainage channel into the flume. The downslope portion of the flume rests on the soil berm downslope of the ditch. Feature C functions as a drainage improvement associated with the Waiahole Ditch. The flume collects storm water from an improved drainage channel and transports the water over the ditch and down the gulch slope, thereby reducing damage to and sedimentation of the ditch during periods of heavy rainfall. Due to its wooden construction, much of the Feature C flume has deteriorated. [Hunkin and Hammatt 2009:47]

As noted in Zapor et al. (2018), based upon consultation with SHPD staff and Mr. Shad Kane, the alignment of SIHP # 50-80-09-2268 along the southern slope of Kalo‘i Gulch is suggested to be a traditional Hawaiian trail alignment facilitating pedestrian travel from the uplands of Pālehua down to the coast.

SIHP # 50-80-09-2268 Feature D was identified by Zapor et al. (2018) and described as follows:

> The newly identified Feature D is a large earthen mound and stacked stone wall [Figure 92 and Figure 93] located in the northeastern portion of the project area running adjacent to SIHP # 50-80-12-6951 and is likely the remnants of the reservoir that can be seen on historic maps at the terminus of the Waiahole Ditch System...Sometime after 1977, the reservoir was filled in with sediment resulting in the current state of Feature D. [draft Zapor et al. 2018:76]

5.2.3 Features of the Remnant Portion of SIHP # -2268 within the Current Project Area

Components related to the Waiahole Ditch were documented within the project area and are discussed below. The Waiahole Ditch and all associated components are related to former water control needs for agriculture in the area.

Several variations of the Waiahole Ditch were observed during the current study. Just outside the northern boundary of the project area, the ditch consists of a more formal construction, with mortared basalt sides and tunnels (Figure 94 through Figure 96). Concrete-lined portions were also observed just north of the project area boundary, as were several tunnel entrances and sluice gate features (Figure 97 and Figure 98). Much of the length of the Waiahole Ditch runs underground in concrete-lined tunnels. In the central portion of the project area, the ditch was observed as an informal earthen ditch, largely overgrown (Figure 99). In the southwest portion of the project area, dry-stacked basalt sides were observed (Figure 100 and Figure 101). As discussed above,

Figure 89. SIHP # 50-80-09-2268 Feature C, view to south (Hunkin and Hammatt 2009:52)

Figure 90. SIHP # 50-80-09-2268 Feature C, showing partially intact wooden flume section, view to south (Hunkin and Hammatt 2009:52)

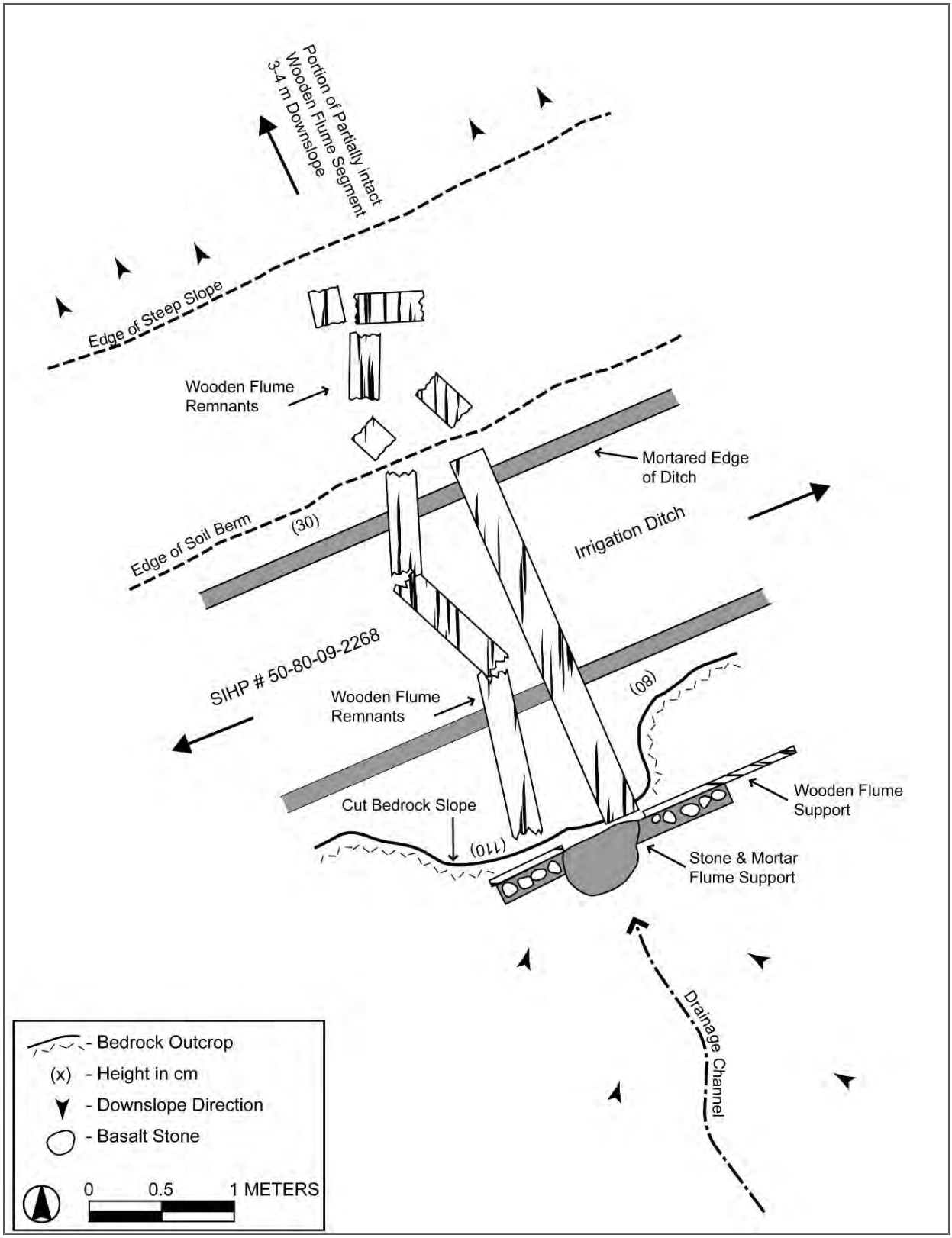

Figure 91. Plan view of SIHP # 50-80-09-2268 Feature C (Hunkin and Hammatt 2009:51)

Figure 92. SIHP # 50-80-09-2268 Feature D, earthen mound, view to southwest (Zapor et al. 2018:79)

Figure 93. SIHP # 50-80-09-2268 Feature D, stacked stone wall, view to southwest (Zapor et al. 2018:79)

Figure 94. Culvert of SIHP # 50-80-09-2268, Waiahole Ditch, northwest of (outside) the project area, view to southwest

Figure 95. Representative photo of SIHP # 50-80-09-2268, Waiahole Ditch outside (northwest) of the project area, view to east

Figure 96. Portion of SIHP # 50-80-09-2268, Waiahole Ditch outside (north) of project area, with date “1920” inscribed on basalt and mortar culvert, view to northeast

Figure 97. Portion of SIHP # 50-80-09-2268, Waiahole Ditch in northeastern project area, view to southwest

Figure 98. Representative photo of SIHP # 50-80-09-2268, Waiahole Ditch construction outside (northwest) of the project area, view to west

Figure 99. Representative photo of SIHP # 50-80-09-2268, Waiahole Ditch (left) in central project area, view to southwest

Figure 100. Representative photo of SIHP # 50-80-09-2268, Waiahole Ditch in southwest project area, dry-stacked basalt, view to north

Figure 101. Representative photo of SIHP # 50-80-09-2268, Waiahole Ditch in southwest project area, view to north

there is a formal concrete and mortared cut basalt blocks portion of the ditch with various components for water control, related to the pump station building that is southeast of the project area (see SIHP # 50-80-08-5593 Feature 2A discussion for description).

Portions of the Waiahole Ditch within and surrounding the project area have additional components related to water control including culverts, metal pipes, sluice gates, and bridges. The first designated feature of the Waiahole Ditch for the current project, **SIHP # 50-80-09-2268 Feature E**, consists of a culvert associated with the ditch, documented in the southwest portion of the project area (Figure 102 through Figure 105). The culvert consists of mortared cut basalt blocks, two to three courses high, constructed around a largely buried concrete drain pipe (see Figure 102). Both sides of the tunnel are faced, and a concrete slab extends over top of the culvert. The concrete slab is approximately 6.5 m long and 1.5 m wide (Figure 103). The faces of the culvert are approximately 3.5 m wide, and the height of the exposed portion is 1.3 m. The observed portion of the mouth of the pipe is 50 cm in diameter. These components are in fair condition. The southeast portion of the concrete slab is damaged due to partial collapse.

SIHP # 50-80-09-2268 Feature F of the ditch system was identified as part of a two-course mortared basalt portion of the ditch in the central portion of the southwest project area (Figure 106 through Figure 111). Feature F consists of a portion of the ditch with pipes, cross beams, and sluice gate components. A metal pipe extends north-south within the ditch, and two metal cross beams extend perpendicular across the ditch face, positioned under the metal pipe directly overlying the ditch surface (see Figure 107). The metal pipe extends beyond both of the cross beams. The metal cross beams are 10 cm wide and are spaced 7.1 m apart. Additionally, a channel extends southeast from the main ditch, which is blocked by a sluice gate feature, the wooden gate of which is still intact (see Figure 108 and Figure 109). The main ditch measures 1.2 m wide, and the channel extending from it is 0.7 m wide, widening to 1.7 m as it extends to the southeast. Depths of the ditch range from 40 to 80 cm, due to the accumulation of sediment in the base of the ditch. The sluice gate component is 0.7 m wide and 0.5 m tall. Notches for a second sluice gate are present in the concrete approximately 12 cm from the intact sluice gate component. The wood of this second sluice feature is no longer intact. Additional sluice notches were noted inside the main ditch as well, approximately 0.5 m southwest of the channel portion. A representative plan view and profile were completed for this section of the ditch (see Figure 110 and Figure 111). All of these components including this portion of the Waiahole Ditch are in fair condition.

SIHP # 50-80-09-2268 Feature G, a second, similar portion of the ditch was documented approximately 18 m northeast of Feature F (Figure 112 and Figure 113). Feature G consists of a mortared cut basalt portion of the ditch, with three pipes (one parallel and two perpendicular), and sluice gate remnants. Here the ditch is oriented north-south and measures 1.3 m wide and ranges from 33 cm to 45 cm deep. Note that much sediment has accumulated in the base of the ditch. A channel extends east off the main ditch which measures 0.7 m wide and 67 cm deep. The same metal pipe detailed above extends parallel along the east edge of the ditch. Additionally, two 5 cm pipes extend perpendicular across the ditch 30 cm north of the east-extending channel, spaced 1.2 m apart. There are notches for two sluice gate features in the east-extending channel.

SIHP # 50-80-09-2268 Feature H consists of a metal drainage flume feature documented in the northern portion of the southwest project area (Figure 115 and Figure 114). Feature H is

Figure 102. SIHP # 50-80-09-2268 Feature E, culvert and bridge components of the Waiahole Ditch in southern project area, view to northeast

Figure 103. SIHP # 50-80-09-2268 Feature E bridge overlying culvert of Waiahole Ditch in southern project area, view to east

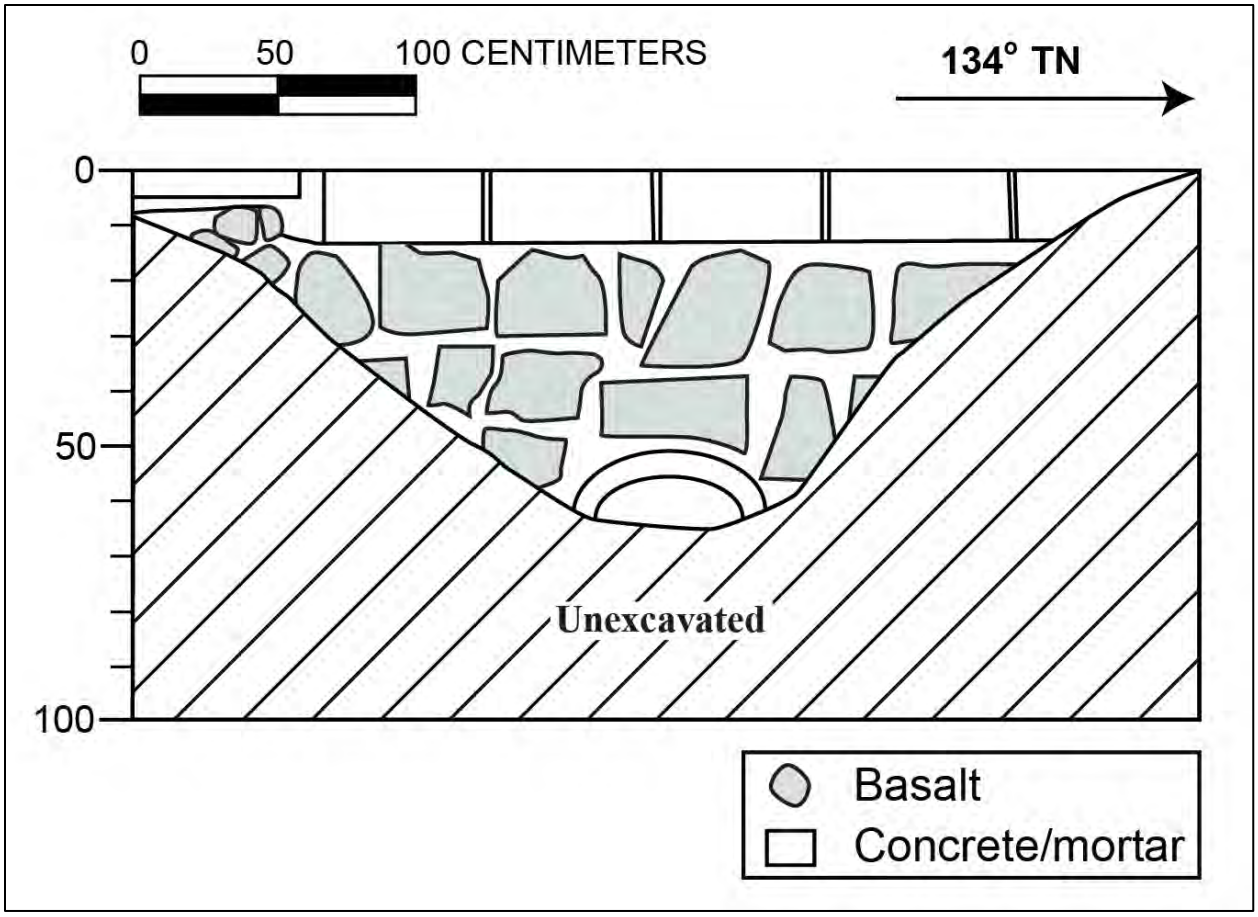

Figure 104. SIHP # 50-80-09-2268 Feature E southwest face of culvert profile

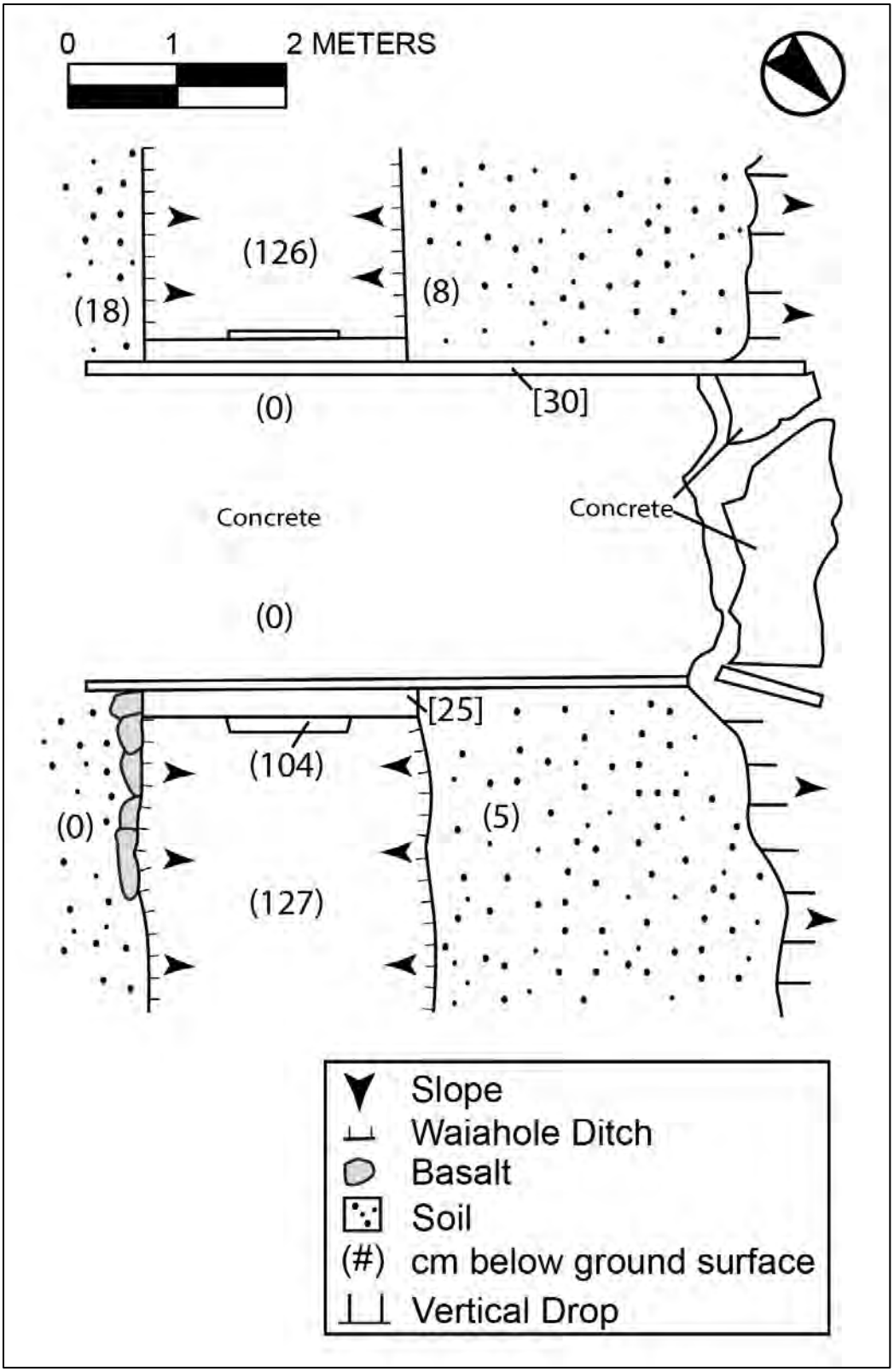

Figure 105. SIHP # 50-80-09-2268 Feature E culvert and ditch plan map

Figure 106. SIHP # 50-80-09-2268 Feature F, basalt and mortar-lined ditch, with metal cross beam (right background), view to north

Figure 107. SIHP # 50-80-09-2268 Feature F, basalt and mortar ditch portion, with metal pipe and cross beam, view to south

Figure 108. Plan view of SIHP # 50-80-09-2268 Feature F, showing pipe, southeast channel, and sluice gate components

Figure 109. SIHP # 50-80-09-2268 Feature F, close-up of southeast channel and sluice gate component, view to north

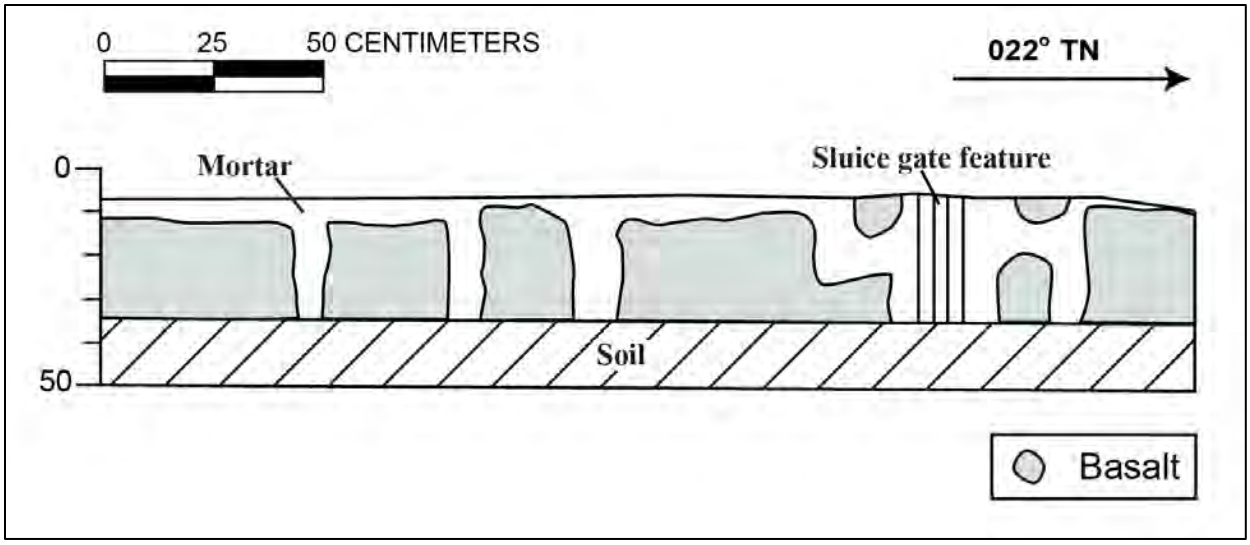

Figure 110. SIHP # 50-80-09-2268 Feature F, west wall of ditch representative profile

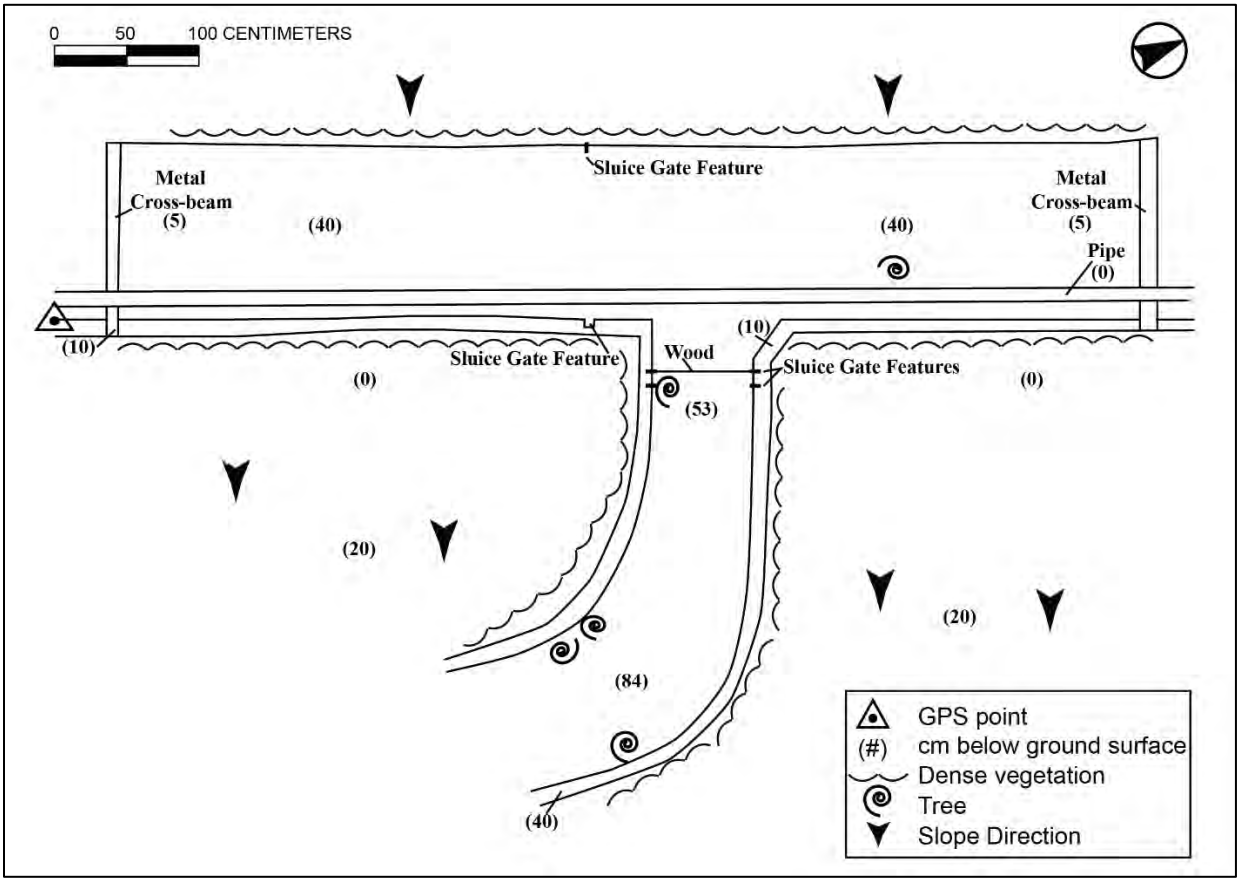

Figure 111. SIHP # 50-80-09-2268 Feature F plan map

Figure 112. SIHP # 50-80-09-2268 Feature G, showing sluice gate component and two metal pipes, view to east

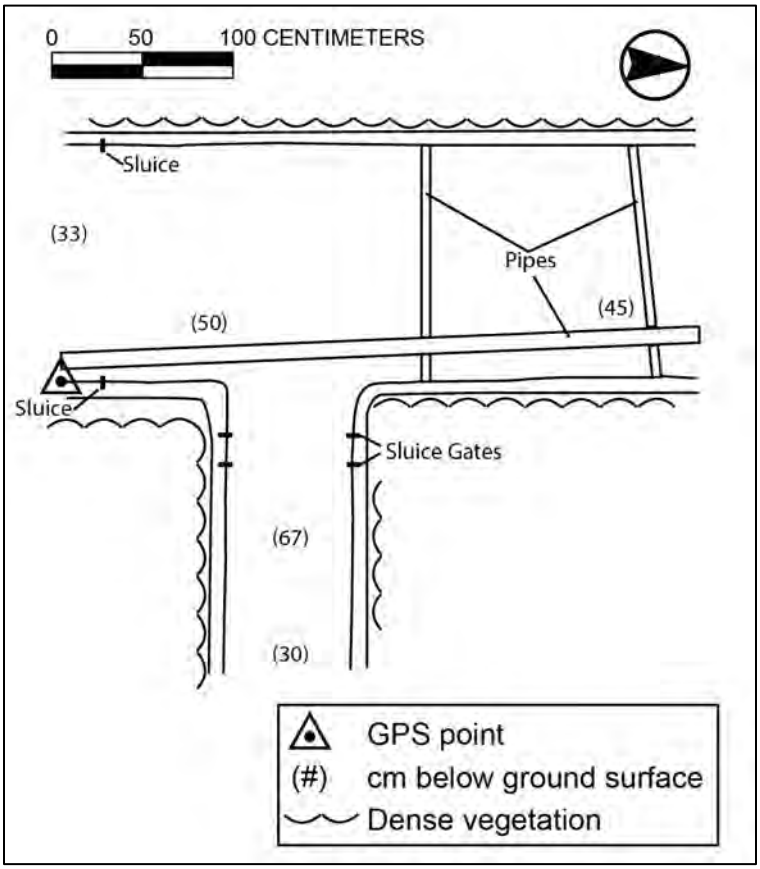

Figure 113. SIHP # 50-80-09-2268 Feature G plan map

Figure 114. Overview of SIHP # 50-80-09-2268 Feature H (left)

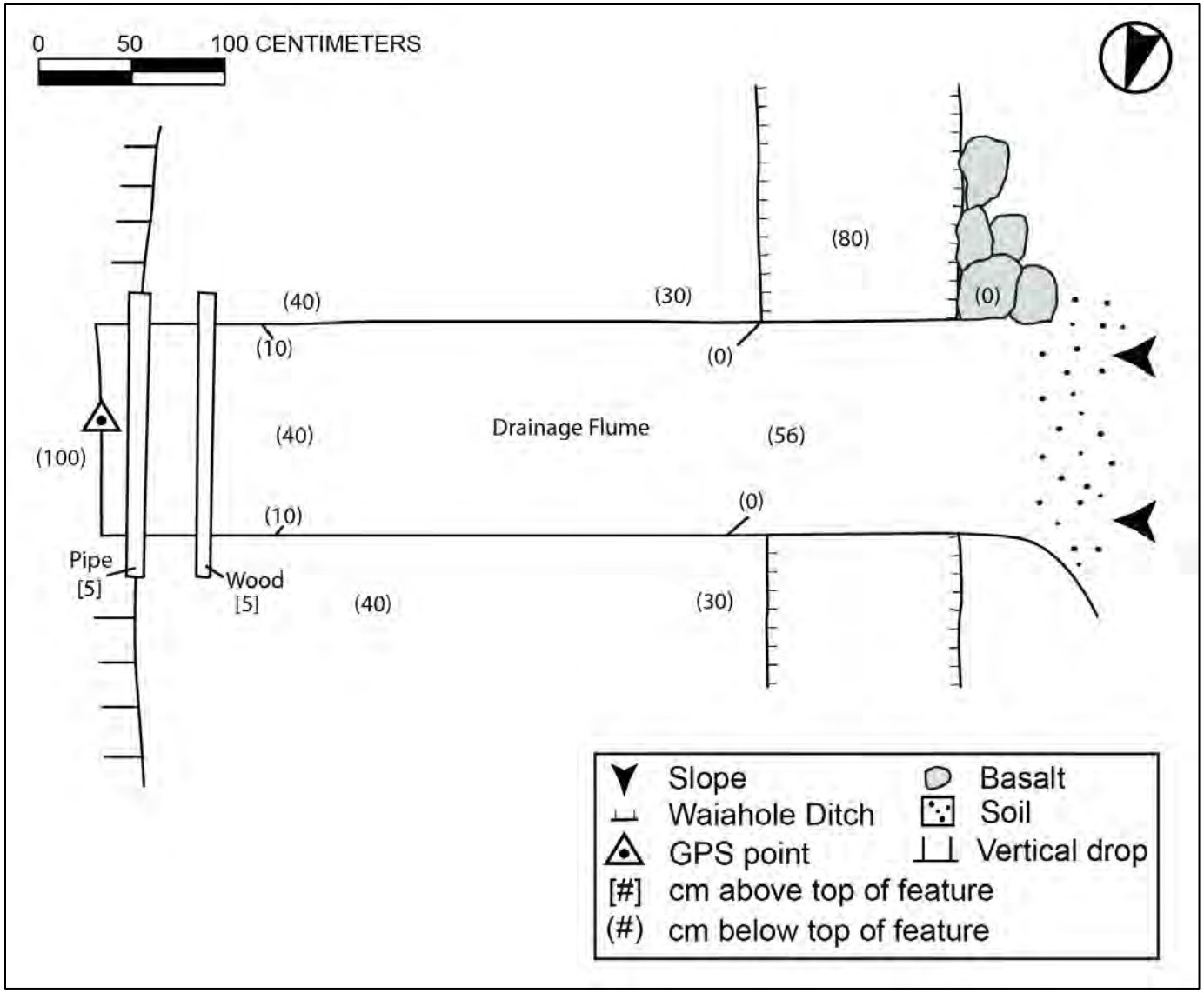

Figure 115. SIHP # 50-80-09-2268 Feature H plan map

oriented northeast-southwest and measures 1.1 m wide and 5.0 m long, and a maximum 56 cm deep (Figure 116). The flume extends toward a vertical drop, at one time funneling water into the gulch below. A decaying wood portion extends perpendicular over the northeast end of the metal chute. Approximately 20 cm from the wood, a metal pipe extends perpendicular over the top of the flume. At the southwest end of the chute, on the south side, there is a pile of mortar and basalt cobbles measuring 1 m wide and 90 cm tall (Figure 117). The flume extends over top of the Waiahole Ditch.

SIHP # 50-80-09-2268 Feature I consists of a portion of the ditch with several associated features, constructed to carry the water over the gulch in the area. This bridge component has four mortared basalt block pillars (Figure 119 through Figure 121). At one time an elevated metal half pipe connected the pillars, the middle of which appears to have collapsed. In the north end a portion of the metal in between the two pillars was still visible, and an incised line was noted, possibly a former space for a sluice gate or similar component (see Figure 120). The middle portion of this feature has largely collapsed, and with much of the footings obscured by earth. Approximately 3.5 m to the south, a basalt and mortar headwall and culvert were observed, measuring 2.5 m long, 20 cm wide, and 95 cm tall.

SIHP # 50-80-09-2268 Feature J is similar to Feature I, another area of components to carry the ditch over gulches in the area. The first component consists of four mortared basalt block pillars connected by an elevated concrete bridge (Figure 122 through Figure 124). The concrete has been entirely filled in with soil and is overgrown, and portions of the pillars are also obscured. A 12-cm metal pipe extends the entire length of this feature and beyond, resting on top of the *makai*/south pillars. The letters “B M +” are inscribed in the mortared surface of the northwestern pillar. Approximately 2 m east of this bridge component is a culvert constructed of mortared basalt, which measures 55 cm tall and 105 cm wide (see Figure 123). Only 80 cm of length is exposed, the remainder covered with earth; however, the tunnel appears to extend toward the ditch wall. Overall, the bridge components of Features J and K span an area approximately 53 m long.

SIHP # 50-80-09-2268 Feature K of the ditch system consists of a culvert and tunnel feature with intact metal sluice gate, along the northern boundary of the project area (Figure 125 through Figure 126). Feature K extends southeast off the ditch, extending under the access road, though the feature could not be identified on the other side of the road. Two concrete patches were noted in the road, which appear to have been used to cover collapsed portions of the tunnel. It is possible the entire tunnel has collapsed. The observable portion of the feature—from the head gate to the end of the second concrete patch—spans 3 m in length and is a maximum of 0.7 m wide. The first, fragmented concrete slab measures 95 cm long and 75 cm wide. The second concrete slab, which is in the middle of the road, measures 1.6 m long by 0.7 m wide. The head wall of Feature I measures 0.9 m long. Overall the feature is in fair condition, as portions of the concrete are fragmented and collapsing.

5.2.4 Significance

SIHP # 50-80-09-2268, Waiahole Ditch and associated features, has been previously assessed by a variety of studies under various criteria. See Section 7 for a full discussion of prior significance assessments. SIHP # 50-80-09-2268 is assessed as significant under HAR §13-284-6 Criteria a, c, and d. The Waiahole Ditch has yielded information on agricultural history of the area and contributed greatly to the development and evolution of the ‘Ewa Plain throughout its history,

Figure 116. SIHP # 50-80-09-2268 Feature H, drainage flume, along north edge of project area, view to northeast

Figure 117. Mortar and basalt pile south end of SIHP # 50-80-09-2268 Feature H, drainage flume, view to west

Figure 118. Collapsed bridge component of SIHP # 50-80-09-2268 Feature I, view to south

Figure 119. Collapsed bridge component of SIHP # 50-80-09-2268 Feature I, view to southwest

Figure 120. Close-up plan view showing metal portion, collapsed bridge component of SIHP # 50-80-09-2268 Feature I

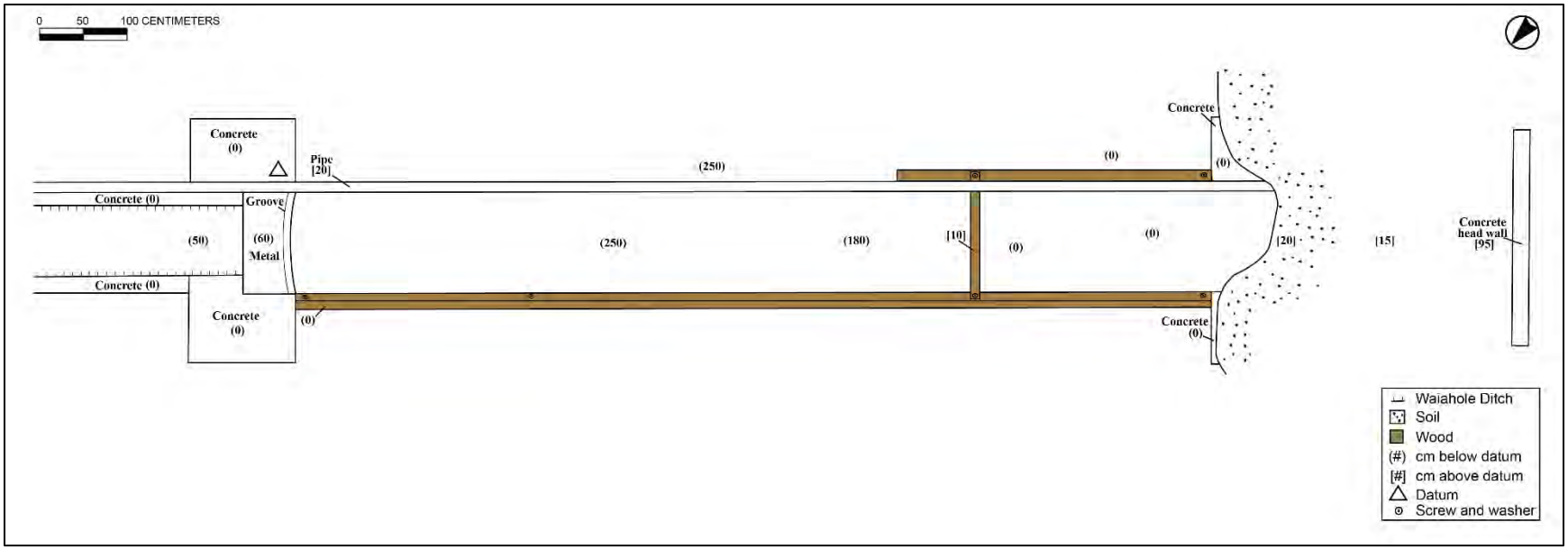

Figure 121. Plan map of SIHP # 50-80-08-2268 Feature I, showing portion of the Waiahole Ditch, collapsed bridge components, and head wall

Figure 122. Overview of bridge component of SIHP # 50-80-09-2268, Feature J, view to southwest

Figure 123. Culvert component of SIHP # 50-80-09-2268 Feature J documented east of bridge component, view to north

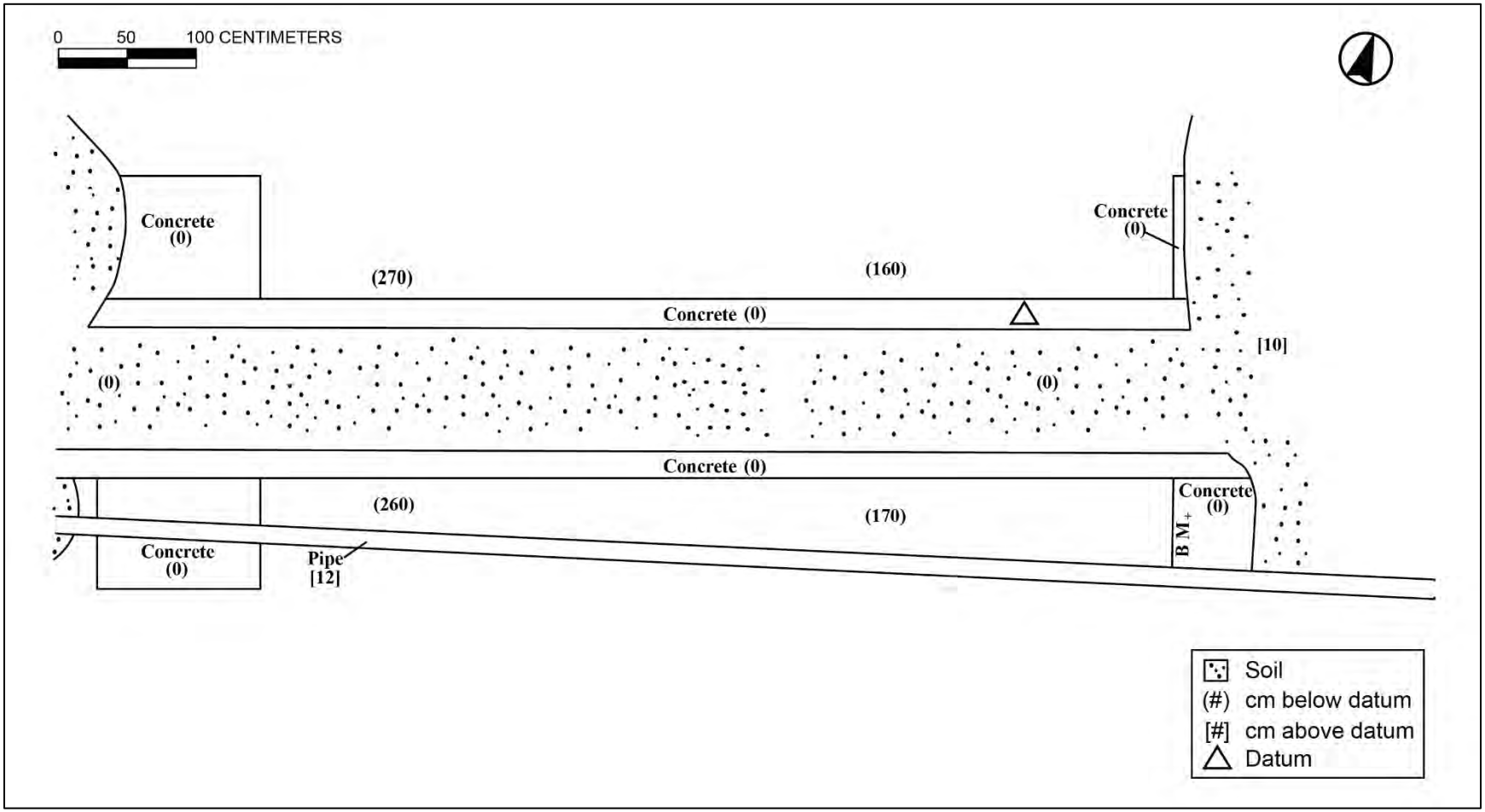

Figure 124. Plan map of SIHP # 50-80-09-2268 Feature J, bridge component

Figure 125. SIHP # 50-80-09-2268 Feature K, culvert and tunnel feature, view to north

Figure 126. SIHP # 50-80-09-2268 Feature K, showing culvert with intact sluice gate, view to east

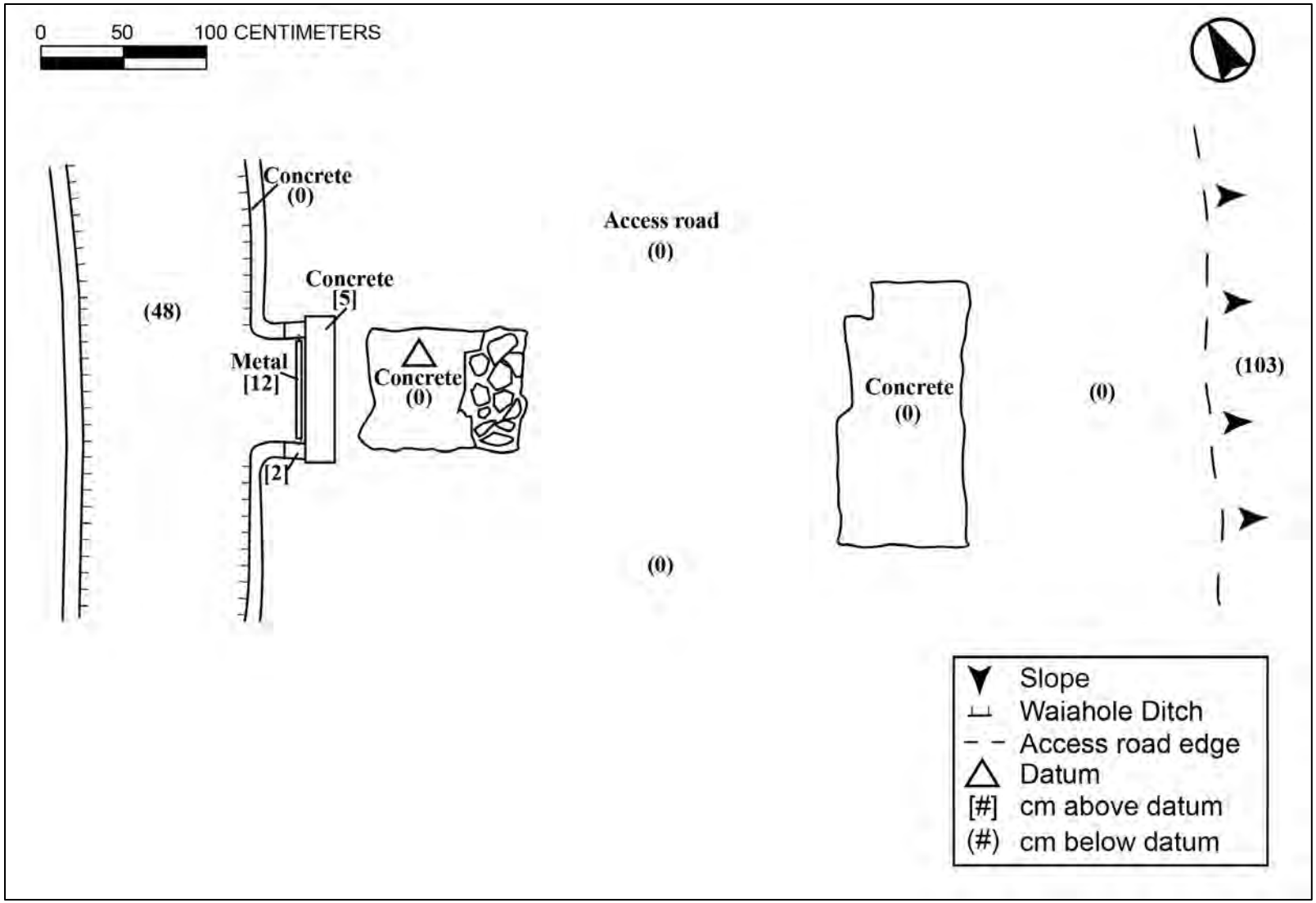

Figure 127. Plan map of SIHP # 50-80-09-2268 Feature K

and may continue to yield additional information on plantation-era history on O‘ahu. However, within the project area, the historic property only retains sufficient integrity of location, which is also diminished in portions of the project area due to erosion and neglect. While there are some portions that retain some integrity of design, materials, and workmanship within the project area, this integrity is diminished. The overall ditch is significant, however, the remnant portion of SIHP # 50-80-09--2268 within the project area does not retain sufficient integrity to be considered significant.

Section 6 Summary and Interpretation

At the request of Tetra Tech, Inc., and on behalf of AES Distributed Energy, CSH has prepared this AISR for the AES West O‘ahu Solar project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu, TMK: [1] 9-2-002:007 (por.). The project area is on undeveloped lands in the southeastern foothills of the Wai‘anae Range, northeast of Pu‘u Makakilo and the Makakilo subdivision and about 600 m northwest of the intersection of the H-1 Freeway and the Kualaka‘i Parkway.

Background research indicates little traditional land use in the portion of Honouliuli Ahupua‘a in which the project area is situated. Large settlements were primarily concentrated near the coast, near marine and estuarine resources, or in the irrigated lowlands suitable for wetland cultivation. Any evidence of traditional land use in the area was likely wiped out by historic agricultural and ranching activities that lasted through the mid-twentieth century. The northeast portion of the project area and much of the surrounding land was occupied by Oahu Sugar Company fields by 1925. The Waiahole Ditch, constructed for much needed irrigation of the sugarcane fields, is known to extend through the current project area. Small plantation-related residential camps were the only settlements found in the upper slopes in the early twentieth century, with “Pump Camp 5” existing within the project area, according to historic maps. Various roads and fence lines related to agricultural and/or ranching activities in the region are known to have existed in the project area at one time. Archaeological studies in the vicinity of the project area have documented various plantation-era historic properties including walls, alignments, mounds, ditches and other irrigation features, as well as portions of the Waiahole Ditch (SIHP # 50-80-09-2268).

Fieldwork included 100% pedestrian inspection of the project area, GPS data collection, and documentation of surface historic properties. Two previously identified historic properties were documented within the project area: SIHP # 50-80-08-5593, historic irrigation and plantation infrastructure, and SIHP # 50-80-09-2268, the Waiahole Ditch System. The AIS documented two features of SIHP # 50-80-08-5593: drain-pipes (Feature 1) and a complex of components related to the pump house and mill located just southeast of the project area (Features 2A through 2E). No indications of traditional land use were observed. No remnants of Pump Camp 5 were identified. The majority of the SIHP # 50-80-08-5593 features were identified extending through the northern portion of the project area.

The Waiahole Ditch System (SIHP # 50-80-09-2268) and associated components were identified extending through the western portion of the project area. The AIS documented seven remnant features of SIHP # 50-80-09-2268: a culvert and bridge (Feature E), two ditch portions with metal pipes and sluice gate components (Features F and G), a metal drainage flume (Feature H), two bridge components (Features I and J), and a culvert feature with sluice gate (Feature K). The remnant portion of SIHP # 50-80-09-2268 within the project area is at the far west end of the ditch system. It is not a portion of the continuous transmission line Waiahole Ditch (most of which is still in use), but rather extends from a reservoir fed directly from the ditch that extends from Windward O‘ahu. From the reservoir, Ko‘olau water is fed into various ditches. While the remnant of the ditch within the project area is undoubtedly part of the Waiahole Ditch System as a whole, the portion within the project area and its components are in remnant condition. Additional portions of the remnant ditch and associated components are still extant in the vicinity, outside the project area.

The results of this AIS correspond with the history of the slopes of Honouliuli Ahupua‘a, representing historic agriculture, ranching, and related activities throughout the twentieth century.

Section 7 Significance Assessments

Historic property significance is evaluated and assessed based on the five State of Hawai‘i historic property significance criteria. To be considered significant, a historic property must possess integrity of location, design, setting, materials, workmanship, feeling, and/or association and meet one or more of the following broad cultural/historic significance criteria (in accordance with HAR §13-284-6):

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; or

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.

Two previously identified historic properties were documented within the project area. Table 4 lists the historic properties along with their significance assessments and specific mitigation commitments. These mitigation commitments are included in this AISR for the review and concurrence of the SHPD.

SIHP # 50-80-08-5593, historic irrigation system and plantation infrastructure, was previously assessed by Dega et al. (1998) as significant under Hawai‘i State historic property significance Criteria a (be associated with events that have made an important contribution to the broad patterns of our history) and d (has yielded, or may be likely to yield, information important for research on prehistory or history). The current study assesses SIHP # 50-80-08-5593 as significant only under Criterion d. This historic property has yielded information on land utilization and agricultural history of the ‘Ewa Plain. However, it is not associated with specific, impactful events in the area, unlike the Waiahole Ditch, which immeasurably altered the entirety of the landscape. Much of the irrigation system has been buried and destroyed by erosion and livestock. Therefore, the historic property possesses diminished but sufficient integrity of location, design, materials, and workmanship, for which it’s significant.

SIHP # 50-80-09-2268, The Waiahole Ditch System, has a long history of significance evaluation (Table 5).

- The Bishop Museum Public Archaeology Section Applied Research Group (Goodman and Nees 1991) conducted archaeological reconnaissance and inventory surveys of 3,600 acres in the uplands of Waiawa Ahupua‘a, and touched on the Waiahole Ditch (SIHP # 50-80-09-2268) as it crossed their project area (Goodman and Nees 1991:64). The only

Table 4. Archaeological historic property integrity, significance, and project-specific mitigation commitments

SIHP #	Formal Type/ Description	Integrity							Significance	Mitigation Commitments
		Location	Design	Setting	Materials	Workmanship	Feeling	Association		
50-80-08-5593	Historic irrigation system and plantation infrastructure	Y	Y	N	Y	Y	N	N	d	No further work
50-80-09-2268	Waiahole Ditch System	Y	N	N	N	N	N	N	a, c, and d	No further work

Table 5. Significance evaluations for portions of the Waiahole Ditch

Study or Review	General Location	Evaluation in terms of HAR criteria	Evaluation in terms of National/Hawai‘i Register of Historic Places (NRHP/HRHP) criteria
Goodman and Need 1991	3,600 acres in uplands of Waiawa Ahupua‘a	Significance not evaluated: “significance […] has been realized through field and archival research and no further work is recommended”	
Hammatt et al. 1996	1,339 acres within portions of Waipio and Waiawa Ahupua‘a	Significance not evaluated: “If the portion of the Waiahole Ditch which crosses the two parcels of the project area is ever to be impacted by future development, the State Historic Preservation Division should be notified beforehand, so that appropriate mitigative measures, if necessary, can be established.”	
Dega et al. 1998	Proposed University of Hawai‘i West O‘ahu Campus project	Significance not evaluated: “The Waiahole Ditch System has previously been assessed as significant” (refers to Goodman and Nees 1991)	
Tulchin and Hammatt 2004	86-acres at Pālehua in Makakilo	Not evaluated under HAR criteria	Significant under NRHP and HRHP Criterion A and D
Tulchin et al. 2009	Koa Ridge project	HAR significance not evaluated	Significant under NRHP and HRHP Criteria A, C, and D
SHPD acceptance letter for Tulchin et al. 2009	Koa Ridge project	SHPD acceptance letter for this study makes no reference to site significance.	
Hunkin and Hammatt 2009	Makakilo Dr Extension project	HAR significance not evaluated	Significant under NRHP and HRHP Criteria A, C, and D
SHPD review letter for Hunkin and Hammatt 2009	Makakilo Dr Extension project	HAR significance not evaluated	Significant under NRHP and HRHP Criteria A, B, and D
Shideler and Hammatt 2018	Koa Ridge project	HAR significance not evaluated	Evaluated integrity; supports significance assessment made in Tulchin et al. 2009 as significant under NRHP and HRHP Criteria A, C, and D

Study or Review	General Location	Evaluation in terms of HAR criteria	Evaluation in terms of National/Hawai‘i Register of Historic Places (NRHP/HRHP) criteria
SHPD review letter for Shideler and Hammatt 2018	Koa Ridge project	Assessed as significant pursuant to HAR §13-284-6 Criteria a, c, and d	NRHP and HRHP significance not addressed
Zapor et al. 2018	Makakilo Dr Extension project	Assessed as significant pursuant to HAR §13-275-6, under Criteria a, c, and d	Evaluated for listing on the NRHP and HRHP pursuant to 36 CFR 60.4 and HAR §13-198-8

discussion of significance is in their statement “The significance of the following sites has been realized through field and archival research and no further work is recommended: State Sites […] 2268; B4-15 (the Waiahole Ditch)” (Goodman and Nees 1991:137). Thus, while the Waiahole Ditch is assigned an SIHP #, there is really no discussion of significance of the Waiahole Ditch in the Goodman and Nees (1991) study.

- A Hammatt et al. (1996) archaeological inventory survey of 1,339 acres of Castle & Cooke lands within portions of Waipio and Waiawa Ahupua‘a discusses that portion of the Waiahole Ditch within the Koa Ridge area west of the H-2 Freeway. At the time of that study, it was anticipated that a portion of the ditch (which conveyed large volumes of water of significant import) would not be impacted. While the significance of the Waiahole Ditch was noted, the significance was not formally evaluated. It was simply asserted that “If the portion of the Waiahole Ditch which crosses the two parcels of the project area is ever to be impacted by future development, the State Historic Preservation Division should be notified beforehand, so that appropriate mitigative measures, if necessary, can be established” (Hammatt et al. 1996:55).
- The Dega et al. study asserts (1998:22), “The Waiahole Ditch System has previously been assessed as significant (see Goodman and Nees 1991).” The Dega et al. study offers no further discussion of the significance of the Waiahole Ditch System (and avoids any substantive comment regarding the conclusion of the referenced Goodman and Nees 1991 study).
- A Tulchin and Hammatt 2004 AIS of an approximately 86-acre proposed Pālehua Community Association project identified a portion of the Waiahole Ditch System. SIHP # 50-80-09-2268 was evaluated as significant under NRHP and HRHP Criteria A and D (Tulchin and Hammatt 2004:65).
- The Tulchin et al. (2009:66–68) archaeological inventory survey addresses that portion of the Waiahole Ditch within the Koa Ridge project area east of the H-2 Freeway crossing a small northern tributary gulch of Pānakauahi Gulch. Two features have been designated for the Waiahole Ditch during the Koa Ridge project (but without any letter or numeric designations): one for the main ditch including both the open ditch and Pānakauahi siphon and one feature designation including two 1-m long basalt boulder support walls.

  The 2009 archaeological inventory survey provides the following assessment of significance:

  > SIHP # 50-80-09-2268 is assessed as significant under Criterion A (associated with events that have made an important contribution to the broad patterns of our history), Criterion C (embody the distinctive characteristics of a type period or method of construction), and Criterion D (have yielded, or may be likely to yield information important in prehistory or history) of the National and Hawai‘i Registers of Historic Places evaluation criteria. [Tulchin et al. 2009:66]

  The integrity of SIHP # 50-80-09-2268, Waiahole Ditch was not assessed at the time of identification (Hammatt et al. 1996:47–50; Tulchin et al. 2009:89–91). The SHPD acceptance letter for this study dated 10 February 2009 (LOG NO. 2009.0605, DOC. NO. 0902WT21) makes no reference to historic property significance.

- An archaeological inventory survey for a Makakilo Drive Extension project (Hunkin and Hammatt 2009) discusses a portion of the Waiahole Ditch and concludes, “The SIHP # 50-80-09-2268 alignment continues to be significant under criteria A, C, and D” with reference to the criteria established for the NRHP and HRHP (Hunkin and Hammatt 2009:65).

  The SHPD acceptance letter for this AIS dated 18 August 2009 (LOG NO. 2008.3209, DOC. NO. 0908NM28) asserts that SIHP # 50-80-09-2268, the Waiahole Ditch System is eligible for listing on the NRHP and HRHP under Criteria A, B, and D (the AIS declares significance under Criteria A, C, and D and the acceptance letter specifies A, B, and D).

- A preservation plan for the Koa Ridge project (Shideler and Hammatt 2018) addressed a portion of the SIHP # 50-80-09-2268, Waiahole Ditch System. The report evaluated the significance of the Waiahole Ditch System as follows:

  > SIHP # -7046 is evaluated as possessing integrity of location, design, materials, and workmanship. The setting is evaluated as lacking integrity as the character of the place as a locus of agriculture has been lost and the vegetation is much different. The feeling of agricultural life of the historic property has been lost. The historic property has lost its association with the events and activities of agriculture.
  >
  > The relationship of the historic property to the local history of agriculture and the integrity of location, design, materials, and workmanship is evaluated as supporting the site significance assessment made in 2009. [Shideler and Hammatt 2018:20]

  So while not spelled out per se in the 2018 preservation plan, the preservation plan supports the significance assessment made in 2009 “assessed as significant under Criterion A\[…] Criterion C […] and Criterion D of the NRHP and HRHP evaluation criteria.”

  The SHPD acceptance letter for this preservation plan dated 28 February 2018 (Log No. 2018.00220, Doc. No. 1802JA04) asserts slightly differently that “Site 2268 retains integrity of location, design, materials, and workmanship and is assessed as significant under HAR §13-284-6 Criteria a, c, and d.”

- A supplemental archaeological inventory survey for the Makakilo Drive Extension project (Zapor et al. 2018) further documented previously identified components of the Waiahole Ditch and documented one newly identified feature. Zapor et al. (2018) assess the ditch as significant pursuant to HAR §13-275-6, under Criteria a, c, and d.

Based on the findings of this AIS report, SIHP # 50-80-09-2268 is assessed as significant under HAR §13-284-6 Criteria a, c, and d. The historic property has yielded information on the agricultural history of the area and contributed greatly to the development and evolution of the ‘Ewa Plain throughout its history. However, within the project area, the historic property only retains sufficient integrity of location, which is also diminished in portions of the project area due to erosion and neglect. While there are some portions that retain some integrity of design, materials, and workmanship within the project area, this integrity is very diminished. While the overall ditch is significant, the remnant portion of SIHP # 50-80-09-2268 within the project area does not retain sufficient integrity to be considered significant.

Section 8 Project Effect and Mitigation Commitments

8.1 Project Effect

Two historic properties (SIHP #s 50-80-08-5593 and 50-80-09-2268) were identified within the project area (the same as identified in a prior Dega et al. 1998 study). The portion of SIHP # 50-80-09-2268 within the project area does not retain sufficient integrity to be considered significant, and therefore no further work is recommended for the historic property. This is in keeping with the conclusions of the Dega et al. 1998 study and the SHPD review(s) that accepted that study (see Appendix A).

Sufficient information regarding the location, extent, function, and age of the portion of SIHP # 50-80-08-5593 within the project area has been generated by the current archaeological inventory survey investigation to mitigate any adverse effect caused by the proposed project.

Therefore, pursuant to HAR §13-284-7, the project-specific effect determination is “No historic properties affected.”

8.2 Mitigation Commitments

The proposed project will have no effect on significant historic properties within the project area, therefore no mitigation commitments are required.

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Appendix A SHPD Acceptance of the Dega et al. 1998 AIS

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

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ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS
WATER RESOURCE MANAGEMENT

February 3, 1999

Mr. Michael Dega, MA
Scientific Consultant Services, Inc.
711 Kapiolani Boulevard, Suite 777
Honolulu, Hawaii 96813

LOG NO: 22959
DOC NO: 9901EJ28

Dear Mr. Dega:

SUBJECT: **Historic Preservation Review of An Archaeological Inventory Survey of the University of Hawai'i, West O'ahu Campus, District of 'Ewa, Island of O'ahu, Hawaii'i (1998 Dega et al.)**
Honouliuli, 'Ewa, O'ahu
TMK: 9-2-002:001 por.; 9-2-004:005 por.

Thank you for the submittal of the replacement pages for the above report which completes the historic preservation review for this project. We can now conclude that the inventory survey was successfully executed. The report has been added to our library for public use.

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

Aloha,

Don Hibbard, Administrator
Historic Preservation Division

EJ:jk

FEB 9 1999

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON, CHAIRPERSON
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LAND DIVISION
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

June 15, 1998

LOG NO: 21708
DOC NO: 9806SC02

Mr. Michael Dega, MA
Scientific Consultant Services, Inc.
711 Kapiolani Boulevard, Suite 777
Honolulu, Hawai'i, 96813

Dear Mr. Dega:

SUBJECT: Chapter 6E-8 Historic Preservation Review of a Draft Report on an Archaeological Inventory Survey of the Proposed University of Hawai'i, West O'ahu Campus
Hono'uli'uli, 'Ewa, O'ahu
TMK: 9-2-002: 001 por.; 9-2-004: 005 por.

Thank you for the recent submission of a draft report documenting the results of an archaeological inventory survey of a 998-acre property near Makakilo, O'ahu (*An Archaeological Inventory Survey of the University of Hawai'i, West O'ahu Campus, District of 'Ewa, Island of O'ahu, Hawai'i [TMK: 9-2-2: 1 por.; 9-2-4: 5 por.]*. 1998. Dega et al.). We provide the following comments.

We believe that the survey was conducted acceptably, with a total of 2 historic sites found: 2268, the Waiahole Ditch, a historic irrigation feature; 5593, a complex of water transport and irrigation features related to 20th century sugar cane production. Before we can accept the report as final, however, we would like to see several minor corrections made. Once we receive these revisions (and they may be submitted on separate pages), we anticipate accepting the report and concluding that the survey was successfully executed.

Should you have any questions, please feel free to call Sara Collins at 587-0013.

Aloha,

DON HIBBARD, Administrator
State Historic Preservation Division

SC:amk

JUN 15 1998

M. Dega
Page 2

ATTACHMENT I: SPECIFIC COMMENTS ON A REPORT ON THE INVENTORY SURVEY OF THE PROPOSED WEST O'AHU CAMPUS SITE SCIENTIFIC CONSULTANT SERVICES, INC.

Research Results

Page 17, Paragraph 2: The Waiahole Ditch system has a SIHP No. (50-80-09-2268) and was previously reported in Goodman & Nees (1991. *Archaeological Reconnaissance and Inventory Surveys of 3,500 Acres in Waiawa Ahupua'a, 'Ewa, O'ahu*). Please add this information and also indicate the location of the site in the project area on Figure 2. Also, could you please provide a summary statement of the numbers and types of features that compose SIHP No. 5593?

Page 18, Figure 7: Is this flume part of SIHP 2268 or 5593?

Page 20, Settlement Pattern: While the project area appears to contain only post-contact sites relating exclusively to commercial agriculture, a couple of additional points should be made in this discussion: (1) Were traditional habitation sites in 'Ewa permanent or temporary? (2) Were agricultural sites of any kind reported in some of the studies you cite? For example, you refer to Wolforth's (1998) recently presented evidence for buried pondfields at the West Loch project area.

Recommendations

General: This section will need to be divided into two, separately headed parts: Significance Assessments and Recommendations.

Page 21, Paragraph 4: In view of the above comments, this section will need to be revised to reflect the presence of two, not one, historic sites in the project area.

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Appendix G
Cultural Impact Assessment Report

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DRAFT
Cultural Impact Assessment for the West Oahu Solar Project, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu TMK: [1] 9-2-002:007

Prepared for
AES Distributed Energy

Prepared by
Kellen Tanaka, B.S.,
David W. Shideler, M.A.,
and
Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawaiʻi, Inc.
Kailua, Hawaiʻi
(Job Code: HONOULIULI 172)

January 2020

Oʻahu Office
P.O. Box 1114
Kailua, Hawaiʻi 96734
Ph.: (808) 262-9972
Fax: (808) 262-4950

www.culturalsurveys.com

Maui Office
1860 Main St.
Wailuku, Hawaiʻi 96793
Ph.: (808) 242-9882
Fax: (808) 244-1994

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Management Summary

Reference	Cultural Impact Assessment for the West Oahu Solar Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu, TMK: [1] 9-2-002:007
Date	January 2020
Project Number(s)	Cultural Surveys Hawai‘i, Inc. (CSH) Job Code: HONOULIULI 172
Agencies	State of Hawai‘i, Department of Health, Office of Environmental Quality Control (DOH/OEQC) and State of Hawai‘i, Land Use Commission (LUC)
Land Jurisdiction	State of Hawai‘i
Project Proponent	AES Distributed Energy
Project Location	The project area is on undeveloped lands located in the southeastern foothills of the Wai‘anae Range, northeast of Pu‘u Makakilo and the Makakilo subdivision and about 600 m northwest of the intersection of the H-1 freeway and the Kualakai Parkway. The project area is depicted on a portion of the 2013 Ewa and Schofield Barracks U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle.
Project Description	The West Oahu Solar project consists of an approximately 12.5-megawatt (MW) ground-mounted solar photovoltaic system, coupled with a 50 MW-hour battery energy storage system (BESS) and related interconnection and ancillary facilities. The solar photovoltaic system would include a series of panels arranged into arrays consisting of evenly spaced rows. The panels would be mounted on a racking system installed on posts. The battery storage system would consist of containerized lithium-ion battery units and inverters distributed throughout the project area. The project would connect to a substation via underground electrical conduit. The substation would be constructed adjacent to and would interconnect with an existing Hawaiian Electric Company (HECO) 46kV transmission line that traverses the site. The project would be accessed via the existing gated entry off Kualakai Parkway (near the intersection with Interstate H-1) and would utilize a network of existing and new onsite access roads. Some road improvements may be needed to facilitate access within the project area. In addition, some site grading would be needed to accommodate the project facilities and to comply with stormwater and civil engineering requirements. In December 2019, CSH was notified of a slight modification to the project area to include additional areas along the perimeter of the project area, as well as maintenance of the existing roadways approaching the project area from the southeast.
Project Acreage	The project area is approximately 101.62 acres (41.12 hectares)
Document Purpose	This cultural impact assessment (CIA) was prepared to comply with the State of Hawai‘i’s environmental review process under Hawai‘i Revised

	Statutes (HRS) §343, which requires consideration of the proposed project’s potential effect on cultural beliefs, practices, and resources. Through document research and cultural consultation efforts, this report provides information compiled to date pertinent to the assessment of the proposed project’s potential impacts to cultural beliefs, practices, and resources (pursuant to the Office of Environmental Quality Control’s *Guidelines for Assessing Cultural Impacts*) which may include traditional cultural properties (TCPs). These TCPs may be significant historic properties under State of Hawai‘i significance Criterion e, pursuant to Hawai‘i Administrative Rules (HAR) §13-275-6 and §13-284-6. Significance Criterion e refers to historic properties that “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” (HAR §13-275-6 and §13-284-6). The document will likely also support the project’s historic preservation review under HRS §6E and §6E-8, and HAR §13-275 and §13-284. The document is also intended to support the discretionary land use permitting process including a State Special Use Permit (SUP) from the Land Use Commision (LUC).
Results of Background Research	Background research for this study yielded the following results, presented in approximate chronological order: 1. Honouliuli is the largest *ahupua‘a* (land division usually extending from the uplands to the sea) in the *moku* (district) of ‘Ewa. Honouliuli translates literally as “dark water,” “dark bay,” or “blue harbor,” and thus is named for the waters of Pearl Harbor which marks the eastern boundary of the *ahupua‘a* (Jarrett 1930:22). Another source translates Honouliuli as “unequal” (*Saturday Press*, 11 August 1883). Honouliuli appears in the “Mo‘olelo of Lepeamoa,” the chicken-girl of Pālama, where Honouliuli is the name of the husband of the chiefess Kapālama, and grandfather of Lepeamoa (Westervelt 1923:164–184). 2. Generally, Honouliuli was described as very hot and dry. Evidence for drought-like conditions are further supported by the relative lack of traditional rain names associated with Honouliuli Ahupua‘a. The Nāulu rain is the only known associated rain name for Honouliuli. Due to the lack of rainwater, freshwater resources were accessed via a karstic system. 3. In traditional Hawaiian times, the areas of exposed coral (Pleistocene limestone) outcrop were undoubtedly more extensive. According to McAllister (1933), holes and pits in the coral were generally accessed for water, while larger pits, often containing

	soil, were used for cultivation. McAllister additionally remarked that even “today” (McAllister began his survey work in 1930, and thus his comments are a reflection of the Honouliuli environment during the early twentieth century), *mai‘a* (banana; *Musaceae*) and *kō* (sugarcane; *Saccharum officinarum*) were being cultivated within the pit caves (sink holes) (McAllister 1933:109). 4. The traditional *ka‘ao* (legends) associated with the area speak of the *akua* (godly) brothers, Kāne and Kanaloa. It was their supernatural feat of hurling *pōhaku* (stone) across the island that determined the boundaries of land divisions (Sterling and Summers 1987:1). Additional *mo‘olelo* (stories) speak of Hi‘iaka and her travels across the plains of ‘Ewa. In particular, the *wahi pana* (storied place) of Kaupe‘a (located south of the current project area) is described. Kamakau describes Kaupe‘a as a wide plain where a grove of *wiliwili* (*Erythrina sandwicensis*) stands (Kamakau 1991a:47). This plain is an *ao kuewa*, a realm belonging to homeless souls. In general, the *kama‘āina* (native born) of both Honouliuli Ahupua‘a and ‘Ewa District made a point to avoid this place. 5. Pu‘uokapolei is a prominent hill located on the ‘Ewa coastal plain that was the primary landmark for travelers on the trail running from Pearl Harbor to Wai‘anae. A *heiau* (pre-Christian place of worship) was once on the summit of the hill, however, by the time of McAllister’s survey of O‘ahu it had been destroyed (McAllister 1933:108). The hill was also used as a point of solar reference or as a place for celestial observations of the winter and summer solstice. A ceremony at a *heiau* on Pu‘uokapolei provides a vantage point to capture the sun setting directly behind Pu‘ula‘ila‘i, a peak farther west in the Wai‘anae Range. A coinciding ceremony at Kūpalaha Heiau in Waikīkī captures the same essence as the sun sets behind Pu‘uokapolei. 6. Additional *heiau* located within Honouliuli included Pu‘u Ku‘ua located at Palikea, in addition to two unidentified *heiau*. These two unidentified *heiau* are located at the foot of Pu‘u Kanehoa and Pu‘u Kuina, respectively. 7. In later historic times, a network of trails encircled and crossed the Wai‘anae Range, allowing passage from West Loch to the Honouliuli lowlands, past Pu‘uokapolei and Waimānalo Gulch to the Wai‘anae coast and onward circumscribing the shoreline of O‘ahu (‘Ī‘ī 1959:96–98). The main trail along the south shore of O‘ahu would have been approximately 1.5 km to the southeast. A main trail extending up the central valley of O‘ahu would have been approximately 3 km to the east. The 1825 Malden map shows

	a trail extending from the main trail along the south shore of O‘ahu into the uplands in the Pālehua area as passing just a couple hundred meters to the southwest of the project area. 8. The rich resources of Pu‘uloa—the fisheries in the lochs, the shoreline fishponds, the numerous springs, and the irrigated lands along the streams—made ‘Ewa a prize for competing chiefs. ‘Ewa Moku was also a political center and home to many chiefs in its day. Oral accounts of *ali‘i* (royalty) recorded by Hawaiian historian Samuel Kamakau date back to at least the twelfth century. *Ali‘i* associated with Honouliuli and greater ‘Ewa Moku included Kākuhihewa, Keaunui, Lakona, Mā‘ilikūkahi, and Kahahana. 9. In early historic times, the population of Honouliuli was concentrated at the western edge of West Loch in the vicinity of Kapapapuhi Point in the “Honouliuli Taro Lands.” This area was clearly a major focus of population due to the abundance of fish and shellfish resources in close proximity to a wide expanse of well-irrigated bottomland suitable for wetland taro cultivation. 10. Early foreign accounts describe the southwest coast of O‘ahu, including Honouliuli Ahupua‘a, as an area “a little distance from the sea, [where] the soil is rich and all the necessaries of life are abundantly produced” (Vancouver 1798 in Sterling and Summers 1978:36). A sailor among Vancouver’s crew observed, however, that “from the number of houses within the harbor it should seem to be very populous; but the very few inhabitants who made their appearance were an indication of the contrary” (Vancouver 1798 in Sterling and Summers 1978:36). 11. Following the Māhele of 1848, 99 individual land claims in the *ahupua‘a* of Honouliuli were registered and awarded by King Kamehameha III. No *kuleana* land claims were made for land within the current project area or vicinity. The vast majority of the Land Commission Awards (LCA) were located in Honouliuli near the taro lands of the *‘ili* (land division, smaller than an *ahupua‘a*) of Pu‘uloa and the Pu‘uloa Salt Works. The largest award (Royal Patent 6071, LCA 11216, *‘Āpana* [parcel] 8) in Honouliuli Ahupua‘a was granted to Miriam Ke‘ahi-Kuni Kekau‘onohi on January 1848 (Native Register 1848) who acquired a deed to all unclaimed land within the *ahupua‘a*, including the present project area. 12. Beginning with the time of Western Contact, however, Hawaiian populations were introduced to many virulent western diseases which began to decimate the native populations. Thus, four years following the 1832 census, the ‘Ewa population had dropped to

	3,423 (Schmitt 1973:9, 36), “a decrease of 592 in 4 years” (Ewa Station Reports 1836). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. 13. With the increasing foreign interests on O‘ahu Island during the last half of the nineteenth century, an array of agricultural enterprises were attempted. In 1871, John Coney rented the lands of Honouliuli to James Dowsett and John Meek, who used the land for cattle grazing. In 1877, James Campbell purchased most of Honouliuli Ahupua‘a for a total of $95,000. 14. By 1889, the Ewa Plantation Company was established and lands throughout Honouliuli were designated for sugarcane cultivation. Sugar production exploded with the successful drilling of an artesian well by James Campbell on the ‘Ewa Plain. Campbell’s first well was named Waianiani (“crystal waters”) by the *kama‘āina* of Honouliuli (Nellist 1925). By 1930, Ewa Plantation had drilled 70 artesian wells to irrigate cane lands; artesian wells provided fresh water to Honouliuli for nearly 60 years (Ho‘okuleana 2014). 15. In 1897, B.F. Dillingham established the Oahu Sugar Company (OSC) on 12,000 acres leased from the estates of John Papa ‘Ī‘ī, Bishop, and Robinson. The Oahu Sugar Company had over 900 field workers, composed of 44 Hawaiians, 473 Japanese, 399 Chinese, and 57 Portuguese. The first sugar crop was harvested in 1899, ushering in the sugar plantation era in Waipahu (Ohira 1997). Prior to commercial sugar cultivation, these lands were described as being “of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project” (Condé and Best 1973:313). 16. The Waiahole Water Company was formally incorporated in 1913 and was originally a subsidiary of the Oahu Sugar Company. The Waiahole Ditch was designed by engineer Jorgen Jorgensen, with recommendations by engineer J.B. Lippencott and assisted by W.A. Wall. Upon its completion in 1916, the Waiahole Ditch was 35 km (21.9 miles) long and cost $2.3 million. The 32 million gallons of daily water enabled the O‘ahu Sugar Company to grow to “some 20 square miles […] ranging in elevation from 10 ft at the Waipio Peninsula […] to 700 ft at the Waiahole Ditch” (Condé and Best 1973:313). The ditch system is included on the state inventory of archaeological sites as Site no. 50-80-09-2268. The Waiahole Ditch System crossed through the western portion of the present project area.

	17. The early twentieth century saw the lands of Honouliuli heavily utilized by both civilians and the U.S. military for transportation. The U.S. Government began acquiring the coastal lands of ‘Ewa for development of a naval base at Pearl Harbor. In 1901, the U.S. Congress formally ratified annexation of the Territory of Hawaii, and the first 1,356.01 acres of Pearl Harbor land were transferred to U.S. ownership. 18. In 1937, 18 miles of roads were built in the coastal Honouliuli area, and in 1939-1940 the U.S. bought 3,500 acres of land in this area (Landrum et al 1997:62–67), to build several other military camps and installations, including Barbers Point Naval Air Station. 19. Following the Japanese Navy’s attack on Pearl Harbor on 7 December 1941, the Territory of Hawaii was declared under martial law and the writ of *habeas corpus* (the requirement for a person under arrest to be brought before a judge or into court) was suspended (U.S. Department of the Interior 2014:6–7). Persons of Japanese and European ancestry in Hawai‘i suspected of disloyalty to the United States were rounded up and imprisoned by the U.S. military and the Federal Bureau of Investigations (FBI) (U.S. Department of the Interior 2014:xii). In 1943, the Honouliuli Internment Camp was constructed to intern citizens, resident aliens, and prisoners of war. Located in Honouliuli Gulch, east of the project area, the camp was the “last, largest, and longest-used World War II confinement site in Hawai‘i,” holding approximately 320 internees and nearly 4,000 prisoners of war (U.S. Department of the Interior 2014:xiv).
Results of Community Consultation	CSH attempted to contact 70 Hawaiian organizations, agencies, and community members. Of the 12 people that responded, one provided written testimony and three *kama‘āina* (Native-born) and/or *kūpuna* (elders) participated in formal interviews for more in-depth contributions to the CIA. Consultation was received from community members as follows: 1. Christian Kaimanu Yee, *kama‘āina* and knowledgeable of *mo‘olelo* and *wahi pana* 2. Shad Kāne, member of Kapolei Hawaiian Civic Club, Chair of the O‘ahu Council of Hawaiian Civic Clubs Committee on the Preservation of Historic Sites and Cultural Properties, Ali‘i Ai Moku of the Kapuāiwa Chapter of the Royal Order of Kamehameha Ekahi, and ‘Ewa Moku Representative on the State Aha Moku Advisory Committee. 3. Tom Berg, former Councilman, District 1 4. Lynette Paglinawan, cultural practitioner, educator, teaches a course on Native Hawaiian Healing at University of Hawai‘i West O‘ahu

Impacts and Recommendations	Based on information gathered from the community consultation, participants voiced their concerns in a cultural context. 1. Mr. Shad Kāne stated he is not in opposition to the proposed project. He noted the project area has been previously disturbed by sugarcane production. 2. Mr. Tom Berg stated that the project has been “proposed on a pueo (owl) foraging and breeding ecosystem.” He noted that records indicate that per earliest colonial contact, the *pueo* is most abundant on the slopes from Pu‘u Kapua‘i to West Loch, in the area where the project is slated. He added that “Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood.” He stated that the proposed project will “encroach on prime pueo habitat-considered to be graded A+—“a ten (10)”—when it comes to the degree of pueo habitat in use on this project site.” 3. Mr. Berg added that the *pueo* has “a direct connection to Native Hawaiian family lineage in Ewa Beach,” noting the *pueo* is the *‘aumakua* for the Michael Lee family and their accounts which go back over seven generations are documented at the State Archives Building in Honolulu. 4. Mr. Berg also stated that the project site is “inhabited by the ōpe‘ape‘a [Hawaiian hoary bat, *Lasiurus cinereus semotus*] at various times of the seasons,” noting that in 1910, the State of Hawai‘i documented *‘ōpe‘ape‘a* within a half-mile of the project area. 5. Mr. Berg stated his concern that the “property in question will not receive the proper protocol to conclude no endangered species inhabit the area.” Mr. Berg recommended that “a thorough and complete protocol is adopted to repeat the inventory exercise for pueo and ‘ōpe‘ape‘a over the course of a calendar year would be in order so the project does not inadvertently contribute to more endangered species habitat loss.” He also recommended inquiring with Dr. Melissa Price and Dr. Javier Cotin of the Project Pueo Biologist Team and Department of Fish and Wildlife (DOFAW) Biologist Afsheen Siddiqi regarding *pueo* protocol. 6. Mr. Berg also expressed his concern for the possible negative aspects of light at an adjacent parcel. He expressed concern that a solar panel may reflect neighboring lighting operations into “the flight patterns of migrating birds and the *‘ōpe‘ape‘a* and *pueo* in particular need to be addressed.” 7. Ms. Lynette Paglinawan stated that “the area from Waimānalo Gulch over to Kapolei to the location of University of Hawai‘i West O‘ahu (UHWO) was known by very early residents there to be the place where “*ao kuewa*,” wandering spirits, congregated from *makai* [toward the sea] to *mauka* [toward the mountains] up Pālehua

	and especially near the cluster of *wiliwili* [*Erythrina sandwicensis*] trees in Kaupe‘a.” She expressed her concerns regarding the effects that the proposed project will have on the *ao kuewa*, which she believes are attracted to energy. She also expressed her concerns of the effect of the spirits on the solar panels, noting “that’s high energy. It will be like going to the game room.” She also noted that UHWO experiences numerous electrical problems due to the presence of these spirits. 8. Ms. Paglinawan noted that “this area where the University [of Hawai‘i West O‘ahu] is located has a lot of trails that go from *mauka-makai*, come from Honolulu going towards Nānākuli.” She stated that project proponents should be mindful of the locations of ancient trails, noting that the ancient trails are still used by spirits to travel from *mauka* to *makai* within Honuliuli Ahupua‘a. 9. Ms. Paglinawan recommended planting “a wall of trees” surrounding the proposed project area as restitution to the spirits who may be displaced by the proposed project. She also noted that planting of “a wall of trees” around the proposed project area would have other benefits including the production of oxygen and providing a habitat for Native Hawaiian birds. 10. Ms. Paglinawan also expressed her concerns regarding the psychological impacts for the people that encounter the spirits, noting trauma on workers at the UHWO, as well as, families who live in the area. She was particularly concerned for the children who encounter these spirits, noting her belief that children “see many more things than adults do.” 11. Project construction workers and all other personnel involved in the construction and related activities of the project should be informed of the possibility of inadvertent cultural finds, including human remains. In the event that any potential historic properties are identified during construction activities, all activities will cease and the SHPD will be notified pursuant to HAR §13-280-3. In the event that *iwi kūpuna* (Native Hawaiian skeletal remains) are identified, all earth moving activities in the area will stop, the area will be cordoned off, and the SHPD and Police Department will be notified pursuant to HAR §13-300-40. In addition, in the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR §13-300 and HRS §6E-43, is recommended. 12. In the event that *iwi kūpuna* and/or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinterment plan and cultural preservation plan for proper cultural protocol, curation, and long-term maintenance.

Analysis	The following analysis is a summary of Section 8.4. Based on information gathered from the cultural and historical background and community consultation, no culturally significant resources were identified within the project area. At present, there is no documentation or testimony indicating traditional or customary Native Hawaiian rights are currently being exercised “for subsistence, cultural and religious purposes and possessed by ahupua‘a tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778” (Hawai‘i State Constitution, Article XII, Section 7) within the project area. While no cultural resources, practices, or beliefs were identified as currently existing within the project area, Honouliuli Ahupua‘a maintains a rich cultural history in the exercising of traditional or customary Native Hawaiian rights within the project *ahupua‘a*. Honouliuli Ahupua‘a is the largest *ahupua‘a* in the *moku* of ‘Ewa. The environment of Honouliuli is very hot and dry. These environmental limitations forced ingenuity and innovation. *Kama‘āina* of Honouliuli used agricultural sinkholes that accumulated water within them via a subterranean water or karst system; this water also contained nutrient-rich sediment allowing plants such as *kalo, kī*, and *noni* to survive. The post-Contact period brought numerous changes to the *ahupua‘a* of Honouliuli. Traditional agricultural was rapidly replaced by large-scale commercial ventures. The discovery of artesian water beneath the ‘Ewa plains by James Campbell in 1879 led to the establishment of sugarcane plantations in Honouliuli including the Oahu Sugar Company. Much of the *mauka* (upland) lands in western Honouliuli, including ridges and deep gulches, were unsuitable for commercial sugar cultivation and remained pasture land for grazing livestock. The Donn 1906 map suggests the present project area was at the edge of sugarcane cultivation at that time (see Figure 15). By 1920, however, much of the lands of Honouliuli were used for commercial sugarcane cultivation (Frierson 1972:18). The project area is situated between Pu‘u Kapua‘i which is located 0.5 km to the northwest and Pu‘u Makakilo located 1.2 km to the southwest. These are understood as “very late cones [of the Wai‘anae volcano] […] composed of a varied mixture of cinder, spatter and lava flows” (Macdonald et al. 1983:429). Pukui et al. (1974:199) translate “Pu‘u Kapua‘i” as “footprint hill,” however, the association with that name is unknown. “Pu‘u Makakilo” is translated as “observing eyes” (Pukui et al. 1974:201). The association of this name is also unknown. The project area is also located between two deeply dissected gulches, Kalo‘i Gulch which is located 300 m to the southwest and Honouliuli Gulch located 700 m to the northeast of the project area. These gulches are at a comparable elevation and are believed to rarely run with water. The name “Ka-lo‘i” translates to “the taro patch” (Pukui et al. 1974:77). Sterling and Summers (1978:35) associate Kalo‘i Gulch with a number of

	vignettes regarding the “Waihuna” or “Punahuna” hidden spring. It was also noted that the hidden spring “had been one of the principal sources of water for all that country, which was quite heavily populated before the smallpox epidemic of 1840” (Ida E.K. von Holt in Sterling and Summers 1978:35). In traditional times, trails were well used for travel within the *ahupua‘a* between *mauka* and *makai* (shore) and laterally between *ahupua‘a*. A historical trail system existed on O‘ahu extending from Honolulu to Wai‘anae. A cross-*ahupua‘a* (east-west) trail passed through Honouliuli north of Pu‘uokapolei, and continued along the coast to Wai‘anae following the route of the modern Farrington Highway. Early historic maps depict a trail that branches off the cross-*ahupua‘a* trail into the uplands in the Pālehua area. The 1825 Malden map (see Figure 7) shows a trail extending into the Pālehua area a couple hundred meters to the southwest of the project area. A 1919 map (see Figure 16) shows an unimproved road alignment just south of the project area, understood as the Pālehua Road, approximating a traditional Hawaiian footpath into the uplands. However, a 1922 map (see Figure 17 and Figure 18 showing annotations), shows the Pālehua trail as arcing through the western portion of the project area before arcing north of Pu‘u Makakilo. This trail may have always been somewhat braided. The trail appears to only be depicted on the 1922 map (see Figure 17 and Figure 18) and appears to have been largely under Sugar Cane Field 30 in the 1925 map (Figure 19). This trail was not identified on the ground in either of the AIS studies of this area (Dega et al. 1998 and Welser et al. 2019). Interviewee Lynette Paglinawan stated that “this area where the University [of Hawai‘i West O‘ahu] is located has a lot of trails that go from *mauka-makai*, come from Honolulu going towards Nānākuli.” She noted that “spirits travel on ancient trails” which they use to “go from *mauka* going down to *makai*.” She added that these “ancient trails are still in use,” noting that people who live in homes that have been built on or near these ancient pathways have experienced “strange happenings” which she believes are due to the *‘uhane* (spirits) which still use these ancient trails to travel from *mauka* to *makai*. Ms. Paglinawan stated that as a result of the development of the *moku* of ‘Ewa including the *ahupua‘a* of Honouliuli, “we destroyed the habitat of the *ao kuewa* which is the *wiliwili* trees.” She recommended planting “a wall of trees” surrounding the proposed project area which would provide a home for the displaced spirits. She also discussed the types of plants that were previously found in the area which include *noni* plants, coconut trees, *lauhala* trees, and *‘ulu* trees. She noted that these plants were “very plentiful but sparse not like a big grove where it’s like a park of trees, it was interspersed throughout.”

	The “Ewa Karst” which consists of limestone caves formed in the uplifted coral was undoubtedly more extensive during traditional Hawaiian times. Where not covered by alluvium or stockpiled material, this Pleistocene limestone outcrop has characteristic dissolution “pit caves” (Mylroie and Carew 1995) which were sometimes also used as burial caves. Burials have been encountered in the coastal areas of the Honouliuli Ahupua‘a, however, previous archaeological studies (Dega et al. 1998) within the project area have not documented any burials within the project area nor within the vicinity of the project area. An archaeological inventory survey conducted for the University of Hawai‘i West O‘ahu Campus that encompassed the entirety of the project area (Dega et al. 1998) identified no surface Hawaiian features. Dega et al. (1998:i) noted several plantation-era “flumes, aqueducts, ditches, pumps, and other irrigation features occurring within the heavily modified landscape of the project area.” The features represented an irrigation complex (State Inventory of Historic Places [SIHP] # 50-80-08-5593) which was used for sugarcane cultivation from the 1920s through more recent times. A portion of the Waiahole Ditch System (SIHP # 50-80-09-2268) was also documented crossing through the northwest section of the project area and continuing southwest through the lower agricultural fields. In written testimony provided to CSH via email on 19 August 2019, Mr. Tom Berg, former City Councilman, stated the project has been “proposed on a pueo (owl) foraging and breeding ecosystem.” The *pueo*, which are found on all of the main Hawaiian islands, are listed by the State of Hawai‘i as endangered on the island of O‘ahu (DLNR 2005). The Department of Land and Natural Resources (DLNR) states that *pueo* are most commonly found in “open habitats such as grasslands, shrublands, and montane parklands, including urban areas and those actively managed for conservation” (DLNR 2005). Mr. Berg also noted that records indicate that per earliest colonial contact, the *pueo* is most abundant on the slopes from Pu‘u Kapua‘i to West Loch, adding that “Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood.” He also noted *pueo* are not forest dwellers, preferring “scrub, open fields/dirt landscapes with some grass.” He stated that the proposed project will “encroach on prime pueo habitat-considered to be graded A+—“a ten (10)”—when it comes to the degree of pueo habitat in use on this project site.” Mr. Berg also stated that the project site is “inhabited by the ōpe‘ape‘a at various times of the seasons.” He noted that in 1910, the State of Hawai‘i documented *‘ōpe‘ape‘a* within a half-mile of the project area. *‘Ōpe‘ape‘a* is “the only land mammal native to the Hawaiian archipelago” and is

	found on all of the main Hawaiian islands except for Ni‘ihau (DLNR 2005:3-13). Mr. Berg stated his concern that the “property in question will not receive the proper protocol to conclude no endangered species inhabit the area.” He recommended that “a thorough and complete protocol is adopted to repeat the inventory exercise for pueo and ‘ōpe‘ape‘a over the course of a calendar year would be in order so the project does not inadvertently contribute to more endangered species habitat loss.” He also recommended inquiring with Dr. Melissa Price and Dr. Javier Cotin of the Project Pueo Biologist Team and Department of Fish and Wildlife (DOFAW) Biologist Afsheen Siddiqi regarding *pueo* protocol. Mr. Berg also expressed his concern for the possible negative aspects of lighting operations at an adjacent parcel which may reflect off of a solar panel into “the flight patterns of migrating birds and the *‘ōpe‘ape‘a* and *pueo* in particular need to be addressed.”
Ka Pa‘akai Analysis	In Ka Pa‘akai v. Land Use Commission, 94 Hawai‘i 31, 74, 7 P.3d 1068, 1084 (2000), the Court held the following analysis also be conducted: 1. The identity and scope of valued cultural, historical, or natural resources in the project area, including the extent to which traditional and customary native Hawaiian rights are exercised in the project area; 2. The extent to which those resources—including traditional and customary native Hawaiian rights—will be affected or impaired by the proposed action; and 3. The feasible action, if any, to be taken by the LUC to reasonably protect native Hawaiian rights if they are found to exist. Based on information gathered from the cultural and historical background, and the community consultation, culturally significant resources have been identified within the *ahupua‘a*. Although not within the project area, documentation and testimony indicates traditional or customary Native Hawaiian rights are possessed and are currently being exercised within the *ahupua‘a* by *ahupua‘a* tenants who are descendants of Native Hawaiians who inhabited the Hawaiian Islands prior to 1778 (Hawai‘i State Constitution, Article XII, Section 7). While no cultural resources, practices, or beliefs were identified as currently existing within the project area, Honouliuli Ahupua‘a maintains a rich cultural history in the exercising of traditional or customary Native Hawaiian rights within the project *ahupua‘a*. The proposed action will not affect or impair traditional and customary Native Hawaiian rights exercised in the *ahupua‘a* in which the project area is located. Therefore no action needs to be taken by the LUC to reasonably protect native Hawaiian rights as a result of this project.

	Therefore, the information provided in the CIA demonstrates the proposed project will not have any adverse effect on traditional and customary Native Hawaiian rights within the *ahupua‘a*.

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Section 1 Introduction

1.1 Project Background

At the request of Tetra Tech, Inc., and on behalf of AES Distributed Energy, Cultural Surveys Hawai‘i, Inc. (CSH) has prepared this cultural impact assessment (CIA) for the West Oahu Solar Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu, TMK: [1] 9-2-002:007 (por.). The project area is on undeveloped lands in the southeastern foothills of the Wai‘anae Range, northeast of Pu‘u Makakilo and the Makakilo subdivision and 600 m northwest of the intersection of the H-1 Freeway and the Kualakai Parkway. The project area is depicted on a portion of the 2013 Ewa and Schofield Barracks U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle (Figure 1), a tax map plat (Figure 2), and a 2018 aerial photograph (Figure 3).

The West Oahu Solar Project consists of an approximately 12.5-megawatt (MW) ground-mounted solar photovoltaic system, coupled with a 50 MW-hour battery energy storage system (BESS) and related interconnection and ancillary facilities. The solar photovoltaic system would include a series of panels arranged into arrays consisting of evenly spaced rows. The panels would be mounted on a racking system installed on posts. The battery storage system would consist of containerized lithium-ion battery units and inverters distributed throughout the project area.

The project would connect to a substation via underground electrical conduit. The substation would be constructed adjacent to and would interconnect with an existing Hawaiian Electric Company (HECO) 46kV transmission line that traverses the site. The project would be accessed via the existing gated entry off Kualakai Parkway (near the intersection with Interstate H-1) and would utilize a network of existing and new onsite access roads. Some road improvements may be needed to facilitate access within the project area. In addition, some site grading would be needed to accommodate the project facilities and to comply with stormwater and civil engineering requirements.

In December 2019, the project area was slighty modified to include additional areas along the perimeter of the project area, as well as maintenance of the existing roadways approaching the project area from the southeast.

1.2 Document Purpose

This CIA was prepared to comply with the State of Hawai‘i’s environmental review process under Hawai‘i Revised Statutes (HRS) §343, which requires consideration of the proposed project’s potential effect on cultural beliefs, practices, and resources. Through document research, this report provides information compiled to date pertinent to the assessment of the proposed project’s potential impacts to cultural beliefs, practices, and resources (pursuant to the Office of Environmental Quality Control’s *Guidelines for Assessing Cultural Impacts*) which may include traditional cultural properties (TCPs). These TCPs may be significant historic properties under State of Hawai‘i significance Criterion e, pursuant to Hawai‘i Administrative Rules (HAR) §13-275-6 and §13-284-6. Significance Criterion e refers to historic properties that “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

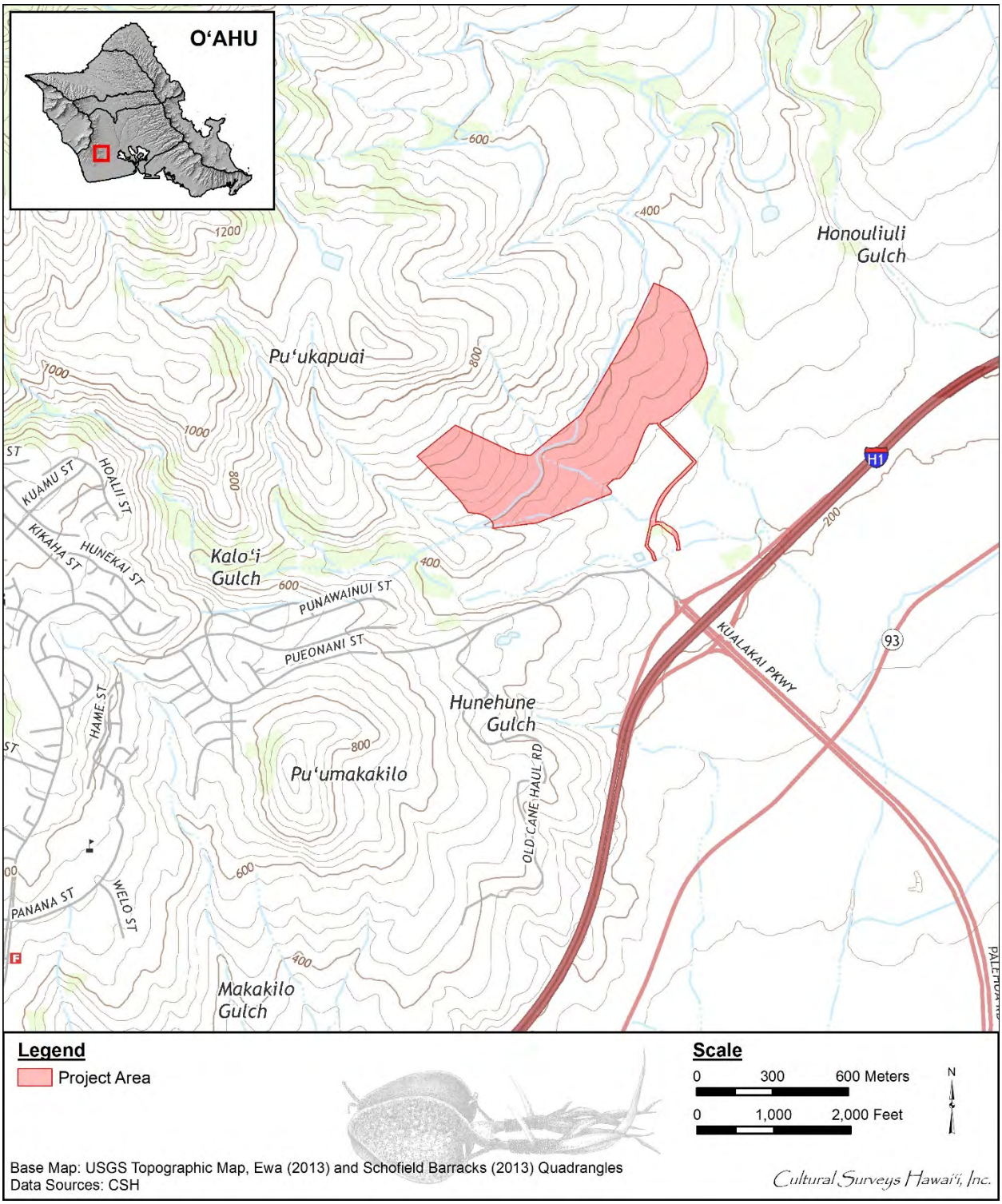

Figure 1. Portion of the 2013 Ewa and Schofield Barracks USGS 7.5-minute topographic quadrangles showing the location of the project area

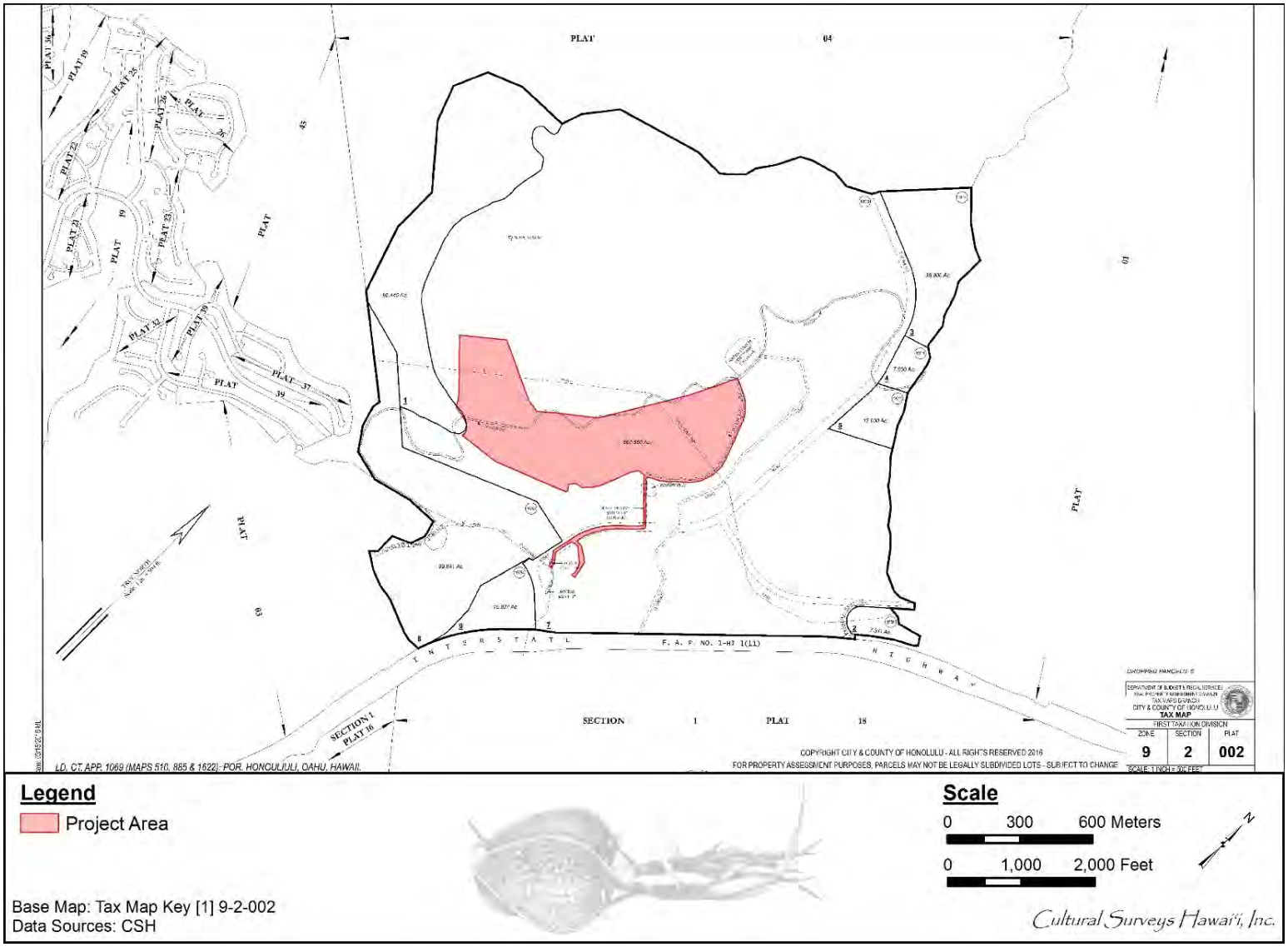

Figure 2. Tax Map Key (TMK) [1] 9-2-002 showing the location of the project area (Hawai‘i TMK Service 2014)

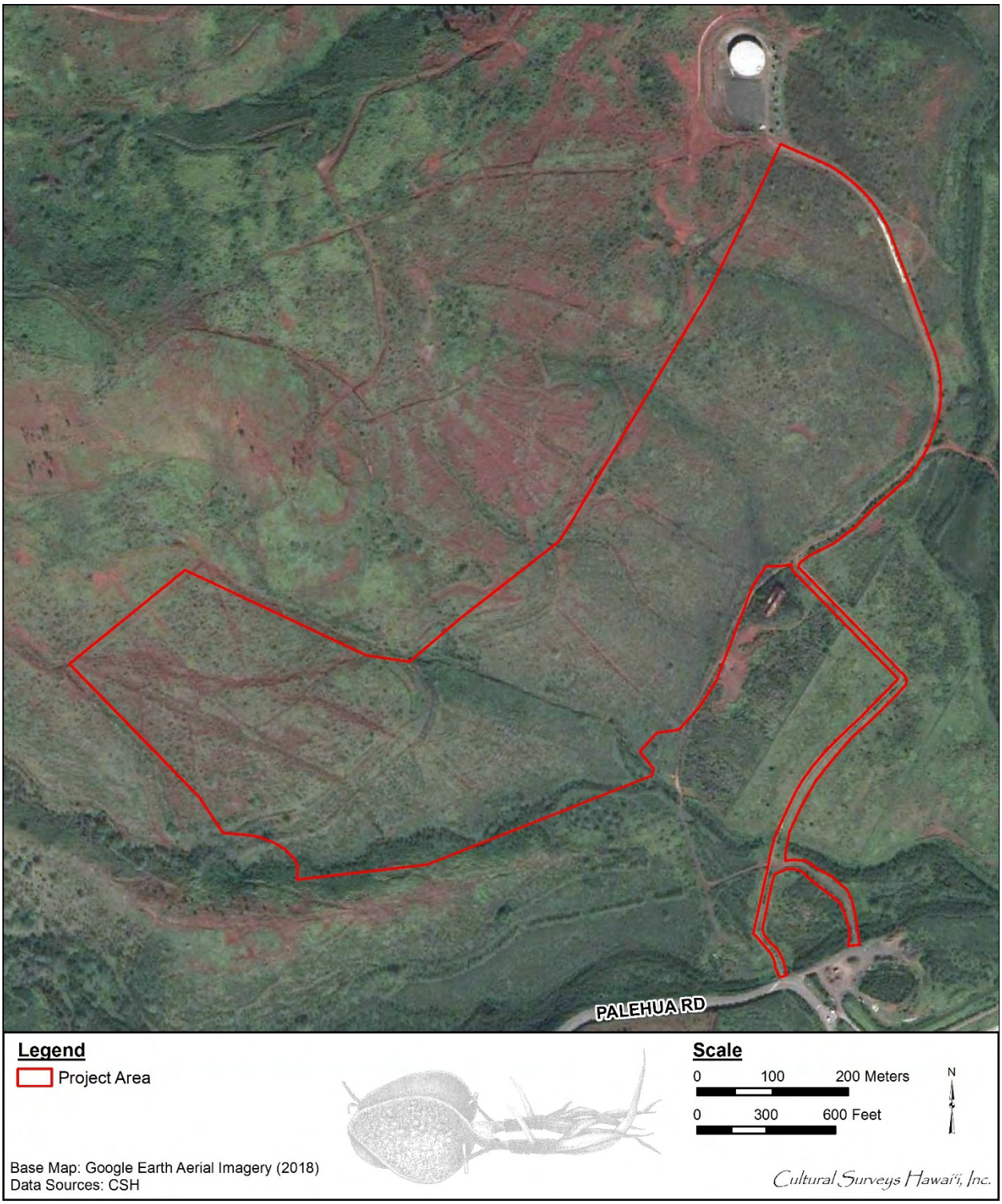

Figure 3. Aerial photograph of the project area (Google Earth 2018)

history and cultural identity" (HAR §13-275-6 and §13-284-6). The document will likely also support the project's historic preservation review under HRS §6E and HAR §13-275 and §13-284. The document is also intended to support the project's environmental review and the discretionary land use permitting process including a State Special Use Permit (SUP) from the Land Use Commision (LUC).

1.3 Scope of Work

The scope of work for this cultural impact assessment includes the following:

1. Examination of cultural and historical resources, including Land Commission documents, historic maps, and previous research reports, with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal, and other resources or agricultural pursuits as may be indicated in the historic record.
2. Review of previous archaeological work at and near the subject parcel that may be relevant to reconstructions of traditional land use activities; and to the identification and description of cultural resources, practices, and beliefs associated with the parcel.
3. Consultation and interviews with knowledgeable parties regarding cultural and natural resources and practices at or near the parcel; present and past uses of the parcel; and/or other practices, uses, or traditions associated with the parcel and environs.
4. Preparation of a report that summarizes the results of these research activities and provides recommendations based on findings.

1.4 Environmental Setting

1.4.1 *Ka Lepo* (Soils)

According to the U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) database (2001) and soil survey data gathered by Foote et al. (1972), the project area's soils consist of Kawaihapai clay loam, 2 to 6% slopes (KIB), Mahana silty clay loam, 6 to 12% slopes, eroded (McC2), Mahana silty clay loam, 12 to 20% slopes, eroded (McD2), Mahana silty clay loam, 20 to 35% slopes, eroded (McE2), Molokai silty clay loam, 7 to 15% slopes (MUC) and Molokai silty clay loam, 15 to 25% slopes (MUD) soils (Figure 4).

Kawaihapai series soils are described as follows:

> This series consists of well-drained soils in drainageways and on alluvial fans on the coastal plains on the islands of Oahu and Molokai. These soils formed in alluvium derived from basic igneous rock in humid uplands. They are nearly level to moderately sloping. Elevations range from nearly sea level to 300 feet. The annual rainfall amounts to 30 to 50 inches. […] These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of kiawe, koa haole, lantana, and bermudagrass. [Foote et al. 1972:63–64]

Further, Kawaihapai clay loam, 2 to 6% slopes soils (KIB), are described as having slow runoff and a slight erosion hazard (Foote et al. 1972).

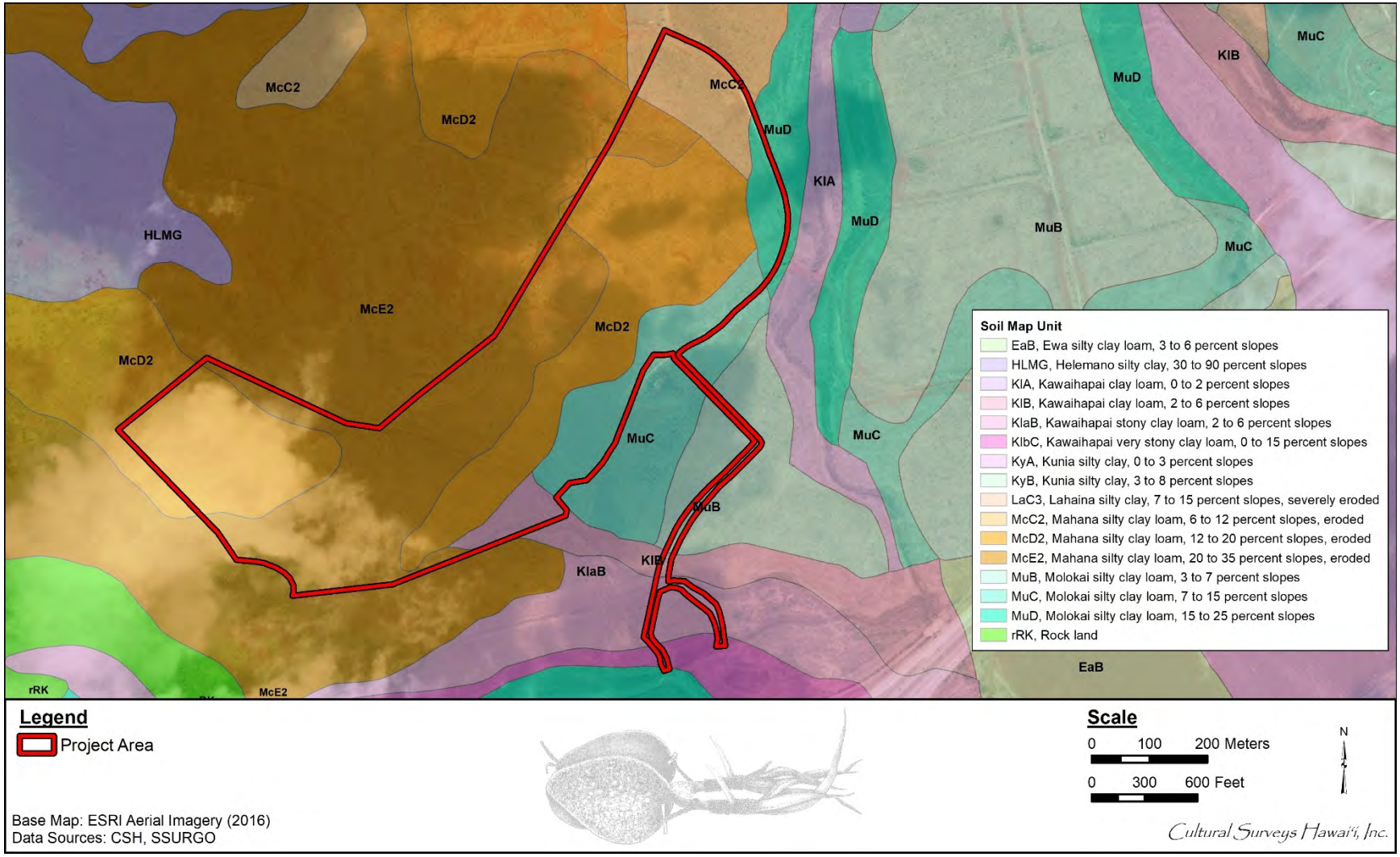

Figure 4. ESRI Aerial Imagery (2016) with overlay of Soil Survey of the State of Hawaii (Foote et al. 1972; USDA SSURGO 2001), indicating soil types within and surrounding the project area

Mahana series soils are described as follows:

> This series consists of well-drained soils on uplands on the islands of Kauai and Oahu. These soils developed in volcanic ash. They are gently sloping to very steep. Elevations range from 1,000 to 3,000 feet. The annual rainfall amounts to 30 to 45 inches. […] These soils are used for pasture, woodland, wildlife habitat, irrigated sugarcane, and water supply. The natural vegetation consists of puakeawe, aalii, ricegrass, molassesgrass, silver oak, yellow foxtail, lantana, joee, Japanese tea, passion flower, and associated plants. [Foote et al. 1972:85]

Mahana silty clay loam, 6 to 12% slopes, eroded (McC2) soils are described as follows:

> This soil occurs on ridgetops and moderately sloping uplands […] Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. […] In places roots penetrate to a depth of 5 feet or more. […] This soil is used for pasture, woodland, wildlife habitat, pineapple, and sugarcane. [Foote et al. 1972:85–86]

Mahana silty clay loam, 12 to 20% slopes, eroded (McD2) soils, are described as having medium runoff and a moderate erosion hazard, used for pasture, woodland, wildlife habitat, and sugarcane (Foote et al. 1972).

Mahana silty clay loam, 20 to 35% slopes, eroded (McE2) soils are further described as follows:

> Most of the surface layer has been removed by erosion. Runoff is very rapid, and the erosion hazard is very severe. Included in mapping were areas where all of the surface layer and part of the subsoil have been removed by erosion. Also included were small, stony areas and reddish-colored upland soils that are underlain by a panlike layer at a depth of 15 to 50 inches. This soil is used for pasture, pineapple, and irrigated sugarcane. [Foote et al. 1972:86]

Molokai series soils are described as follows:

> This series consists of well-drained soils on uplands on the islands of Maui, Lanai, Molokai, and Oahu. These soils formed in material weathered from basic igneous rock. They are nearly level to moderately steep. Elevations range mainly from nearly sea level to 1,000 feet but are as much as 1,500 feet on Lanai. The annual rainfall amounts to 20 to 25 inches, most of which occurs between November and April. […] These soils are used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. The natural vegetation consists of kiawe, ilima, uhaloa, feather fingergrass, and buffelgrass. [Foote et al. 1972:96]

Molokai silty clay loam, 7 to 15% slopes (MUC) soils, are described as occurring on knoll slope breaks, with medium runoff and a moderate erosion hazard (Foote et al. 1972). This material is used for sugarcane, pineapple, pasture, wildlife habitat, and home sites (Foote et al. 1972).

Molokai silty clay loam, 15 to 25% slopes (MUD) soils are further described as follows:

> This soil occurs on Oahu. In most places the slope does not exceed 20 percent. Runoff is medium, and the erosion hazard is severe. Workability is slightly difficult because of the slope. Included in mapping were small areas where boulder cores are exposed. This soil is used for sugarcane and pineapple. [Foote et al. 1972:97]

1.4.2 *Ka Makani* (Winds)

Makani is the general Hawaiian term for wind. Each land division was given a name for a specific wind. Names of wind were assigned based on but not limited to its direction of flow, strength, and geographic location. The four commonly known winds associated with the *moku* of ‘Ewa are Māunuunu of Pu‘uloa, Moa‘e kū of Ewaloa, Waikōloa of Līhu‘e, and Kona of Pu‘ukapolei (Alameida 1997). Māunuunu is a strong blistering sea breeze at Pu‘uloa (Andrews 1865; Pukui and Elbert 1986). Moa‘e kū is a northeasterly wind which means to resist, or a foreign wind (Andrews 1865; Pukui and Elbert 1986). Waikōloa is a cold northwest wind (Pukui and Elbert 1986). Kona is a name of the southwest wind (Andrews 1865). Another mentionable wind found in most chants associated with the *moku* of ‘Ewa is Wai‘ōpua. Its literal translation means the water of cloud banks (Pukui and Elbert 1986). Below are clips of chants that emphasize the importance of these winds.

In the traditional story *The Wind Gourd of La‘amaomao*, Pāka‘a and his son Kūapāka‘a are descendants of the wind goddess La‘amaomao whose traditional home was in a gourd that also contained all of the sacred winds of Hawai‘i. La‘amaomao controlled and called forth the winds by chanting their names (Nakuina 1992). Pāka‘a’s chant traces the winds from the *moku* of ‘Ewa. The winds of the region Moa‘e kū and Kona are poetically recalled:

He Moae-ku ko Ewaloa	*Moa‘e-ku is of Ewaloa*
He Kehau ko Waiopua	*Kēhau is of Waiopua*
He Waikoloa ko Lihue	*Waikōloa is of Līhu‘e*
He Kona ko Puuokapolei	*Kona is of Pu‘uokapolei.*

[Ke Au Okoa, Volume III, Number 30, 14 November 1867; Nakuina 1992:51]

In *The Epic Tale of Hi‘iakaikapoliopele*, the goddess Hi‘iaka, the youngest sister of the fire goddess Pele, born an egg and carefully warmed and nourished by Pele herself (Westervelt 1916:69), embarks on a quest to retrieve her older sister’s lover, Lohi‘au. While traversing the island chain, Hi‘iaka encounters various gods and demi-gods, spirits and shapeshifters, as well as chiefs and commoners. According to the *mo‘olelo* (story), Hi‘iaka watches as her beloved friend Hōpoe is killed by the embers of her sister Pele. She chants atop of Pōhākea and tells of the cold harsh wind of Waikōloa, Maunauna and Wai‘ōpua.

KAU HO‘OKAHI HANERI A	CHANT ONE HUNDRED
ME KANALIMAKUMAMĀKOLU	AND FIFTY-THREE
Aloha ku‘u hoa i ka pū‘ali lā	Alas my friend of the rugged mountain pass
A luna i Pōhākea, he luna o Kamaoha	On high at Pōhākea, above Kamaoha
He lae ‘ino ‘o Maunauna *‘O Līhu‘e ke hele ‘ia*	Maunauna is a dangerous escarpment Līhu‘e’s high plain yet to be traversed
Honi i ke ‘ala mau‘u	Inhaling the scent of the grasses
I ke ‘ala o ke kupukupu	The fragrance of kupukupu fern

E linoa ala e ka Waikōloa	Entwined by the Waikōloa breeze
E ka makani he Wai‘ōpua	By the wind called Wai‘ōpua
Ku‘u pua, me he pua lā i ku‘u maka	My blossom, like a flower in my sight
Ka ‘oni i ka haku ‘ōnohi, kā ka wai lā i li‘u	Moving before my eyes, washed salty by tears
I ku‘u maka lā, e uē au lā.	There in my sight, I weep.

[Ho‘oulumahiehie 2008a:280; Ho‘oulumahiehie 2008:262]

1.4.3 *Ka Ua* (Rains)

Precipitation is a major component of the water cycle and is responsible for depositing *wai* (fresh water) on local flora. Pre-Contact *kānaka* (Native Hawaiians) recognized two distinct annual seasons. The first, known as *kau* (period of time, especially summer) lasts typically from May to October and is a season marked by a high-sun period corresponding to warmer temperatures and steady trade winds. The second season, *ho‘oilo* (winter, rainy season) continues through the end of the year from November to April and is a much cooler period when trade winds are less frequent, and widespread storms and rainfall become more common (Giambelluca et al. 1986:17). Being on the leeward side of O‘ahu, ‘Ewa is typically very hot and dry. Honouliuli receives an annual rainfall of about 550 mm (22 inches) on the coastal and inland region of the *ahupua‘a* and about 1,200 mm (39 inches) in the northern region up into the Wai‘anae Mountain Range (Giambelluca 2013). Each small geographic area on O‘ahu had a Hawaiian name for its own rains. According to Akana and Gonzalez (2015),

> Our kupuna had an intimate relationship with the elements. They were keen observers of their environment, with all of its life-giving and life-taking forces. They had a nuanced understanding of the rains of their home. They knew that one place could have several different rains, and that each rain was distinguishingable from another. They knew when a particular rain would fall, its color, duration, intensity, the path it would take, the sound it made on the trees, the scent it carried, and the effect it had on people. [Akana and Gonzalez 2015:XV]

Honouliuli was no exception to this naming practice. Despite the relative lack of rainfall in this area, the Nāulu rain is known to be associated with the *ahupua‘a* of Honouliuli. This rain is generally understood as a sudden shower, and more commonly associated with Kawaihae, Hawai‘i and Ni‘ihau (notoriously dry locations as well) (Akana and Gonzalez 2015:187). The Nāulu rain is mentioned in a *oli* (chant) offered by Hi‘iakaikapoliopele. During Hi‘iaka’s travel through ‘Ewa she recites this affectionate *oli* as she recalls the Kai‘okia edict placed on her and Lohi‘au by Pele:

‘A‘ole au e hele i ke kaha o Kaupe‘a	I shall not tread Kaupe‘a’s expanse
Kēlā kaha kūpā koili a ka lā i ke kula	That stretch where the sun beats down on the plain
Ua kūpono a‘ela ka lā i ka piko o Wākea	The sun is right overhead, at the navel of Wākea
Ola i ke ahe a ka makani Māunuunu	I am spared by the Māunuunu wind

I ka hapahapai mai a ka makani ‘Ao‘aoa	By the uplifting ‘Ao‘aoa breeze
Ke koi lā i ke ao o ka Nāulu *e hanini i ka wai*	Urging the Nāulu storm clouds to pour down their waters
Ola ihola nā kupa kama‘āina i ka wai *a ka ‘ōpua*	The natives here survive on water from the clouds
Ke halihali a‘ela nā ‘ōpua i ke awa lau	Which billowing clouds carry along to the branching lochs
E koi mai ana iā Hi‘iaka e kūo‘e hele *i ke kula*	Compelling Hi‘iaka to trudge that open stretch
I kuleana i lāhui ai ka moe i laila	Duty making rest forbidden there
I laila au lohe i ke kani leo le‘a a ka *‘ō‘ō i ke kula*	There I heard the happy trill of the *‘ō‘ō* bird on the plain
Ho‘āikāne ana lāua me ke kai o *Wāwaemoku*	Befriending the sea of Wāwaemoku
Mokumokuāhua loko, kupākupā koili *i ka ‘ino*	My heart grieves, thrashed by harm
I ‘ino ho‘i au i kēia kanaka i ka hiki *‘ana mai*	I may be harmed by this person upon arrival
I kāhela a‘ela ka ‘ai a ka manu	Leaving the birds to feed expansively
I ka pua o ka wiliwili	On the blossoms of the *wiliwili* trees
Wili a‘ela nā ‘ōpua i luna	The clouds spin above
No luna wau	I am from above
Wili a‘ela nā ‘ōpua i lalo	The clouds spin below
Lalo ē!	Below indeed!
Lilo i lalo ka hele ‘ana a ke kanaka	The movement of mankind is cast down
Kalakala ke ao no Hawai‘i	Craggy are the clouds from Hawai‘i
I ka pā ‘ia mai e kēia makani	Blown here by this wind
‘A‘ole a‘u makana i ka lā o ka hilahila	I have no gift to offer on this day of shame
E hili hewa paha auane‘i au	I shall perhaps end up astray
Wilia i na‘e, wilia i lalo	Spiraling windward, or to the lee
Wilia i kai, wilia i uka	Spinning toward the sea, toward the highlands
‘O kauhale a ka ‘ōlelo	O house made of words

Ho‘ohiki ihola i kānāwai	Utter as an edict
Kau ihola i kānāwai	Place as a law
He kānāwai ‘okia	An order of separation
‘Ālina ihola kā ‘o Pu‘uloa	Thus Pu‘uloa is branded by epithet
He ‘āina kauā.	A land of outcasts and slaves.

[Ho‘oulumāhiehie 2008a:294–295; Ho‘oulumāhiehie 2008b:275–276]

The general lack of rain names is indicative of historic environmental conditions within the *ahupua‘a*; these conditions, in turn, shaped agricultural practices in the area. Environmental limitations forced ingenuity and innovation. McAllister provides written evidence of the innovative ways in which Honouliuli's *kama‘āina* approached agricultural activities:

> […] It is probable that the holes and pits in the coral were formerly used by Hawaiians. Frequently the soil on the floor of the larger pits was used for cultivation, and even today one comes upon bananas and Hawaiian sugar cane still growing in them. They afford shelter and protection, but I doubt if previous to the time of Cook there was ever a large population here. [McAllister 1933:109]

1.4.4 *Nā Kahawai* (Streams)

Honouliuli Ahupua‘a, and the encompassing ‘Ewa District, are notoriously dry. Agricultural sinkholes were especially important on the ‘Ewa plain. In traditional Hawaiian times, the areas of exposed coral (Pleistocene limestone) outcrop were undoubtedly more extensive. Limestone outcrop, composed of detritus, calcareous sand, reef dwelling organisms, and coralline algae, is subject to dissolution from water. This dissolution has formed a series of connected and isolated caves under the ‘Ewa Plains. Although invisible to human eyes, streams flow under the surface of Honouliuli via the karsic system. “Sink holes” would accumulate water within them via a subterranean water or karst system; this water also contained nutrient-rich sediment that allowed plants such as *kalo* (taro; *Calocasia esculenta*), *kī* (ti; *Cordyline fruticosa*), and *noni* (Indian mulberry; *Morinda citrifolia*) to survive.

Proceeding *mauka* from this limestone plain is a series of gulches draining the Wai‘anae Mountains. The largest of these is Honouliuli Gulch toward the east side of the plain that drains into West Loch. The gulch is bisected by the Honouliuli Stream, the primary water body of the Honouliuli Watershed. The “perennial/intermittent” Honouliuli Stream and its tributaries “have a total stream length of 32.5 miles” (O‘ahu Resource Conservation and Development Council 2013:16).

To the west are fairly steep gradient gulches forming a more linear than dendritic drainage pattern. The major gulches from east to west are Kalo‘i, Hunehune, Makalapa, Makakilo, Awanui, Pālailai, Makaīwa, Waimānalo, and Limaloa. These gulches are steep-sided in the uplands and generally of a high gradient until they emerge onto the flat ‘Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms they carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes, they are either raging uncontrollably or are dry, and

do not form stable water sources for traditional agriculture in their upper reaches. The western Honouliuli gulches, in contrast to those draining into Pearl Harbor to the east, do not have valleys suitable for extensive irrigated agriculture. However, this lack is more than compensated by the rich watered lowlands at the base of Honouliuli Gulch.

Topography of the area is moderately sloping. In terms of hydrology, the area is drained by two deeply dissected gulches, Kalo‘i Gulch 300 m to the southwest and Honouliuli Gulch 700 m to the northeast. These gulches at a comparable elevation are believed to rarely run with water. Historic maps indicate a spring located approximately 2.2 km to the north. Such infrequent springs may have been key to the early human activity on the southeast Wai‘anae slope.

The lowlands fronting the west loch of Pearl Harbor (Kaihuopala‘ai) were suitable for the cultivation of the traditional Hawaiian staple crop, *kalo*. For spiritual and dietary reasons, *kalo* was a sacred staple in the Hawaiian diet. According to Hawaiian mythology, man was born from the taro plant.

The *Kumulipo* (“origin, genesis”) details this kinship. Hāloa, “he of the long breath,” is the second son of Wākea and Papa. Wākea and Papa’s first born, Hāloa-naka was born premature and died shortly after his birth (Kanahele 1995:17). After burying Hāloa-naka, a *kalo* plant sprouted at his grave. Shortly after, a second son (Hāloa) was born. A human child, Hāloa symbolizes *kalo* and man. *Kalo* is a metaphor for life, Kanahele explains as follows:

> In the mythologies of many cultures, plants have been used to symbolize human spiritual growth. Hawaiians made taro a metaphor for life because, like the taro plant, it needs to be rooted in good soil and to be constantly nourished with the waters of *Kāne*. As the stalk grows taller with its leaves reaching toward the light of the sun, symbolized by *Wākea*, so Hawaiians grow aspiring to be closer to their heavenly spirit. Just as every young shoot can become a full-grown plant, so can they become gods as descendants of Hāloa. As every plant must die, however, they too must die. And from the remains a new plant lives again. In this continuity of life, both plant and man repeat the mystery of the unending cycle. [Kanahele 1995:18]

However, by the mid-nineteenth century traditional agriculture was becoming quickly supplanted by large-scale commercial ventures. The focus of agricultural production soon shifted toward sugarcane and pineapple, with concerted efforts made to turn open space into plantations. The drilling for artesian wells began in 1879 with cattle rancher James Campbell on the ‘Ewa Plains (Board of Water Supply, City and County of Honolulu 2017). Utilizing a well driller, Campbell drilled several hundred feet down until reaching a large supply of pure, fresh water (Board of Water Supply, City and County of Honolulu 2017). According to the Board of Water Supply (2017):

> This discovery led to a water boom on the island, as ranchers and plantation developers began drilling furiously for more of the precious resource. Within 20 years, the boom came to a bust. Artesian wells, abandoned and neglected, wasted millions of gallons of water. By the turn of the century, Oahu suffered a water panic. Wells were salting up. Water levels were dropping. The problem was that the system had grown too much, too fast and too haphazardly. [Board of Water Supply 2017]

Campbell’s first well was named Waianiani (“crystal waters”) by the *kama‘āina* of Honouliuli (Nellist 1925). By 1930, Ewa Plantation had drilled 70 artesian wells to irrigate cane lands; artesian wells provided fresh water to Honouliuli for nearly 60 years (Ho‘okuleana 2014). Campbell’s original Honouliuli well was finally sealed by the City and County of Honolulu in 1939 (Ho‘okuleana 2014).

1.4.5 *Lihikai a me ka Moana* (Seashore and Ocean)

There exist several naming traditions for Honouliuli. Invaraibly, there are several explanations for Honouliuli’s name. One tradition notes that Honouliuli means “dark water,” “dark bay,” or “blue harbor,” and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua‘a*. The Hawaiians called Pearl Harbor, Pu‘uloa (“long hill”). According to *mo‘olelo*, this location was a storied place, due to the presence of Ka‘ahupāhau. Ka‘ahupāhau, queen of all sharks of O‘ahu, dwelled in a large cavern on the Honouliuli side of Pearl Harbor (Clark 1977:69).

> The Hawaiians knew Pearl Harbor as Pu‘uloa, and they believed that there, dwelling in a large cavern on the Honouliuli side of the harbor, Ka‘ahupāhau, the queen of all sharks on O‘ahu, made her home. Her chief guard was a brother shark, who lived in a pit at the entrance to the lochs. The Hawaiian people said the drydock was built over the cavern of Ka‘ahupāhau’s son, who also lived in Pu‘uloa. Angered by the violation of his home, the shark prince destroyed the imposing structure. The engineers in charge of the project attributed the collapse of the foundation to hydrostatic pressure. Whatever the cause, several years’ work was wrecked within minutes […] this time, before starting to rebuild, they asked the Hawaiians to bless the site. After that the work continued without further trouble. [Clark 1977:69–70]

Both seashore and ocean provided physical and spiritual sustenance (NOAA 2017) for the people of Honouliuli. According to Malo, the ocean was divided into smaller divisions, stretching from *‘ae kai* (water’s edge) to *moana* (pelagic zone) (Malo 1951:25–26). Outside the coastal areas was the belt known as *kua-au*, where the shoal water ended (Malo 1951:26). Further out was the *kai-au*, deeper waters designated for surfing, swimming, or spearing squid (Malo 1951:26). For Honouliuli Ahupua‘a, specifically between Kalaeloa and Kūalaka‘i, the sea of this region was identified as Hilo-one. It appears the name is drawn from an on-shore locality known as Hilo-one. According to Maly and Maly (2012),

> That place, Hilo-one, […] is situated on the northern side of Kualakai, towards Kalaeloa. And the name of the spring in which Hiiaka looked and saw her reflection was Hoakalei (Reflection of a lei). It was at this place that Hiiaka saw the two lehua trees growing, from which she picked the blossoms too make her four garlands. [Maly and Maly 2012:125]

While walking the coastline between Kalaeloa and Kūalaka‘i, the goddess sang out the following,

O Hiiaka ka wahine,	Hiiaka is the woman
Ke ako la i ka pua o Hoakalei,	Who picked the flowers of Hoakalei,

Ke kui la, ke uo la i ka manai	And with a needle strung and made them into
Eha ka lei, ka apana lei lehua	four garlands, the sectioned lei of the
a ka wahine la,	woman
Kuu pokii.	O my younger sibling.
Kuu pokii mai ke ehu makani o lalo.	My younger sibling who came from the place where the dusty wind rises from below
Lulumi aku la i ke kai o Hilo-one.	Overturned in the sea of Hilo-one.
No Hilo ke aloha, Aloha wale ka lei—e.	The *aloha* is for Hilo, Love for the *lei.*

[Ka Na‘i Aupuni, Volume II, Number 6, 7 June 1906, Ka Moolelo o Hiiaka-i-ka-poli-o=Pele; Maly and Maly 2012:125]

Moving westward from Pu‘uloa are Iroquis Beach, Pu‘uloa Beach Park (formerly ‘Ewa Beach Park), One‘ula Beach Park, in addition to Keahi Point. These beaches comprise the coastal portion of Honouliuli; use of these beaches increased during the plantation era, when employees of the nearby sugar plantations utilized the coastal areas for subsistence and recreation.

Traditionally, the seashore and ocean areas were vitally important for resource extraction in the early days of settlement. Fishermen along the coast maintained a respected status within traditional Hawaiian society; Kanahele asserts that “early Hawaiians regarded fishing as the oldest, and hence the most prestigious, of professions” (Kanahele 1995:17).

According to Charles Howard Edmondson (1946:5), the coastal waters of Pearl Harbor were “a natural aquarium for many varieties of marine animals.” Titcomb (1952:7) identifies the Pearl Harbor area as the only large natural inland lagoon, famous for its fish and fishponds. The *nehu* (anchovy; *Anchoviella purpurea*) was said to fill the lochs of Pearl Harbor. Citing Kamakau, Margaret Titcomb writes that the *nehu*, “filled the lochs from the channel of Pu‘uloa (Pearl Harbor) inland to the Ewas” (Titcomb 1952:97). Due to the presence of the *nehu*, the *kama‘āina* of Honouliuli and ‘Ewa developed this saying,

> *He kai puhi nehu, puhi lala ke kai o ‘Ewa e, e noho i ka la‘i o ‘Ewa nui a La‘akona* (“A sea that blows up *nehu*, blows them up in rows, is ‘Ewa, until they rest in the calm of great ‘Ewa-a-La‘akona”). [Kamakau 1991a:84]

1.4.6 Built Environment

The project area was utilized for commercial sugarcane from the early twentieth century into the late 1970s. Some of the sugarcane plantation infrastructure in the vicinity was relatively elaborate with the Waiahole Ditch (partially within the project area) transporting irrigation water from windward O‘ahu into the foothills of the southern Wai‘anae Range. The sugarcane fields have remained fallow for decades. Some plantation infrastructure is still present in the form of cane haul roads and remnant irrigation features (see Figure 3). The project area is otherwise undeveloped. The H-1 Freeway is approximately 800 m south of the project area.

Section 2 Methods

2.1 Archival Research

Research centers on Hawaiian activities including *ka‘ao* (legends), *wahi pana* (storied places), *‘ōlelo no‘eau* (proverbs), *oli* (chants), *mele* (songs), traditional *mo‘olelo*, traditional subsistence and gathering methods, ritual and ceremonial practices, and more. Background research focuses on land transformation, development, and population changes beginning with the early post-Contact era to the present day.

Cultural documents, primary and secondary cultural and historical sources, historic maps, and photographs were reviewed for information pertaining to the study area. Research was primarily conducted at the CSH library. Other archives and libraries including the Hawai‘i State Archives, the Bishop Museum Archives, the University of Hawai‘i at Mānoa’s Hamilton Library, Ulukau, The Hawaiian Electronic Library (Ulukau 2014), the State Historic Preservation Division (SHPD) Library, the State of Hawai‘i Land Survey Division, the Hawaiian Historical Society, and the Hawaiian Mission Houses Historic Site and Archives are also repositories where CSH cultural researchers gather information. Information on Land Commission Awards (LCAs) were accessed via Waihona ‘Aina Corporation’s Māhele database (Waihona ‘Aina 2000), the Office of Hawaiian Affairs (OHA) Papakilo Database (Office of Hawaiian Affairs 2015), and the Ava Konohiki Ancestral Visions of ‘Āina website (Ava Konohiki 2015).

2.2 Community Consultation

2.2.1 Scoping for Participants

We begin our consultation efforts with utilizing our previous contact list to facilitate the interview process. We then review an in-house database of *kūpuna* (elders), *kama‘āina*, cultural practitioners, lineal and cultural descendants, Native Hawaiian Organizations (NHOs; includes Hawaiian Civic Clubs and those listed on the Department of Interior’s NHO list), and community groups. We also contact agencies such as SHPD, OHA, and the appropriate Island Burial Council where the proposed project is located for their response on the project and to identify lineal and cultural descendants, individuals and/or NHO with cultural expertise and/or knowledge of the study area. CSH is also open to referrals and new contacts.

2.2.2 “Talk Story” Sessions

Prior to the interview, CSH cultural researchers explain the role of a CIA, how the consent process works, the project purpose, the intent of the study, and how their *‘ike* (knowledge) and *mana‘o* (thought, opinion) will be used in the report. The interviewee is given an Authorization and Release Form to read and sign.

“Talk Story” sessions range from the formal (e.g., sit down and *kūkākūkā* [consultation, discussion] in participants choice of place over set interview questions) to the informal (e.g., hiking to cultural sites near the study area and asking questions based on findings during the field outing). In some cases, interviews are recorded and transcribed later.

CSH also conducts group interviews, which ranges in size. Group interviews usually begin with set, formal questions. As the group interview progresses, questions are based on interviewee’s

answers. Group interviews are always transcribed and notes are taken. Recorded interviews assist the cultural researcher in 1) conveying accurate information for interview summaries, 2) reducing misinterpretation, and 3) missing details to *mo‘olelo*.

CSH seeks *kōkua* (assistance) and guidance on identifying past and current traditional cultural practices of the study area. Those aspects include general history of the *ahupua‘a*; past and present land use of the study area; knowledge of cultural sites (for example, *wahi pana*, archaeological sites, and burials); knowledge of traditional gathering practices (past and present) within the study area; cultural associations (*ka‘ao* and *mo‘olelo*); referrals; and any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the study area.

2.2.3 Completion of Interview

After an interview, CSH cultural researchers transcribe and create an interview summary based on information provided by the interviewee. Cultural researchers give a copy of the transcription and interview summary to the interviewee for review and ask to make any necessary edits. Once the interviewee has made those edits, we incorporate their *‘ike* and *mana‘o* into the report. When the draft report is submitted to the client, cultural researchers then prepare a finalized packet of the participant’s transcription, interview summary, and any photos that were taken during the interview. We also include a thank you card and honoraria. This is for the interviewee’s records.

It is important to CSH cultural researchers to cultivate and maintain community relationships. The CIA report may be completed, but CSH researchers continuously keep in touch with the community and interviewees throughout the year—such as checking in to say hello via email or by phone, volunteering with past interviewees on community service projects, and sending holiday cards to them and their *‘ohana* (family). CSH researchers feel this is an important component to building relationships and being part of an *‘ohana* and community.

“*I ulu no ka lālā i ke kumu*—the branches grow because of the trunk,” an *‘ōlelo no‘eau* (#1261) shared by Mary Kawena Pukui with the simple explanation: “Without our ancestors we would not be here” (Pukui 1983:137). As cultural researchers, we often lose our *kūpuna* but we did not lose their wisdom and words. We routinely check obituaries and gather information from other informants if we have lost our *kūpuna*. CSH makes it a point to reach out to the *‘ohana* of our fallen *kūpuna* and pay our respects including sending all past transcriptions, interview summaries, and photos for families to have on file for genealogical and historical reference.

Section 3 *Ka‘ao* and *Mo‘olelo*

Hawaiian storytellers of old were greatly honored; they were a major source of entertainment and their stories contained lessons while interweaving elements of Hawaiian lifestyles, genealogy, history, relationships, arts, and the natural environment (Pukui and Green 1995:IX). According to Pukui and Green (1995), storytelling is better heard than read for much becomes lost in the transfer from the spoken to the written word and *ka‘ao* are often full of *kaona* or "double meanings."

Ka‘ao are defined by Pukui and Elbert (1986:108) as a "legend, tale […], romance, [and/or], fiction." *Ka‘ao* may be thought of as oral literature or legends, often fictional or mythic in origin, and have been "consciously composed to tickle the fancy rather than to inform the mind as to supposed events" (Beckwith 1970:1). Conversely, Pukui and Elbert (1986:254) define *mo‘olelo* as a "story, tale, myth, history, [and/or] tradition." The *mo‘olelo* are generally traditional stories about the gods, historic figures or stories which cover historic events and locate the events with known places. *Mo‘olelo* are often intimately connected to a tangible place or space (*wahi pana*).

In differentiating *ka‘ao* and *mo‘olelo* it may be useful to think of *ka‘ao* as expressly delving into the *wao akua* (realm of the gods), discussing the exploits of *akua* (gods) in a primordial time. *Mo‘olelo* on the other hand, reference a host of characters from *ali‘i* (royalty) to *akua*; *kupua* (supernatural beings) to *maka‘āinana* (commoners); and discuss their varied and complex interactions within the *wao kānaka* (realm of man). Beckwith elaborates, "In reality, the distinction between *ka‘ao* as fiction and *mo‘olelo* as fact cannot be pressed too closely. It is rather in the intention than in the fact" (Beckwith 1970:1). Thus a so-called *mo‘olelo*, which may be enlivened by fantastic adventures of *kupua*, "nevertheless corresponds with the Hawaiian view of the relation between nature and man" (Beckwith 1970:1).

Both *ka‘ao* and *mo‘olelo* provide important insight into a specific geographical area, adding to a rich fabric of traditional knowledge. The preservation and passing on of these stories through oration remains a highly valued tradition. Additionally, oral traditions associated with the study area communicate the intrinsic value and meaning of a place, specifically its meaning to both *kama‘āina* as well as others who also value that place.

The following section presents traditional accounts of ancient Hawaiians living in the vicinity of the project area. Many relate an age of mythical characters whose epic adventures inadvertently lead to the Hawaiian race of *ali‘i* and *maka‘āinana*. The *ka‘ao* in and around the project area shared below are some of the oldest Hawaiian stories that have survived; they still speak to the characteristics and environment of the area and its people.

3.1 *Ka‘ao*

3.1.1 The Naming of Honouliuli

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

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of land they would throw a stone and where the stone fell would

> be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Waianae range and it landed somewhere, in the Waimanalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed. [Told to E.S. by Simeon Nawaa, 22 March 1954 in Sterling and Summers 1978:1]

Honouliuli means “dark water,” “dark bay,” or “blue harbor,” and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupua‘a*. Another explanation for the name comes from the “Legend of Lepeamoa,” the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa. The land of Honouliuli was named for the grandfather of Lepeamoa (Thrum 1923:164–184).

It is likely that the boundaries of the westernmost *ahupua‘a* of ‘Ewa were often contested with people of the neighboring Wai‘anae District. The ‘Ewa people could cite divine sanction that the dividing point was between two hills at Pili o Kahe:

> This is a spot where two small hills of the Waianae range come down parallel on the boundary between Honouliuli and Nanakuli (Ewa and Waianae). The ancient Hawaiians said the hill on the Ewa side was the male and the hill on the Waianae side was female. The stone was found on the Waianae side hill and the place is known as Pili o Kahe (*Pili* = to cling to, *Kahe* = to flow). The name refers, therefore, to the female or Waianae side hill. And that is where the boundary between the two districts runs. [Told to E.S. by Simeon Nawaa, 22 March 1954 in Sterling and Summers 1978:1]

3.1.2 Kāne and Kanaloa and the *Loko I‘a* (Fishpond) of Pu‘uloa

According to an account in the Hawaiian newspaper *Ka Loea Kālai‘āina* (10 June 1899), several of the fishponds in the Pu‘uloa area were made by the brother gods, Kāne and Kanaloa. A fisherman living in Pu‘uloa, named Hanakahi, prayed to unknown gods until one day two men came to his house. They revealed to him that they were the gods to whom he should pray. Kāne and Kanaloa then built fishponds at Ke‘anapua‘a, but were not satisfied. Then they built the fishpond Kepo‘okala, but were still not satisfied. Finally, they made the pond Kapākule, which they stocked with all manner of fish. They gifted all of these fishponds to Hanakahi and his descendants (Handy and Handy 1972:473; *Ka Loea Kālai‘āina*, 8 July 1899, Volume III, Number 26).

Mary Pukui (1943:56–57), who visited Kapākule Fishpond when she was young, writes that the pond was built by the *menehune* (legendary race of small people who worked at night, building fishponds, roads, temples) under the direction of the gods Kāne and Kanaloa. Pukui describes several unique aspects of this pond:

> On the left side of the pond stood the stone called Hina, which represented a goddess of the sea by that name. Each time the sea ebbed, the rock became gradually visible, vanishing again under water at high tide. Ku, another stone on the right, was never seen above sea level. This stone represented Ku‘ula, Red Ku, a god for fish and fishermen. From one side of the pond a long wall composed of

> driven stakes of hard wood, ran toward the island [Laulaunui] in the lochs. When fish swam up the channel and then inside of this wall, they invariably found themselves in the pond. A short distance from the spot where the pond touched the shore was a small ko‘a or altar composed of coral rock. It was here that the first fish caught in the pond was laid as an offering to the gods. [Pukui 1943:56]

The fishpond contained many fish, especially the *akule* (bigeye scad; *Selar crumenophthalmus*), thus its name, “the enclosure for *akule* fish” (Pukui 1943:56–57). The pond was destroyed when the channel to Pearl Harbor was dredged in the early twentieth century. The caretaker of the pond took the stones Kū and Hina to a deep place in the ocean and sunk them so “none would harm or defile them.” Cobb (1905:733) writes that the pond was used to catch the larger *akule* (goggler), *‘ōpelu* (mackerel scad; *Decapterus macarellus*), *weke* (goat fish; *Mullidae*), *kawakawa* (bonito; *Euthynnus affinis*), and sharks. It was unusual for having walls made of coral. This contradicts much of the *mo‘olelo* saying that sharks were not killed in Pearl Harbor. However, Kamakau does relate that Kekuamanoha and Kauhiwawaeono, two conspirators against Kamehameha I, lived at Pu‘uloa. The chief Kauhiwawaeono was known to murder people and use their bodies as shark bait (Kamakau 1992:182, 232).

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

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

3.1.3 Pu‘okapolei, Astronomical Marker and Heiau

Pu‘uokapolei was the primary landmark for travelers on the cross-*ahupua‘a* trail that ran from Pearl Harbor in the east to Wai‘anae in the west (‘Ī‘ī 1959:27, 29; Nakuina 1992:54; E.M. Nakuina 1904 in Sterling and Summers 1978:34). *Pu‘u* means “hill” and Kapolei means “beloved Kapo,” a reference to the sister of the goddess, Pele. Kamakau says ancient Hawaiians used Pu‘uokapolei as an astronomical marker to designate the seasons:

> […] the Oahu people who reckoned the time (Oahu *po‘e helu*) called the season Kau for the setting of the sun from Pu‘uokapolei, a hill in Honouliuli, ‘Ewa, to the

> opening of Mahinaona (*i ke kawaha o Mahinaona*). When the sun moved south from Pu‘uokapolei—and during the season of the sun in the south—for the coming of coolness and for the sprouting of new buds on growing things—the season was called Ho‘oilo [winter, rainy season]. [Kamakau 1976:14]

A ceremony commemorating the changing of the seasons is still observed each year in the beginning of May at Waikīkī and Honouliuli. This ceremony was documented in a previous cultural impact assessment conducted by CSH (Genz et al. 2012). Sam ‘Ohukani‘ōhi‘a Gon III, Na Wa‘a Lalani Kahuna O Pu‘u Koholā, and the late Kumu Hula John Keola Lake’s *hula hālau* (*hula* instruction) perform *oli* and *hula* (dance), explaining that the *kilo hōkū* (astronomers) of O‘ahu observed how, from the perspective of Waikīkī, the sun sets in a southerly direction over the ocean during the winter solstice and in a northerly direction behind the ‘Ewa ridgeline during the summer solstice. During the springtime, the position of the setting sun marches steadily northward each day, and at the beginning of May, the sun sets behind Pu‘uokapolei, perfectly centered within its depression from the vantage point of Kūpalaha Heiau just west of the Waikīkī Aquarium. A coinciding ceremony at a *heiau* on Pu‘uokapolei similarly views the setting of the sun behind Pu‘ula‘ila‘i farther west, and a line of sight extending eastward from Pu‘ula‘ila‘i, Pu‘uokapolei, and the former site of Kūpalaha Heiau ends at the closely associated Papa‘ena‘ena Heiau. Mr. Gon suggests Papa‘ena‘ena Heiau may have been part of the ceremonies of this astronomical event.

3.1.4 Kamapua‘a and Kamaunuaniho at Pu‘uokapolei

Pu‘uokapolei was known to be the home of Kamapua‘a’s grandmother, Kamaunuaniho, one of the three migrants from Kahiki that were ancestors to the people of O‘ahu (Legend of Kamapuaa, Fornander 1919a:5[2]:318; Kahiolo 1978:81, 107). Kamapua‘a, the Hawaiian pig god, once lived in Kaluanui on the windward side of O‘ahu, but he escaped to ‘Ewa when he was pursued by the chief Olopana.

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

Emma Nakuina goes on to note, “A very short time ago [prior to 1904] the foundations of Kamaunuaniho’s house could still be seen at Puuokapolei” (Nakuina 1904:51). Another account (*Ka Loea Kālai‘āina*, 13 January 1900 in Sterling and Summers 1978:34) speaks of Kekele‘aikū, the older brother of Kamapua‘a, who also lived on Pu‘uokapolei.

In Lilikalā Kame‘eleihiwa’s version of the *mo‘olelo* of Kamapua‘a, Pele and Kamapua‘a meet and a battle ensues on Hawai‘i Island between the two. Kamapua‘a tells Kekele‘aikū,

> ‘Listen to me, elder brother. You wait here. When you smell the stench of burning bristles, then you must assume I am dead. However, if indeed you do not smell the stench of the bristles, you will know that your younger brother has not been harmed and that he has “eaten of the cooked taro.” ’ [Kame‘eleihiwa 1996:62]

Kamapua‘a travels to Hawai‘i Island where Pele chases him with fire out of the *lehua* (*Metrosideros macropus, M. collina subsp. polymorpha*) forest. Kamapua‘a ran from Pele but could only cling to an *‘ama‘uma‘u* (*Sadleria cyatheoides*) fern (Kame‘eleihiwa 1996:95). The fire continued to burn around Kamapua‘a as he clung on for his life. His bristles began to burn as well, sending a stench of burning pig bristles around the Hawaiian Islands. Kekele‘aikū smelled the stench of burning pig bristles and began to cry, thinking that his brother perished in battle with Pele (Kame‘eleihiwa 1996:95). Kekele‘aikū then hung himself, deeply saddened for the loss of his beloved brother, Kamapua‘a. Kekele‘aikū’s body was left at Pu‘uokapolei with his grandmother.

3.1.5 Kahalaopuna at Pōhākea Pass

One of the most popular legends of O‘ahu is that of Kahalaopuna (or Kaha), a young woman of Mānoa who was slandered by others and then killed by her betrothed, Kauhi, a chief from Ko‘olau, O‘ahu. While the numerous accounts (e.g., Day 1906:1-11; Fornander 1919b:5:188–192; Kalākaua 1990:511–522; Nakuina 1904:41–45; Patton 1932:41–49; Skinner 1971:220–223; Thrum 1907:118–132) vary in details they typically have Kahalaopuna slain and then revived repeatedly with the aid of a protective owl spirit. Kauhi forces her to hike west from Mānoa through the uplands until they get to Pōhākea Pass through the southern Wai‘anae Range in north Honouliuli. At Pōhākea Pass, Kauhi beats her with a stick until she is very dead (“*Ia hahau ana a Kauhi i ka lā‘au, make loa o Kahalaopuna*”). Her spirit (*‘uhane*) flies up into a *lehua* tree and chants for someone to go notify her parents of her fate. Upon hearing the news, her parents fetched Kahalaopuna back to Mānoa and she was restored to life.

3.1.6 *Mo‘o* at Maunauna

Moses Manu in recounting the Legend of Keaomelemele makes a reference to a *mo‘o* (lizard or water spirit) named Maunauna who lived above Līhu‘e (presumably at the landform of that name in extreme northern Honouliuli) and who was regarded as a bad lizard (*Kuokoa* 25 April 1885 in Sterling and Summers 1978:37).

3.1.7 Coastal Village of Kūalaka‘i

“Legend of the Children” is a tale that foretold the breaking of the eating *kapu* (taboo) by the *ali‘i*. A young brother and sister always fished at Kūalaka‘i, a beach area on the southern coast of Honouliuli. On this day, they laid out their nets, but all they caught was one *palani* (surgeonfish; *Acanthurus dussumieri*), a fish that was *kapu* for men; only women could eat it.

> […] They fished again and again until the afternoon and nothing was caught. The children were weary and went home without fish. When they came as far as Puu-o-Kapolei where the blossoms of the ma‘o looked golden in the sunlight, the sister sat down to make ma‘o leis for themselves. When the leis were made they went across the breadth of Kaupe‘a to Waipio. [*Ka Loea Kālai‘āina*, 22 July 1899:15; translation in Sterling and Summers 1978:7]

They stopped at the stream of Ka‘aimalu on the way to their home and the sister convinced her brother to share the fish between the two, thus breaking the *kapu*. “Because these children ate fish secretly, the spot is called Kaai-malu (Secret eating) to this day” (Sterling and Summers 1978:7).

3.1.4 The First Breadfruit Brought from Kahiki

The chief Kaha‘i left from Kalaeloa, a coastal area in Honouliuli, for a trip to Kahiki. On his return to the Hawaiian Islands, he brought back the first breadfruit (Kamakau 1991b:110) and planted it near the waters of Pu‘uloa or “long hill,” now known as Pearl Harbor (Beckwith 1940:97).

3.1.5 The Traveling Mullet of Honouliuli

The story of (Ka) Ihuopala‘ai is largely associated with the tradition of the *‘anae-holo* or traveling mullet (Thrum 1907:270–272):

> The home of the anae-holo is at Honouliuli, Pearl Harbor, at a place called Ihuopalaai. They make periodical journeys around to the opposite side of the island, starting from Puuloa and going to windward, passing successively Kumumanu, Kalihi, Kou, Kalia, Waikiki, Kaalawai, and so on, around to the Koolau side, ending at Laie, and then returning by the same course to their starting-point. [Thrum 1907:271]

In Thrum’s account, Ihuopala‘ai is a male who possesses a *kū‘ula*, or fish god, which supplied the large mullet known as *‘anae* (also *‘ama‘ama*; *Mugil cephalus*; when 12 inches or more, they are referred to as *‘anae*). His sister lived in Lā‘ie and there came a time when there were no fish. She sent her husband to visit Ihuopala‘ai who was kind enough to send the fish following his brother-in-law on his trip back to Lā‘ie.

This story is associated with a poetical saying documented by Mary Kawena Pukui about Honouliuli:

> ***‘Ōlelo No‘eau* #1330**
>
> *Ka i‘a hali a ka makani*
>
> The fish fetched by the wind. [Pukui 1983:145]

Pukui (1983:145) explains, “The *‘anaeholo*, a fish that travels from Honouliuli, where it breeds, to Kaipāpa‘u on the windward side of O‘ahu. It then turns about and returns to its original home. It is driven closer to shore when the wind is strong.”

McAllister offers a variation of the *mo‘olelo*:

> The site is named for Kaihuopalaai, said to be a daughter of Konikonia and his wife Hinaaimalama. Fornander (37, vol. 5, p. 270) writes: ‘. . . on Oahu, Kaihuopalaai saw a godly man by the name of Kapapaapuhi [see Site 139] who was living at Honouliuli, Ewa; she fell in love with him and they were united, so Kaihuopalaai has remained in Ewa to this day. She was changed into that fishpond in which mullet are kept and fattened, and this fish is used for that purpose to this day.’ [McAllister 1933:108]

Kaihuopala‘ai, which means “the nose of Pala‘ai” (Pukui et al. 1974:68) is also the name the Hawaiians used for the west loch of Pearl Harbor. McAllister recorded that other Hawaiians say there never was a fishpond by that name.

> According to old Hawaiians, there never was a fishpond by this name. In another version (77, p. 270), Ihuopalaai is the brother of a woman living in Laie. As the fish were scarce in Laie, this woman sent her husband to Ihuopalaai, who had the mullet follow her husband on his return trip which was made along the shore around Makapuu Point with the mullet following in the water. Makea tells me that Kaihuopalaai's sister was named Malaekahana. Another story tells of a man who lured the mullet around the island by tossing sweet potatoes into the sea (68, p. 38). [McAllister 1933:108]

Beckwith (1918) says that Kaihuopala‘ai changed into the fishpond near Kapapapuhi Point, which means "the eel flats."

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

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

3.1.6 Ka-lua-ōlohe Caves of Honouliuli

‘Ewa was famous for the many limestone caves formed in the uplifted coral, called the "Ewa Karst." This Pleistocene limestone outcrop, where not covered by alluvium or stockpiled material, has characteristic dissolution "pit caves" (Mylroie and Carew 1995), which are nearly universally, but erroneously, referred to as "sink holes" (Halliday 2005). These pit caves, or sinkholes, vary widely in areal extent and depth, with some of the more modest features comparable in volume to 5-gallon buckets, while some of the larger features, although usually irregularly shaped, are several meters wide and several meters deep. In traditional Hawaiian times, the areas of exposed coral outcrop were undoubtedly more extensive.

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

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

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

After some initial objections by the niece of Keali‘iahonui, the body was removed from the outer coffin, the rest was sunk, and the coffin was later buried somewhere in Pu‘uloa.

3.1.7 Kanekua‘ana

Kanekua‘ana is a *kia‘i* (guardian) in the form of a *mo‘o* that took care of the people that lived from Honouliuli to Hālawa. Even those who were not her descendants were cared for in times of need. When *i‘a* (marine food) became scarce they would build a *waihau heiau* (a *heiau* for *mo‘o*) and pray for Kanekua‘ana’s blessing. She blessed them with an abundance of *i‘a*.

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

The people were also blessed with many other *i‘a* including *‘ōpae huna*, transparent shrimp (*pariambus typicus*), *‘ōpae kākala*, spiked shrimp (*caridina gracilirostris*), *nehu maoli*, *nehu pala*, types of anchovy, *mahamoe*, and *‘ōkupe*, types of bivalves. Some of these marine resources are no longer seen today (Maly and Maly 2003:60).

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

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

3.1.8 Palila

In the *mo‘olelo* of the hero Palila, the famous warrior had a supernatural war club. He could throw the club a long distance, hang on to the end of it, and fly along the club’s path. Using this power, he touched down in several places in Honouliuli, Waipi‘o, and Waikele. One day he used

his supernatural war club to carry himself to Ka‘ena Point at Wai‘anae, and from there east across the district of ‘Ewa. Fornander writes,

> *Haalele keia ia Kaena, hele mai la a Kalena, a Pohakea, Maunauna, Kanehoa, a ke kula o Keahumoa, nana ia Ewa. Ku keia i laila nana i ke ku a ka ea o ka lepo i na kanaka, e pahu aku ana keia i ka laau palau aia nei i kai o Honouliuli, ku ka ea o ka lepo, nu lalo o ka honua, me he olai la, makau na kanaka holo a hiki i Waikele. A hiki o Palila i laila, e paapu ana na kanaka i ka nana lealea a ke ‘lii o Oahu nei, oai o Ahuapau.* [Fornander 1918:143]
>
> After leaving Kaena he came to Kalena, then on to Pohakea, then to Manuauna [a peak in Honouliuli], then to Kanehoa [a peak in Honouliuli], then to the plain of Keahumoa [upland plain from Honouliuli to Waipio] and looking toward Ewa. At this place he stood and looked at the dust as it ascended into the sky caused by the people who had gathered there; he then pushed his war club toward Honouliuli. When the people heard something roar like an earthquake they were afraid and they all ran to Waikele. When Palila arrived at Waikele he saw the people gathered there to witness the athletic games that were being given by the king of Oahu, Ahupau by name. [Fornander 1918:142]

3.1.9 Kākuhihewa

The Hawaiian *ali‘i* were also attracted to the region of the project area. One historical account of particular interest, appearing in the newspaper *Ke Au Hou*, refers to an *ali‘i* residing in Ko‘olina, southwest of the project area:

> Koolina is in Waimanalo near the boundary of Ewa and Waianae. This was a vacationing place for chief Kakuhihewa and the priest Napuaikamao was the caretaker of the place. Remember reader, this Koolina is not situated in the Waimanalo side of the Koolau side of the island but the Waimanalo in Ewa. It is a lovely and delightful place and the chief, Kakuhihewa loved this home of his. [*Ke Au Hou*, 13 July 1910, Volume I, Number II, Sterling and Summers 1978:41]

3.2 Wahi Pana

Wahi pana are legendary or storied places of an area. These legendary or storied places may include a variety of natural or human-made structures. Oftentimes dating to the pre-Contact period, most *wahi pana* are in some way connected to a particular *mo‘olelo*, however, a *wahi pana* may exist without a connection to any particular story. Davianna McGregor outlines the types of natural and human-made structures that may constitute *wahi pana*:

> Natural places have *mana* or spiritual power, and are sacred because of the presence of the gods, the *akua*, and the ancestral guardian spirits, the *‘aumakua*. Human-made structures for the Hawaiian religion and family religious practices are also sacred. These structures and places include temples, and shrines, or *heiau*, for war, peace, agriculture, fishing, healing, and the like; *pu‘uhonua*, places of refuge and sanctuaries for healing and rebirth; agricultural sites and sites of food production such as the *lo‘i* pond fields and terraces slopes, *‘auwai* irrigation ditches, and the

> fishponds; and special function sites such as trails, salt pans, *hōlua* slides, quarries, petroglyphs, gaming sites, and canoe landings. [McGregor 1996:22]

As McGregor makes clear, *wahi pana* can refer to natural geographic locations such as streams, peaks, rock formations, ridges, offshore islands and reefs, or they can refer to Hawaiian land divisions such as *ahupua‘a* or *‘ili*, and man-made structures such as fishponds. In this way, the *wahi pana* of Honouliuli tangibly link the *kama‘āina* of Honouliuli to their past. It is common for places and landscape features to have multiple names, some of which may only be known to certain *‘ohana* or even certain individuals within an *‘ohana*, and many have been lost, forgotten or kept secret through time. Place names also convey *kaona* and *huna* (secret) information that may even have political or subversive undertones. Before the introduction of writing to the Hawaiian Islands, cultural information was exclusively preserved and perpetuated orally. Hawaiians gave names to literally everything in their environment, including individual garden plots and *‘auwai* (water courses), house sites, intangible phenomena such as meteorological and atmospheric effects, *pōhaku*, *pūnāwai* (freshwater springs), and many others. According to Landgraf (1994), Hawaiian *wahi pana* “physically and poetically describes an area while revealing its historical or legendary significance” (Landgraf 1994:v). Place names and *wahi pana* of Honouliuli are identified on Figure 5.

3.2.1 *Heiau* (Pre-Christian Place of Worship)

Heiau were pre-Christian places of worship. Construction of some *heiau* was elaborate, consisting of large communal structures, while others were simple earth terraces or shrines (McAllister 1933:8). *Heiau* are most commonly associated with important religious ceremony; large structures with platforms or altars of one or more terraces were indicative of such function (McAllister 1933:8). Archaeologist Gilbert McAllister reports on two known *heiau* in the *ahupua‘a* of Honouliuli, as well as two other sites that could have possibly been *heiau*. These *heiau* were located on Pu‘u o Kapolei, on Pu‘u Ku‘ua, at the foot of Pu‘u Kanehoa, and at the foot of Mauna Kapu (McAllister 1933).

3.2.1.1 Pu‘u o Kapolei

A *heiau* was once located on Pu‘u o Kapolei, but it had been destroyed by the time of McAllister’s (1933:108) survey of the island in the early 1930s. The hill was used as a point of solar reference or as a place for such observations (Fornander 1919c:6[2]:297). Pu‘uokapolei may have been regarded as the gate of the setting sun, just as the eastern gate of Kumukahi in Puna is regarded as the gate of the rising sun; both places are associated with the Hawaiian goddess Kapō (Emerson 1915:41). This somewhat contradicts some Hawaiian cosmologies, in which Kū was the god of the rising sun, and Hina, the mother of Kamapua‘a, was associated with the setting of the sun. Fornander (1919:6[2]:292) states that Pu‘uokapolei may have been a *leina*, jumping off point associated with the wandering souls who roamed the plains of Kaupe‘a and Kānehili, *makai* (toward the sea) of the hill.

McAllister writes that the stones from the *heiau* supplied the rock crusher located on the side of this elevation, about 100 ft away on the sea side. There was once a large rock shelter on the *makai* side where it is said to have been the residence of Kamapua‘a and his grandmother. (McAllister 1933:108). After conquering the majority of O‘ahu, he established his grandmother as queen of this *wahi* (Pukui et al. 1974:203).

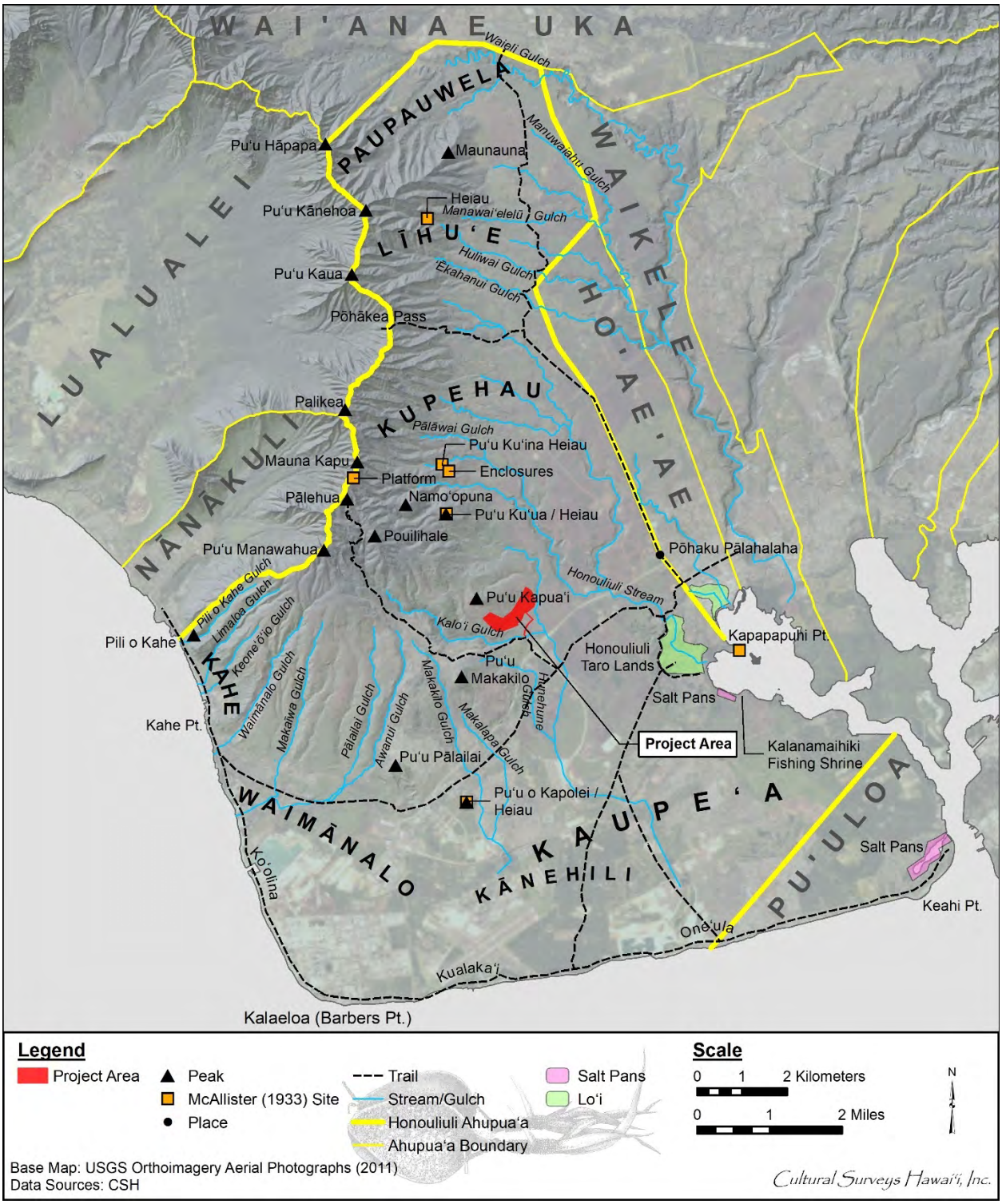

Figure 5. Portion of a 2011 USGS Orthoimagery aerial photograph showing place names, trails and streams of Honouliuli Ahupua‘a and the location of the project area

3.2.1.2 Pu‘u Ku‘ua

Pu‘u Ku‘ua Heiau located in Palikea, Honouliuli, overlooks both Honouliuli and Nānākuli, and is at the height of approximately 1,800 feet (ft). Most of the stones from the *heiau* were used for a cattle pen located on the *makai* side of the site. The part of the *heiau* that hadn’t been cleared for pineapples has been planted in ironwoods (McAllister 1933:108).

3.2.1.3 Unidentified heiau at the foot of Pu‘u Kanehoa

Located at the foot of Pu‘u Kanehoa is a small enclosure thought to have possibly been a *heiau*. McAllister writes,

> My informant, Reiney, recalls the respect the old Hawaiians had for the place when he was punching cattle with them in his youth. It is a walled inclosure 25 by 35 feet. On the inside the walls are between 2 and 3 feet high, and on the outside they range from 2 to 5 feet, depending upon the slope of the land. On three sides the walls are 2 feet wide, but the fourth is 3 feet wide. The walls are evenly faced with a fill of smaller stones. At present the site is surrounded with a heavy growth of *Lantana*; but only a thick growth of grass and two small guava bushes are in the interior, which is most unusual unless human hands keep the interior clear. Possibly this is not a *heiau* but a small inclosure considered sacred for some reason. [McAllister 1933:107]

3.2.1.4 Unidentified heiau at the foot of Pu‘u Kuina

Located in Aikukai, Honouliuli, at the foot of Pu‘u Kuina what looked to be a terrace is all that remained when McAllister cataloged Site 134. He notes of the inability to determine the size of the *heiau* or the number of terraces that once stood (McAllister 1933:107).

3.2.2 Plains of ‘Ewa

3.2.2.1 The Plains of Kaupe‘a

Several places on the ‘Ewa coastal plain are associated with *ao kuewa*, the realm of the homeless souls. Samuel Kamakau explains Hawaiian beliefs in the afterlife:

> There were three realms (*ao*) for the spirits of the dead […] There were, first, the realm of the homeless souls, the *ao kuewa*; second, the realm of the ancestral spirits, the *ao ‘aumakua*; and third, the realm of Milu, *ke ao o Milu.*
>
> The *ao kuewa*, the realm of homeless souls, was also called the *ao ‘auwana*, the realm of wandering souls. When a man who had no rightful place in the *‘aumakua* [family or personal gods] realm (*kanaka kuleana ‘ole*) died, his soul would wander about and stray amongst the underbrush on the plain of Kama‘oma‘o on Maui, or in the *wiliwili* grove of Kaupe‘a on Oahu. If his soul came to Leilono [in Hālawa, ‘Ewa near Red Hill], there it would find the breadfruit tree of Leiwalo, *ka‘ulu o Leiwalo*. If it was not found by an *‘aumakua* soul who knew it (*i ma‘a mau iaia*), or one who would help it, the soul would leap upon the decayed branch of the breadfruit tree and fall down into endless night, the *po pau ‘ole o Milu*. Or, a soul that had no rightful place in the *‘aumakua* realm, or who had no relative or friend

> (*makamaka*) there who would watch out for it and welcome it, would slip over the flat lands like a wind, until it came to a leaping place of souls, *a leina a ka ‘uhane*.
>
> On the plain of Kaupe‘a beside Pu‘uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by *‘aumakua* souls, and be helped to escape. [Kamakau 1991a:47, 49]

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

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

> [*Ka Nupepa Kuokoa*, Volume VII, Number 23, 6 June 1868, He Mele Kanikau no Walia Kahaha na ka moi o Oahu; Fornander 1919c:6[2]:297]

Fornander provides some notes on this lament. The god dwelling at Kapolei is the god Kahahana, stating that this is where his soul has gone. Kamao is one of the names to the door of the underworld. This lament draws an association with wandering souls and the place where the first breadfruit tree was planted by Kaha‘i at Pu‘uloa (Fornander 1919c:6[2]304).

Pukui (1983) offers this Hawaiian saying, which places the wandering souls in a *wiliwili* (*Erythrina sandwicensis*) grove at Kaupe‘a.

> *Ka wiliwili o Kaupe‘a.*
>
> The *wiliwili* grove of Kaupe‘a
>
> In ‘Ewa, O‘ahu said to be where homeless ghosts wander among the trees.
>
> [Pukui 1983:180]

Pukui also shared her personal experience with the wandering spirits on the plain of Kaupe‘a.

> A wide plain lies back of Keahi and Pu‘uloa where the homeless, friendless ghosts were said to wander about. These were the ghosts of people who were not found by their family *‘aumakua* or gods and taken home with them, or had not found the leaping places where they could leap into the nether world. Here [on the plain of Honouliuli] they wandered, living on the moths and spiders they caught. They were often very hungry for it was not easy to find moths or to catch them when found.

> Perhaps I would never have been told of the plain of homeless ghosts if my cousin’s dog had not fainted there one day. My cousin, my aunt and I were walking to Kalaeloa, Barber’s Point, from Pu‘uloa accompanied by Teto, the dog. She was a native dog, not the so-called poi dog of today, with upright ears and body the size of a fox terrier. For no accountable reason, Teto fell into a faint and lay still. My aunt exclaimed and sent me to fetch sea water at once which she sprinkled over the dog saying, ‘*Mai hana ino wale ‘oukou i ka holoholona a ke kaikamahine. U oki ko ‘oukou makemake ‘ilio*.’ ‘Do not harm the girl’s dog. Stop your desire to have it.’ Then with a prayer to her ‘*aumakua* for help she rubbed the dog. It revived quickly and, after being carried a short way, was as frisky and lively as ever.
>
> Then it was that my aunt told me of the homeless ghosts and declared that some of them must have wanted Teto that day because she was a real native dog, the kind that were roasted and eaten long before foreigners ever came to our shores. [Pukui 1943:60–61]

Beckwith (1970:154) has stressed that “the worst fate that could befall a soul was to be abandoned by its ‘aumakua (ancestral spirit) and left to stray, a wandering spirit (kuewa) in some barren and desolate place.” These wandering spirits were often malicious, so the places where they wandered were avoided.

3.2.2.2 The Plains of Pukaua

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

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

> side of the road and see them standing on the plain. [*Ka Loea Kālai‘āina*, 13 January 1900, translation in Sterling and Summers 1978:39]

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

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

Kuu kane i ke awa lau o Puuloa	My man on the many harbored sea of Pu‘uloa
Mai ke kula o Peekaua ke noho	As seen from the plain of Pe‘ekāua
E noho kaua i ke kaha o ka ohai	Let us dwell upon the *‘ōhai* covered shore
I ka wiliwili i ka pua o ka lau noni	Where the *noni* blossoms are twisted together
O ka ihona i Kanehili la	Descending along Kānehili
Ua hili hoi au-e	I am winding along.

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

3.2.2.3 The Inland Plain of Keahumoa

In several legends of ‘Ewa, mention is made of the “plain of Keahumoa.” John Papa ‘Ī‘ī (1959:96) has this plain opposite the trail to Pōhakea Pass, stretching across the *ahupua‘a* of Honouliuli and Hō‘ae‘ae. McAllister (1933:107) states that the plain was west of Kīpapa Gulch in Waikele. It is also mentioned in legends of Waipi‘o. Thus, this is probably a general name for the flat plain *mauka* of the productive floodplain area directly adjacent to Pearl Harbor. This plain would have been east of the present corridor alignment.

3.2.2.3.1 Legend of Nāmakaokapao‘o

Nāmakaokapao‘o was a Hawaiian hero of legendary strength. Nāmakaokapao‘o’s mother was Pokai and his father was Kaulukahai, a great chief of Kahiki, the ancestral home of the Hawaiians. The two met in Hō‘ae‘ae and conceived their child there. The father returned to his home in Kahiki before the birth of his son, leaving his O‘ahu family destitute. A man named Puali‘i saw Pokai and married her. The couple then resided on the plains of Keahumoa, planting sweet potatoes. Nāmakaokapao‘o was a small, brave child who took a dislike to his stepfather, and pulled up the sweet potatoes Puali‘i had planted at their home in Keahumoa. When Puali‘i came after Nāmakaokapao‘o with an axe, Nāmakaokapao‘o delivered a death prayer against him, and slew Puali‘i, hurling his head into a cave in Waipouli, near the beach at Honouliuli (Fornander 1919d:5[2]:274–276).

3.2.2.3.2 Legend of Pikoi

Pikoi was a legendary hero, the son of a crow (*‘alalā*) and brother to five god-sisters in the form of rats. He was famous for his ability to shoot arrows, and often made bets that he could hit rats from a long distance (Fornander 1917a:4[3]:450–463). Pikoi’s skill was commemorated in a saying (Pukui 1983:200):

Ku aku la i ka pana a	Shot by the arrow of Pikoi-[son]
Pikoi-a-ka-‘alalā, keiki pana	of-the-crow, the expert rat-shooter
‘iole o ke kula o Keahumoa.	Of the plain of Keahumoa.

3.2.2.3.3 The Demi-god Māui

In the stories of the demi-god Māui, Keahumoa is the home of Māui‘s grandfather, Kūolokele (Kū-honeycreeper). One day, Māui’s wife, Kumulama, was stolen by the chief Pe‘ape‘amakawalu, called the eight-eyed-bat, who is identified in the creation chant, *Kumulipo*, as the octopus god (Beckwith 1951:136). The chief disappeared with Kumulama in the sky beyond the sea, and escaped so quickly that Māui could not catch him. To recover his wife, Māui’s mother advised him to visit the hut of his grandfather at Keahumoa:

> Maui went as directed until he arrived at the hut; he peeped in but there was no one inside. He looked at the potato field on the other side of Poha-kea, toward Hono-uli-uli, but could see no one. He then ascended a hill, and while he stood there looking, he saw a man coming toward Waipahu with a load of potato leaves, one pack of which, it is said, would cover the whole land of Keahumoa. [Thrum 1923:253–254]

Kūolokele made a *moku-manu* (“bird-ship”) for Māui, who entered the body of the bird and flew to Moanaliha, the land of the chief Pe‘ape‘amakawalu. This chief claimed the bird as his own when it landed on a sacred box, and took it with him into the house he shared with Māui’s wife. When Peapeamakawalu fell asleep, Māui killed him, cut off his head, and flew away back to O‘ahu with his wife and the chief’s head (Thrum 1923:252–259).

3.2.3 Paupauwela and Līhu‘e

Paupauwela, also spelled Popouwela (derivation unknown), is the name of the land area in the extreme *mauka* section of Honouliuli Ahupua‘a. The land area of Līhu‘e is just *makai* of this land, and extends into the *ahupua‘a* of Waipi‘o (adjacent to the eastern border of Honouliuli). Both place names are mentioned in a chant recorded by Abraham Fornander, which was composed as a *mele* for the O‘ahu king, Kūali‘i, as he was preparing to battle Kuiaia, the chief of Wai‘anae:

*Ihea, ihea la ke kahua,*Where?	Where is the battle field
Paio ai o ke koa-a?	Where the warrior is to fight?
I kai i kahua i Kalena,	On the field of Kalena,
I Manini, i Hanini	At Manini, at Hanini,
I ninia i ka wai akua,	Where was poured the water of the god
I ko hana i Malamanui	By your work at Malamanui;
Ka luna o Kapapa, i Paupauwela,	On the heights of Kapapa, at Paupauwela,

I ka hilinai i ke kalele,	Where they lean and rest;
Ka hala o Halahalanui maauea,	At the hala trees of indolent Halahalanui,
E kula ohia ke Pule-e,	At the ohia grove of Pule-e
Ke ‘kua o Lono o Makalii	The god of Lono, of Makalii
Ka lala aalao Ukulonoku,	The fragrant branch of the Ukulonoku,
No Kona paha, no Lihue.	Mayhap from Kona, from Lihue,
No ka la i Maunauna,	For the day at Maunauna
No ka wai i Paupauwela.	For the water at Paupauwela.
Ula ka wai i Paupauwela,	Red is the water of Paupauwela,
Ke kilau o Malamani	,From the slain at Malamani,
Ka moo kilau I Kapapa.	The slain on the ridge at Kapapa.
[Fornander 1917b:4[2]:384–386]	

3.2.4 Maunauna

The hill Maunauna lies between the lands Paupauwela and Līhu‘e. One translation of Maunauna is “mountain sent [on errands].” Two servant *mo‘o* who lived here had no keepers to supply their needs” (Pukui et al. 1974:149). It was at Maunauna, according to one tradition, that the forces of the chiefs Kūali‘i and Kuiaia of Wai‘anae met to do battle, which was averted when a *mele* honoring the god Kū was chanted (see Section 3.5.1). (Fornander 1917b:4[2]:348). In the Legend of Ke-ao-melemele, a woman named Paliuli traveled in this area.

> In a very short time she [Paliuli] walked over the plain of Ewa; Ewa that is known as the land of the silent fish (pearl oysters) […] She went on to the plain of Punalu‘u and turned to gaze at Maunauna point and the plain of Lihue. [Manu 1885, translation in Sterling and Summers 1978:21]

Certain place names in the uplands, including Maunauna, are also mentioned in the story of Lolale’s Lament. The place of Lolale’s residence is given in King Kalākaua’s version of this story (Kalākaua 1990:232): “There lived there at that time in Lihue, in the district of Ewa, on the island of O‘ahu, a chief named Lo-Lale, son of Kalona-iki, and brother of Piliwale, the *alii-nui*, or nominal sovereign, of the island, whose court was established at Waialua.”

In this story, Lolale was a chief of O‘ahu who asked his friend Kalamakua to find him a bride (Kalākaua 1990:228–246; Skinner 1971:217–219). Kalamakua traveled to Maui and chose Kelea, the chief’s sister, and returned with her to O‘ahu; during this time the two grew close. Kelea lived with Lolale for a while, but he was a silent type who was often away from home playing sports and walking in the woodlands. Longing for Kalamakua, Kelea decided to leave her husband, Lolale voiced no “spoken bitterness;” however, after she left, he sang this lament:

> Farewell, my partner of the lowland plains,
>
> On the waters of Pohakeo,
>
> Above Kanehoa,
>
> On the dark mountain spur of Mauna-una!
>
> O, Lihue, she is gone!

Sniff the sweet scent of the grass,

The sweet scent of the wild vines

That are twisted by Waikoloa,

By the winds of Waiopua,

My flower!

As if a mote were in my eye.

The pupil of my eye is troubled;

Dimness covers my eyes. Woe is me!

[Kalākaua 1990:228–246]

3.2.5 Kūalaka‘i

Kūalaka‘i is the name of an area near Barbers Point, located on the southwestern side of Honouliuli Ahupua‘a. Clark (1977:74) says it is named for a type of sea cucumber that squirts a purple fluid when squeezed. Pukui identifies the sea creature as *Tethys* a member of the invertebrate family *Aplysiidae* commonly called sea hares (Pukui et al. 1974:119). Pukui adds this area was once the site of a spring called Hoaka-lei (“lei reflection”) “because Hi‘iaka picked *lehua* flowers here to make a *lei* (garland) and saw her reflection in the water” (Pukui et al. 1974:119).

3.2.6 Kalaeloa

Kalaeloa literally means “the long point” (Pukui et al. 1974:72). Kalaeloa Point was the home of Uhu Makaikai, a *kupua* who could take the form of a man or a giant parrotfish (*uhu).* He is mentioned in several legends concerning the hero Kawelo and with Kawelo’s struggles with the ruling chief of Kaua‘i, ‘Aikanaka.

> This friend was Kauahoa also an alii of Wailua (Kauai). Their king, Aikanaka, in the time of Kakuhihewa of Oahu and Lonoikamakahiki of Hawaii. Aikanaka got offended with Kawelo and sent him to live at Waikiki. Cause. The king at a surf bathing told Kawelo to get a calabash of water for him to wash off with, but on Kawelo’s failing to do it, he took a calabash of soft poi and threw it over Kawelo and sent him off as already stated. At Waikiki, Kawelo studied the art of fighting to be revenged on Aikanaka. A kupua, Uhu makaikai, a fish was his teacher. Makuakeke was his helper in the canoe. The fish lived at Pohaku o Kawai near Kalailoa (Kalaeloa), Oahu (Barber’s Point) . . . [Hawaiian Ethnological Notes, Bishop Museum Vol. II:114, translation in Sterling and Summers 1978:41]

3.2.7 *Ala Hele* (Trails)

John Papa ‘Ī‘ī describes a network of Leeward O‘ahu trails (Figure 6 through Figure 8) which in later historic times encircled and crossed the Wai‘anae Range, allowing passage from West Loch to the Honouliuli lowlands, past Pu‘uokapolei and Waimānalo Gulch to the Wai‘anae coast and onward circumscribing the shoreline of O‘ahu (‘Ī‘ī 1959:96–98). The main trail along the south shore of O‘ahu would have been approximately 1.5 km to the southeast. A main trail extending up the central valley of O‘ahu would have been approximately 3 km to the east. The

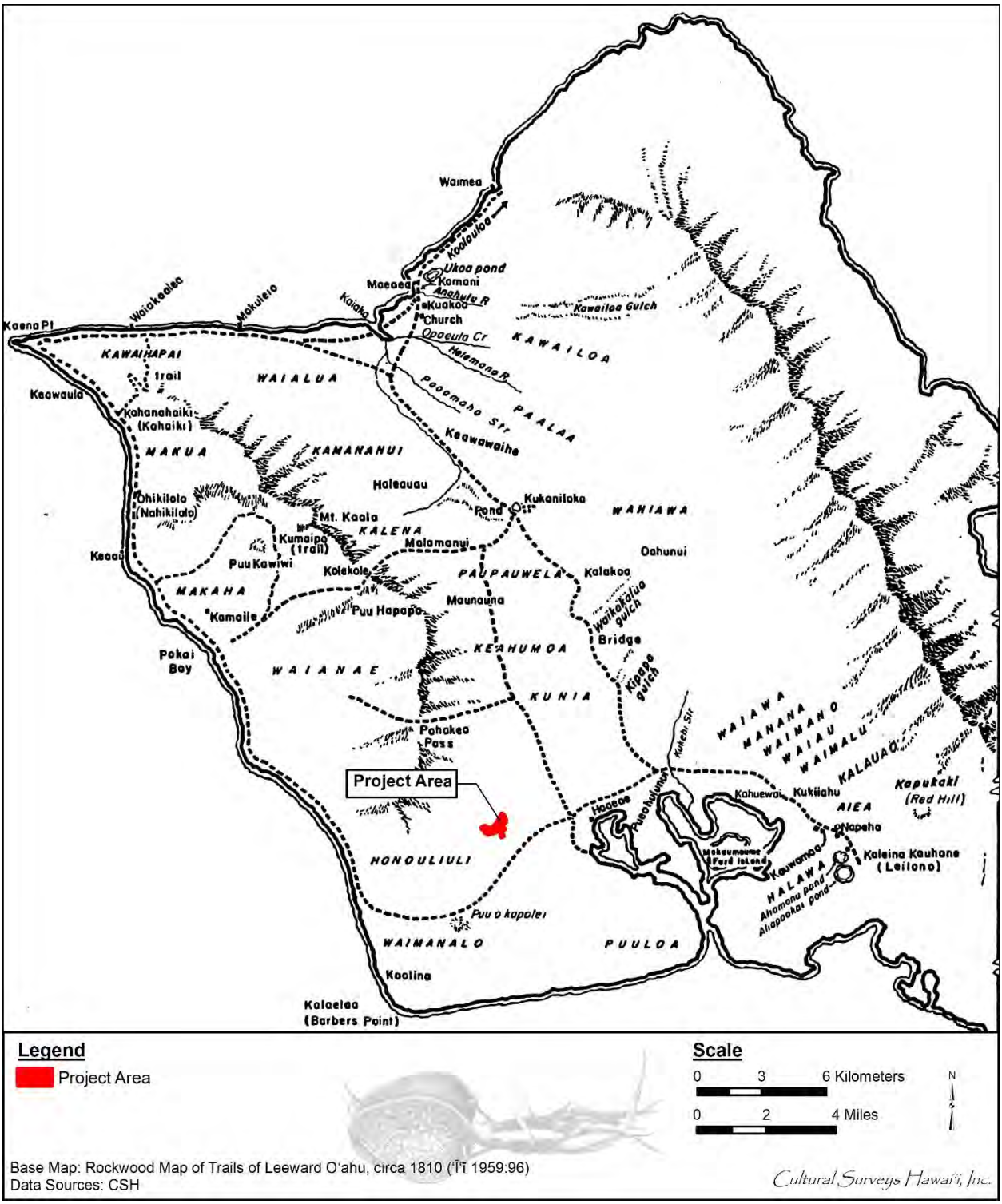

Figure 6. Portion of the 1810 Rockwood map of trails of Leeward O‘ahu with overlay of project area (Ī‘ī 1959:96)

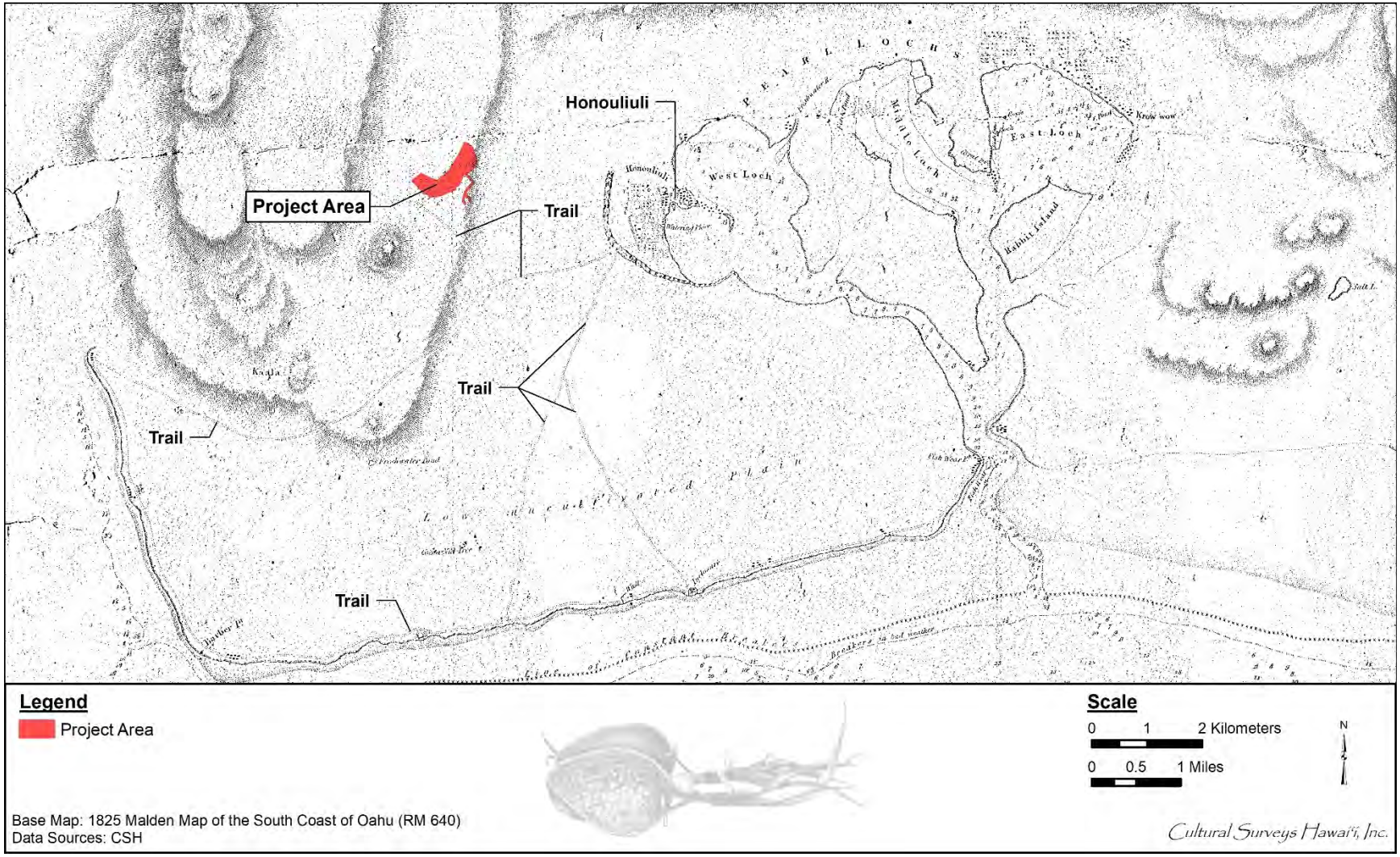

Figure 7. Portion of 1825 Malden map of the South Coast of Oahu showing the location of the project area (note: a trail into the southern Wai‘anae Mountain Range is shown as passing just south of the project area)

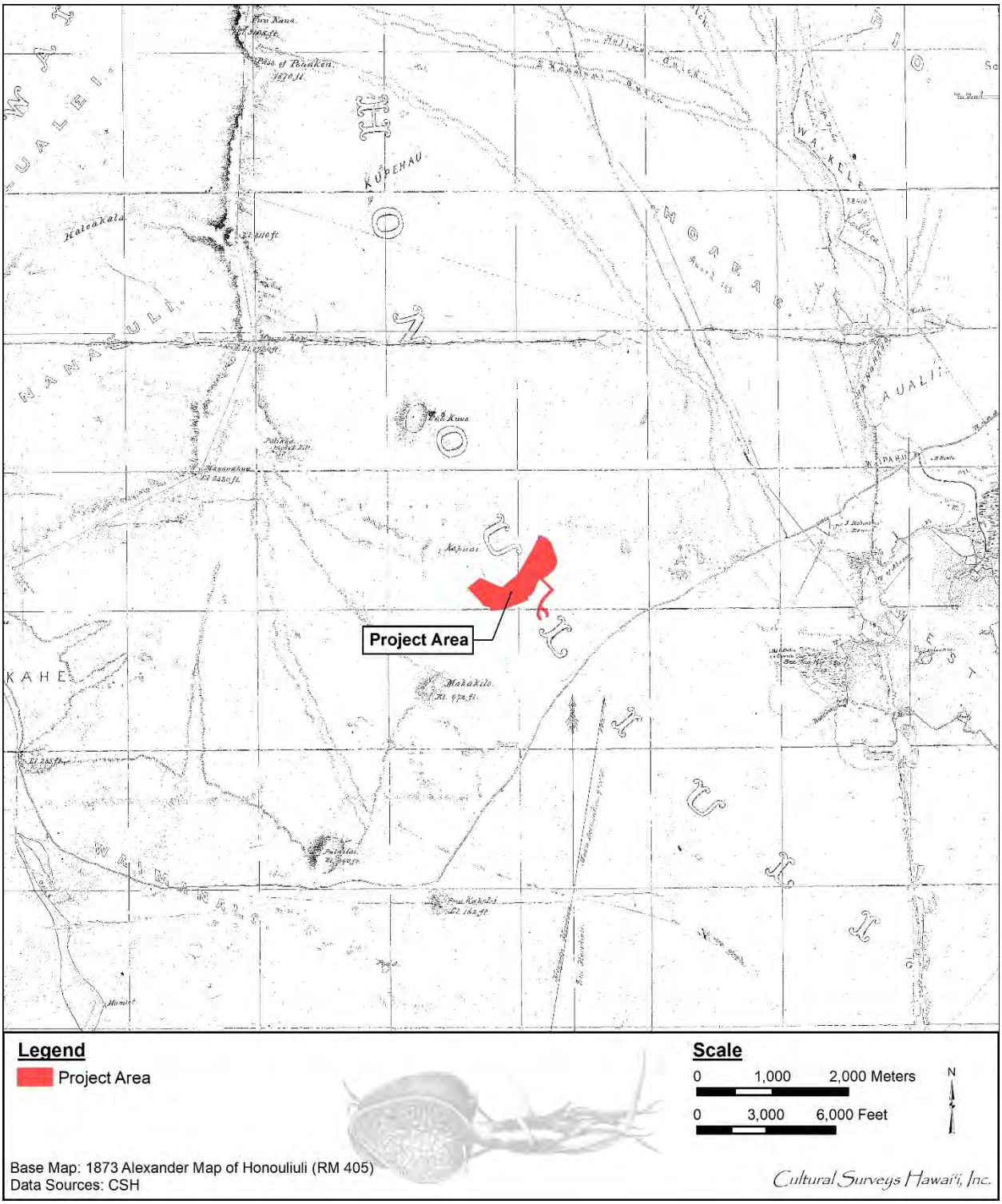

Figure 8. Portion of 1873 Alexander map of Honouliuli showing trail network in vicinity of project area

1825 Malden map (see Figure 7) shows a trail extending from the main trail along the south shore of O‘ahu into the uplands in the Pālehua area as passing just a couple hundred meters to the southwest of the project area. The 1873 Alexander map (see Figure 8), one of the earliest detailed maps of the vicinity, shows no development near the project area.

3.2.7.1 Pōhākea Pass

Pōhākea Pass, on the Wai‘anae Mountain Range, has an elevation of 671 m (2,200 ft) amsl. Pōhākea literally translates to “white stone” (Pukui et al. 1974:185). Pōhākea serves as a passage between *ahupua‘a* of Honouliuli and Lualualei. This is also the location where Hi‘iaka saw cloud omens that her *lehua* (flower of the *‘ōhia* tree [*Metrosideros polymorpha*]) groves had been burned by her sister Pele, and her friend Hōpoe had been turned into stone.

In *The Epic Tale of Hi‘iakaikapoliopele*, Hi‘iaka watches as her beloved friend Hōpoe is killed by the embers of her sister Pele. She chants atop Pōhākea and tells of the winds of Waikōloa and Wai‘ōpua:

KAU HO‘OKAHI HANERI A	CHANT ONE HUNDRED
ME KANALIMAKUMAMĀKOLU	AND FIFTY-THREE
Aloha ku‘u hoa i ka pū‘ali lā	Alas my friend of the rugged mountain pass
A luna i Pōhākea, he luna o Kamaoha	On high at Pōhākea, above Kamaoha
He lae ‘ino ‘o Maunauna	Maunauna is a dangerous escarpment
‘O Līhu‘e ke hele ‘ia	Lihu‘e’s high plain yet to be traversed
Honi i ke ‘ala mau‘u	Inhaling the scent of the grasses
I ke ‘ala o ke kupukupu	The fragrance of kupukupu fern
E linoa ala e ka Waikōloa	Entwined by the Waikoloa breeze
E ka makani he Wai‘ōpua	By the wind called Wai‘ōpua
Ku‘u pua, me he pua lā i ku‘u maka	My blossom, like a flower in my sight
Ka ‘oni i ka haku ‘ōnohi, kā ka wai lā i li‘u	Moving before my eyes, washed salty by tears
I ku‘u maka lā, e uē au lā.	There in my sight, I weep.

[Ho‘oulumahiehie 2008a:262; Ho‘oulumahiehie 2008b:262]

3.3 *‘Ōlelo No‘eau*

Hawaiian knowledge was shared by way of oral histories. Indeed, one’s *leo* (voice) is oftentimes presented as *ho‘okupu* (“a tribute or gift” given to convey appreciation, to strengthen bonds, and to show honor and respect); the high valuation of the spoken word underscores the importance of the oral tradition (in this case, Hawaiian sayings or expressions), and its ability to impart traditional Hawaiian “aesthetic, historic, and educational values” (Pukui 1983:vii). Thus, in many ways these expressions may be understood as inspiring growth within reader or between speaker and listener:

> They reveal with each new reading ever deeper layers of meaning, giving understanding not only of Hawai‘i and its people but of all humanity. Since the sayings carry the immediacy of the spoken word, considered to be the highest form of cultural expression in old Hawai‘i, they bring us closer to the everyday thoughts and lives of the Hawaiians who created them. Taken together, the sayings offer a basis for an understanding of the essence and origins of traditional Hawaiian values. The sayings may be categorized, in Western terms, as proverbs, aphorisms, didactic adages, jokes, riddles, epithets, lines from chants, etc., and they present a variety of literary techniques such as metaphor, analogy, allegory, personification, irony, pun, and repetition. It is worth noting, however, that the sayings were spoken, and that their meanings and purposes should not be assessed by the Western concepts of literary types and techniques. [Pukui 1983:vii]

Simply, *‘ōlelo no‘eau* may be understood as proverbs. The Webster dictionary notes it as “a phrase which is often repeated; especially, a sentence which briefly and forcibly expresses some practical truth, or the result of experience and observation.” It is a pithy or short form of folk wisdom. Pukui equates proverbs as a treasury of Hawaiian expressions (Pukui 1995:xii). Oftentimes within these Hawaiian expressions or proverbs are references to places. This section draws from the collection of author and historian Mary Kawena Pukui and her knowledge of Hawaiian proverbs describing *‘āina* (land), chiefs, plants, and places.

3.3.1 Concerning Sharks

The eastern coast of Honouliuli lies adjacent to Pu‘uloa which has many *mo‘olelo* about sharks, particularly Ka‘ahupāhau, the queen shark of O‘ahu and the most famous guardian shark who lived in Pu‘uloa. Thus, Honouliuli is closely associated with shark *‘aumakua* and *mo‘olelo* which say the people of ‘Ewa were protected by sharks. The following *‘ōlelo no‘eau* are associated with sharks.

3.3.1.1 ‘Ōlelo No‘eau #105

> *Alahula Pu‘uloa, he alahele na Ka‘ahupāhau.*
>
> Everywhere in Pu‘uloa is the trail of Ka‘ahupāhau.
>
> Said of a person who goes everywhere, looking, peering, seeing all, or of a person familiar with every nook and corner of a place. Ka‘ahupāhau is the shark goddess of Pu‘uloa (Pearl Harbor) who guarded the people from being molested by sharks. She moved about, constantly watching. [Pukui 1983:14]

3.3.1.2 ‘Ōlelo No‘eau #1014

> *Ho‘ahewa na niuhi ia Ka‘ahupāhau*
>
> The man-eating sharks blamed Ka‘ahupāhau
>
> Evil-doers blame the person who safeguards the rights of others. Ka‘ahupāhau was the guardian shark goddess of Pu‘uloa (Pearl Harbor) who drove out or destroyed all the man-eating sharks. [Pukui 1983:108]

3.3.1.3 ‘Ōlelo No‘eau #2152

Mehameha wale no o Pu‘uloa, i ka hele a Ka‘ahupāhau

Pu‘uloa became lonely when Ka‘ahupāhau went away

The home is lonely when a loved one has gone. Ka‘ahupāhau, guardian shark of Pu‘uloa (Pearl Harbor), was dearly loved by the people. [Pukui 1983:234]

3.3.1.4 ‘Ōlelo No‘eau #2111

Make o Mikololou a ola i ke alelo

Mikololou died and came to life again through his tongue

Said of one who talks himself out of a predicament. [Pukui 1983:229–230]

3.3.2 Concerning the *Pipi* or Pearl Oyster of Pu‘uloa

Pearl Harbor or Pu‘uloa, derived from the name Waimomi, or “water of the pearl,” an alternate name for the Pearl River. The harbor was thus named after pearl oysters of the family Pteriidae (mainly *Pinctada radiata*), which were once abundant on the harbor reefs and after which many *‘ōlelo no‘eau* were generated.

3.3.2.1 ‘Ōlelo No‘eau #1331

Ka i‘a hāmau leo o ‘Ewa

The fish of ‘Ewa that silences the voice

The pearl oyster, which has to be gathered in silence. [Pukui 1983:145]

Handy and Handy (1972:471) offer a different interpretation: “The pipi was sometimes called ‘the silent fish,’ or, *‘i‘a hamau leo o ‘Ewa,’* ‘Ewa’s silent sea creature since the collectors were supposed to stay quiet while harvesting the shells.”

3.3.2.2 ‘Ōlelo No‘eau #493

Haunāele ‘Ewa i ka Moa‘e

‘Ewa is disturbed by the Moa‘e wind

Used about something disturbing, like a violent argument. When the people of ‘Ewa went to gather the *pipi* (pearl oyster), they did so in silence, for if they spoke, a Moa‘e breeze would suddenly blow across the water, rippling it, and the oysters would disappear. [Pukui 1983:59]

3.3.2.3 ‘Ōlelo No‘eau #274

E hāmau o makani mai auane‘i

Hush, lest the wind rise

Hold your silence or trouble will come to us. When the people went to gather pearl oysters at Pu‘uloa, they did so in silence, for they believed that if they spoke, a gust of wind would ripple the water and the oysters would vanish. [Pukui 1983:34]

3.3.2.4 ‘Ōlelo No‘eau #1357

Ka i‘a kuhi lima o ‘Ewa

The gesturing fish of ‘Ewa

The pipi, or pearl oyster. Fishermen did not speak when fishing for them but gestured to each other like deaf-mutes. [Pukui 1983:148]

3.3.3 Concerning the *‘Anae-holo* of Honouliuli

The migration of the *‘anae-holo* of Honouliuli is described in the following excerpt from which the *‘ōlelo no‘eau* below derives:

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

3.3.3.1 ‘Ōlelo No‘eau #1330

Ka i‘a hali a ka makani

The fish fetched by the wind

The ‘anaeholo, a fish that travels from Honouliuli, where it breeds, to Kaipāpa‘u, on the windward side of O‘ahu. It then turns about and returns to its original home. It is driven closer to shore when the wind is strong. [Pukui 1983:145]

3.3.4 Concerning *Kalo*

A rare taro called the *“kāī o ‘Ewa,”* was grown in mounds in marshy locations in ‘Ewa (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the following saying:

3.3.4.1 ‘Ōlelo No‘eau #2770

Ua ‘ai i ke kāī-koi o ‘Ewa

He has eaten the kāī-koi taro of ‘Ewa

Kāī is O‘ahu’s best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of ‘Ewa, who, like the kāī taro, is not easily forgotten. [Pukui 1983:305]

3.3.5 Concerning the *Ao Kuewa,* Realm of the Homeless Souls

3.3.5.1 ‘Ōlelo No‘eau #1666

Ka wiliwili o Kaupe‘a

The wiliwili grove of Kaupe‘a

In ‘Ewa, O‘ahu. Said to be where homeless ghosts wander among the trees. [Pukui 1983:180]

Pukui (1983:180) offers this Hawaiian saying, which places the wandering souls in a "*wiliwili*" grove at Kaupe‘a, a place in Honouliuli where homeless ghosts wandered among the trees.

3.3.6 Concerning the landscape of ‘Ewa

3.3.6.1 ‘Ōlelo No‘eau #80

The following proverb describes the red landscape of the ‘Ewa plain.

> *‘Āina koi ‘ula i ka lepo.*
>
> Land reddened by the rising dust.
>
> Said of ‘Ewa, O‘ahu. [Pukui 1983:11]

3.3.6.2 ‘Ōlelo No‘eau #2542

The expression below describes the residents of Kaupe‘a ‘Ili.

> *‘Ō‘ū ō loa na manu o Kaupe‘a.*
>
> The birds of Kaupe‘a trill and warble.
>
> Said of the chatter of happy people. [Pukui 1983:278]

3.3.6.3 ‘Ōlelo No‘eau #1855

The expression below discusses the boundaries between *ali‘i* and *maka‘āinana* lands in ‘Ewa.

> *Ku a‘e ‘Ewa; Noho iho ‘Ewa.*
>
> Stand-up ‘Ewa; Sit-down ‘Ewa.
>
> The names of two stones, now destroyed, that once marked the boundary between the chiefs' land (Kua‘e ‘Ewa) and that of the commoners (Noho iho ‘Ewa) in ‘Ewa, O‘ahu. [Pukui 1983:200]

3.4 *Oli* (Chants)

Oli, according to Mary Kawena Pukui (Pukui 1995:xvi–xvii) are often grouped according to content. Chants often were imbued with *mana* (divine power); such *mana* was made manifest through the use of themes and *kaona*. According to Pukui, chants for the gods (*pule*; prayers) came first, and chants for the *ali‘i*, "the descendants of the gods," came second in significance. Chants "concerning the activities of the earth peopled by common humans," were last in this hierarchy (Pukui 1995:xvi–xvii). Emerson conversely states:

> In its most familiar form the Hawaiians–many of whom [were lyrical masters]–used the oli not only for the songful expression of joy and affection, but as the vehicle of humorous or sarcastic narrative in the entertainment of their comrades. The dividing line, then, between the oli and those other weightier forms of the mele, the inoa, the kanikau (threnody), the pule, and that unnamed variety of mele in which the poet dealt with historic or mythologic subjects, is to be found almost wholly in the mood of the singer. [Emerson 1965:254]

While *oli* may vary thematically, subject to the perspective of the *ho‘opa‘a* (chanter), it was undoubtedly a valued art form used to preserve oral histories, genealogies, and traditions, to recall

special places and events, and to offer prayers to *akua* and *‘aumākua* alike. Perhaps most importantly, as Alameida (1993:26) writes, “chants […] created a mystic beauty […] confirming the special feeling for the environment among Hawaiians: their *one hānau* (birthplace), their *kula iwi* (land of their ancestors).”

3.4.1 *Oli* for Kūali‘i

A chant for the chief Kūali‘i, an ancient chief of O‘ahu, mentions the *ahupua‘a* names of the ‘Ewa District including Honouliuli Ahupua‘a. Each phrase usually contains a play on words, as the place name and one meaning of the word, or portion of the word, appears on each line, for example, *kele* in Waikele means “slippery.” However, these word plays are not necessarily related to the actual place name meanings of the *ahupua‘a*.

Uliuli ka poi e piha nei—o Honouliuli;	Blue is the *poi* [pounded taro] which appeases [the hunger] of Honouliuli;
Aeae ka paakai o Kahuaiki—Hoaeae;	Fine the salt of Kahuaike—Hoaeae;
Pikele ka ia e waikele—o Waikele;	Slippery the fish of Waikele— of Waikele;
Ka hale pio i Kauamoa—o Waipio;	The arched house at Kauamoa— of Waipio;
E kuu kaua i ka loko awa—o Waiawa;	Let us cast the net in the *awa*-pond— of Waiawa;
Mai hoomanana ia oe—o Manana.	Do not stretch yourself at—Manana.
He kini kahawai,	Many are the ravines,
He lau kamano—o Waimano;	Numerous the sharks, at Waimano;
Ko ia kaua e ke au—o Waiau;	We are drawn by the current— of Waiau;
Kukui malumalu kaua—Waimalu;	In the *kukui* grove we are sheltered— in Waimalu;
E ala kaua ua ao-e—o Kalauao;	Let us arise, it is daylight— at Kalauao;
E kipi kaua e ai—o Aiea,	Let us enter and dine—at Aiea;
Mai hoohalawa ia oe—o Halawa.	Do not pass by—Halawa.

[*Ka Nupepa Kuokoa*, Book 7, Number 21, 23 May 1868, He mele no Kualii, Kulanipipili, Kulanioka, Kunuiakea; Fornander 1917b:4[2]:400–401]

A chant for the Kaua‘i chief of Kaumuali‘i, a rival of Kamehameha I, also mentions place names of the ‘Ewa District. In a portion of this chant, the wind that blows from one end of ‘Ewa to the other is compared to love.

3.4.2 Hi‘iaka and the Plains of Keahumoa

While passing through ‘Ewa, Hi‘iaka, sister of the goddess Pele, met women stringing *lei* with *ma‘o* flowers. Desiring a *lei* of her own, Hi‘iaka offered a chant:

E lei ana ke kula o Keehumoa i ka ma‘o	The plains of Ke‘ehumoa are garlanded with ma‘o
Ohuohu wale na wahine kui lei o ka nahele	The lei-stringing women of the forest are festively adorned

[Ho‘oumāhiehiemalie 2008a:287; 2008b:268]

In the chant, Hi‘iaka mentions the plains of Ke‘ehumoa which according to McAllister (1933:107) are located west of Kīpapa Gulch in Waikele. Ke‘ehumoa was also possibly a general name for the flat plain *mauka* of the productive floodplain area directly adjacent to Pearl Harbor.

3.4.3 Hi‘iaka and the Plains of Kaupe‘a

Hi‘iaka sang this bitter chant addressed to Lohi‘au and Wahine‘ōma‘o, which uses the association of the Plains of Kaupe‘a as a place for the wandering of lost souls:

Ku‘u aikana i ke awa lau o Pu‘uloa,
Mai ke kula o Pe‘e-kaua, ke noho oe,
E noho kaua e kui, e lei i ka pua o ke kauno‘a,
I ka pua o ke akuli-kuli, o ka wili-wili;
O ka iho‘na o Kau-pe‘e i Kane-hili,
Ua hili au; akahi no ka hili o ka la pomaika‘i;
E Lohiau ipo, e Wahine-oma‘o,
Hoe ‘a mai ka wa‘a i a‘e aku au.

We meet at Ewa’s leaf-shaped lagoon, friends;
Let us sit, if you will on this lea
And bedeck us with wreaths of Kauno‘a,
Of *akuli-kuli* and *wili-wili*,
My soul went astray in this solitude;
It lost the track for once, in spite of luck,
As I came down the road to Kau-pe‘a.
No nightmare dream was that which tricked my soul.
This way, dear friends; turn the canoe this way;
Paddle hither and let me embark.
[Emerson 1915:167–168]

Several other Honouliuli places are mentioned in this chant, including Pe‘ekaua, which may be a variation of Ka-pe‘e or Kaupe‘a, and the plains of Kānehili, the last of which again refers to wandering, as the word *hili* means “to go astray” (Emerson 1993:162). In the chant, Hi‘iaka is moving downhill from Kaupe‘a, probably the plains adjacent to Pu‘uokapolei, toward the coast, the plain of Kānehili.

3.4.1 Ka‘ao no Halemano

In the Legend of Halemano, the romantic O‘ahu anti-hero, he chants a love song with a reference to Honouliuli:

> *Huli a‘e la Ka‘ala kau i luna, Waiho wale kai o Pōka‘ī, Nānā wale ke aloha i Honouliuli, Kokolo kēhau he makani no Līhu‘e* […]
>
> Search is made to the top of Ka‘ala, the lower end of Pōka‘ī is plainly seen. Love looks in from Honouliuli, The dew comes creeping, it is like the wind of Līhu‘e […] [Fornander 1919e:5(2):252]

3.5 *Mele* (Songs)

The following section draws from the Hawaiian art of *mele*, poetic song intended to create two styles of meaning.

> Words and word combinations were studied to see whether they were auspicious or not. There were always two things to consider the literal meaning and the *kaona*, or ‘inner meaning.’ The inner meaning was sometimes so veiled that only the people to whom the chant belonged understood it, and sometimes so obvious that anyone who knew the figurative speech of old Hawai‘i could see it very plainly. There are but two meanings: the literal and the *kaona*, or inner meaning. The literal is like the body and the inner meaning is like the spirit of the poem. [Pukui 1949:247]
>
> The Hawaiians were lovers of poetry and keen observers of nature. Every phase of nature was noted and expressions of this love and observation woven into poems of praise, of satire, of resentment, of love and of celebration for any occasion that might arise. The ancient poets carefully selected men worthy of carrying on their art. These young men were taught the old *meles* and the technique of fashioning new ones. [Pukui 1949:247]

There exist a few *mele* that concern or mention Honouliuli. These particular *mele* may also be classified as *mele wahi pana* (songs for legendary or historic places). *Mele wahi pana* such as those presented here may or may not be accompanied by *hula* or *hula wahi pana* (dance for legendary or historic places). As the Hula Preservation Society notes,

> *Hula Wahi Pana* comprise a large class of dances that honor places of such emotional, spiritual, historical, or cultural significance that chants were composed for them. Only the composers of the chants could know the deepest meanings, as they would be reflections of their feelings and experiences […] Since the subjects of *Wahi Pana* compositions are extremely varied, their implementation through hula are as well. Coupled with the differences from one *hula* style and tradition to the next, *Hula Wahi Pana* can be exceptionally diverse. They can be done sitting or standing, with limited body movement or wide free movement; with or without the use of implements or instruments; with the dancers themselves chanting and/or playing an implement or being accompanied by the *ho‘opa‘a* [drummer and *hula* chanter (memorizer)]. Beyond the particular *hula* tradition, what ultimately determines the manner in which a *Hula Wahi Pana* is performed are the specific

place involved, why it is significant, the story being shared about it, and its importance in the composer's view. [Hula Preservation Society 2014]

3.5.1 Mele no Kūali‘i

The celebrated chief, Kūali‘i, is said to have led an army of twelve thousand against the chiefs of Ko‘olauloa with an army of twelve hundred upon the plains of Keahumoa (Fornander 1917b:4[2]:364-401) which according to McAllister (1933:107) are located west of Kīpapa Gulch in Waikele. Perhaps because the odds were so skewed, the battle was called off and the *ali‘i* of Ko‘olau ceded the districts of Ko‘olauloa, Ko‘olaupoko, Waialua, and Wai‘anae to Kūali‘i. When the *ali‘i* of Kaua‘i heard of this victory at Honouliuli they gave Kaua‘i to Kūali‘i as well and thus he became possessed of all the islands. The strife at Honouliuli was the occasion of the recitation of a song for Kūali‘i by a certain Kapa‘ahulani. This *mele* compares the king to certain places and objects in the islands, in this instance to the first breadfruit planted by Kaha‘i at Pu‘uloa, and a pig and a woman on Pu‘uokapolei, possibly a reference to Kamapua‘a and his grandmother.

In this *mele*, the cold winds of Kumomoku and Leleiwe, near Pu‘uloa in Honouliuli are compared unfavorably to the god Kū:

Aole i like Ku.	Not like these are thou, Ku
Ia ua hoohali kehau,	[Nor] the rain that brings the land breeze,
Mehe ipu wai ninia la,	Like a vessel of water poured out.
Na hau o Kumomoku;	Nor to the mountain breeze of Kumomoku,
Kekee na hau o Leleiwi,	[The] land breeze coming round to Leleiwi.
Oi ole ka oe i ike	Truly, have you not known?
I ka hau kuapuu,	The mountain breezes, that double up your back,
Kekee noho kee, o Kaimohala,	[That make you] sit crooked and cramped at Kaimohala,
O Kanehili i Kaupea-la	The Kanehili at Kaupea?
Aole i like Ku.	Not like these are thou, Ku

[Fornander 1917b:4[2]:390–391]

A later section of this *mele* also refers to Pu‘uokapolei and makes mention of the famous blue *poi* of Honouliuli.

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

[the hunger] of Honouliuli.

[Fornander 1917b:4[2]:400–401]

3.5.2 Eia Mai Au ‘o Makalapua

This particular *mele* pays homage to the royal train called *Lanakila*. In paying homage to this train, the *mele* also pays homage to its most honored and well-known passenger, Queen Lili‘uokalani. This *mele* may also be understood as a protest song.

In analyzing this *mele*, cultural historian Kīhei de Silva notes that “Eia mai Au ‘o Makalapua” is the second of three chants that make up *hō‘alo i ka ihu o ka Lanakila* (Three Train Chants for Lili‘uokalani). He adds that these songs, “when considered in chronological succession […] add a Hawaiian dimension to the story of Benjamin Franklin (B.F.) Dillingham’s Oahu Railway and Land Company (OR&L), a story that otherwise reads far too much like an early script of *How the West was Won*” (de Silva 2003). De Silva provides a chronology of B.F. Dillingham’s rise to influence within Hawaiian political spheres, and his eventual founding and construction of the OR&L line. Dillingham also figures prominently within Honouliuli Ahupua‘a (see Section 4.3.2). Dillingham’s personal history is described by de Silva as follows:

- Arrived in Honolulu in 1865 as first mate of the *Whistler*.
- He promptly fell off a horse and broke his leg. When his ship left without him, he took a job as a clerk in a hardware store.
- 20 years later, in 1885, he had become Hawai‘i’s first big-time land speculator, buying and leasing vast tracts of property in West O‘ahu in hopes of reselling it to housing and ag. interests.
- When no one, in fact, took interest in his largely inaccessible property, he decided to build a railroad through it.
- In 1888, Dillingham convinced Kalākaua to sign a franchise giving him three years to build a line running from Honolulu to the far end of Pearl River Lagoon. His critics called it ‘Dillingham’s Folly,’ but Dillingham boasted that he would put his railroad into operation by Sept. 4, 1889, his 45th birthday.
- Things did not go well in the early months of construction, and in order to fulfill this boast, Dillingham had to fire up a miniscule saddle-tank engine named *Kauila*, hitch it to a flatcar that carried his passengers on jury-rigged seats, and send it bucking, wheezing, and spewing greasy foam down a mile-and-a-half of track that ended in the rice paddies of Pālama.
- Despite this farcical beginning, the construction of Dillingham’s railroad then proceeded in rather impressive fashion: the line was opened to ‘Aiea in November 1889, to Mānana in January 1890, to Honouliuli and ‘Ewa Mill in June and July 1890, to Wai‘anae in July 1895, to Waialua in June, 1898, and to Kahuku in January 1899. [de Silva 2003]

In 1890, as construction of the railway moved forward, B.F. Dillingham bought and shipped to Hawai‘i a passenger coach named *The Pearl* and a locomotive named *General Valleho.* According to de Silva (2003), the *Pearl* was built in San Francisco and was “paneled in rich woods and

outfitted with plush chairs, velvet drapes, electric lights, a kitchen, a lānai with a striped canvas awning, and a new-fangled contraption called a flush toilet." The *General Valleho* was renamed the *Lanakila* by Dillingham:

> […] [He] gave it the number 45, a tribute to his 45th birthday boast and erstwhile victory in the rice paddies of Pālama. The Lanakila became Dillingham's 4th locomotive—after the Kauila, Leahi, and Ka‘ala—and for many years it was regarded as the most attractive engine in the OR&L stable. Dillingham apparently wasted no time in hitching the Pearl to the Lanakila and using the pair as his wine-‘em and dine-‘em celebrity train, the vehicle in which he wooed financial and political support for his business ventures. [de Silva 2003]

As part of Dillingham's plans to woo the influential, he invited King Kalākaua on the inaugural ride on the *Lanakila*. Dillingham also insisted the luxury coach *Pearl* serve as the king's own royal car. De Silva (2003) notes it is "safe for us to assume that Queen Lili‘u[okalani] rode in the Pearl when the *Lanakila* took her on the train rides." With the opening of the ‘Ewa Mill station, Queen Lili‘uokalani once again embarked on a journey on the *Lanakila*; this particular journey took her through "the lowlands of Honouliuli, and finally to the exposed coral plain of Pōlea on which the ‘Ewa Mill Station was located" (de Silva 2003).

Eia mai au ‘o Makalapua	Here I am, Makalapua
Hō‘alo i ka ihu o ka Lanakila.	Traveling where the *Lanakila* goes.
‘O ke ku‘e a ka hao a i Kūwili	The piston works at Kūwili
Ka hiona ‘olu a‘o Hālawa.	And down the pleasant descent of Hālawa.
Ua lawa ka ‘ikena i ke awalau	Satisfying is the view of the lochs
Iā ‘Ewa ka i‘a hāmau leo.	Of ‘Ewa, "land of the silent fish."
Ua piha ka uahi a i Mānana	The smoke rises at Mānana
Aweawe i ke kula o Waipi‘o.	And streams along at Waipi‘o.
I kai ho‘i au a Honouliuli	Then I reached the lowlands of Honouliuli
Ahuwale ke ko‘a o Pōlea.	Where the corals of Pōlea lie exposed.
Ha‘ina ‘ia mai ana ka puana	This is the conclusion of the song
Hō‘alo i ka ihu a ka Lanakila.	Of traveling where the *Lanakila* goes.

[de Silva 2003]

De Silva (2003) provides a remarkable breakdown of this *mele*, delving into the subtext to reveal another layer of understanding, of *kaona*:

> ‘Makalapua' shares […] the sense of awesome efficiency and harmony […] These are apparent in ‘Makalapua's' description of the working of the train's piston at Kūwili, in the rising and billowing of steam at Mānana and Waipi‘o, and especially in the sense of speed with which the mele whisks us from Honolulu to Pōlea in the space of its six, two-line verses. Efficiency and harmony, however, are not at the heart of ‘Makalapua;' it is inspired and driven, instead, by *aloha ‘āina*—love for

the land—and by *kū‘ē ho‘ohui ‘āina*—resistance to annexation. In my reading of the mele, the dominant imagery is that of flower-stringing. The train and track serve as the contemporary equivalent of lei needle and thread; with them, Lili‘u sews a series of beloved place-names and place-associations into a lei of adornment and protection for Ke-awalau-o-Pu‘uloa. Keawalauopu‘uloa, the many-harbored sea of Pu‘uloa, is the old name for Pearl Harbor. The cession of Pearl Harbor to America in return for sugar reciprocity was one of the hottest political issues of ‘Makalapua’s’ day. Lili‘u was absolutely opposed to any Keawalau deals; her brother, on the other hand, had regularly waved this bait at the American nose; he was even rumored, on his Nov. 1890 departure to San Francisco, to have harbored a hidden Pearl Harbor agenda. The key lines of ‘Makalapua’ are ‘Ua lawa ka ‘ikena i ke awalau / Iā ‘Ewa ka i‘ā hāmau leo […] I kai ho‘i au a Honouliuli / Ahuwale ke ko‘a o Pōlea.’ In my reading, these lines say: ‘We hold to our knowledge of Keawalau, we are like its closed-mouthed pipi, its oysters; we will never give up the pearl that we contain; here at the shoreline of Honouliuli we normally silent fish reveal this deeply held conviction.’ [de Silva 2003]

Section 4 Traditional and Historical Background

4.1 Pre-Contact to Early Post-Contact Period

4.1.1 Traditional Agricultural Resources

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

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko‘olau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower parts of the valley sides were excellent for the cultture of yams and bananas. Farther inland grew the *‘awa* for which the area was famous. [Handy and Handy 1972:429]

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

> *Ua ‘ai i ke kāī-koi o ‘Ewa.*
>
> He has eaten the kāī-koi taro of ‘Ewa.
>
> Kāī is O‘ahu’s best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of ‘Ewa, who, like the kāī taro, is not easily forgotten.
>
> [Pukui 1983:305].

Exploitation of the forest resources along the slopes of the Wai‘anae Range—as suggested by E.S. and E.G. Handy—probably acted as a viable subsistence alternative during times of famine:

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

These upper valley slopes may have also been a significant resource for opportunistic quarrying of basalt for the manufacturing of stone tools. This is evidenced in part by the existence of a probable quarrying site (State Inventory of Historic Places [SIHP] # 50-80-12-4322) in Makaīwa Gulch at 152 m (500 ft) above mean sea level, west of the current project area (Hammatt et al. 1991).

Subsequent to Western Contact in the area, the landscape of the ‘Ewa Plain and Wai‘anae slopes was adversely affected by the removal of the sandalwood and other trees, and the introduction of domesticated animals and new vegetation. Goats, sheep, and cattle were brought to the Hawaiian Islands by Vancouver in the early 1790s and allowed to graze freely about the land for some time after. L.A. Henke reports the existence of a longhorn cattle ranch in Wai‘anae by at least 1840 (Frierson 1972:10). During this time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. The following dates for the introduction of exotic vegetation are given by R. Smith and outlined by Frierson (1972:10–11):

1. ‘early,’ c. 1790: for the establishment of Prickly pear cactus, (*Opuntia tuna), Haole koa, (Leucaena leucocephala)* and Guava (*Psidium guajava)*
2. 1835-1840: Burmuda [*sic*] grass (Cynodon dactylon) and Wire grass (Eleusine indica)
3. 1858: Lantana (*Lantana camara)*

The *kiawe* tree (*Prosopis pallida*) was also introduced during this period, either in 1828 or 1837 (Frierson 1972:11).

4.1.2 Traditional Settlement Patterns

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

Oral traditions related to the ‘Ewa line of chiefs recall battles and chiefly claims upon valuable territories. The rich resources of Pu‘uloa—the fisheries in the lochs, the shoreline fishponds, the numerous springs, and the irrigated lands along the streams—made ‘Ewa a prize for competing chiefs. Battles were fought for the ‘Ewa lands, sometimes by competing O‘ahu chiefs and invading chiefs from other islands.

‘Ewa was a political center and home to many chiefs in its day. Oral accounts of *ali‘i* recorded by Hawaiian historian Samuel Kamakau date back to at least the twelfth century:

> The chiefs of Līhu‘e [upland area in ‘Ewa], Wahiawā, and Halemano on O‘ahu were called *lō ali‘i*. Because the chiefs at these places lived there continually and guarded their *kapu*, they were called *lō ali‘i* [from whom a ‘guaranteed’ chief might be obtained, *loa‘a*]. They were like gods, unseen, resembling men. [Kamakau 1991b:40]

In the mid-eleventh century, Māweke, a direct lineal descendant of the illustrious Nanaulu, ancestor of Hawaiian royalty, was a chief of O‘ahu (Fornander 1996:47). Keaunui, the second of his three sons, became the head of the powerful ‘Ewa chiefs. Tradition tells of him cutting a navigable channel through the Pearl River using his canoe. Keaunui’s son, Lakona, became the progenitor of the ‘Ewa chiefs around 1400 (Fornander 1996:224–226). Chiefs within his line, the Māweke-Kumuhonua line, reigned until about 1520-1540, with their major royal center in Līhu‘e in ‘Ewa (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line. He was slain by his men at the fortress of Waewae near Līhu‘e (Fornander 1996:88; Kamakau 1991b:54).

Mā‘ilikūkahi was born *ali‘i kapu* (sacred chief) at the birthing stones of Kūkaniloko (Kamakau 1991b:53) and became *mō‘ī* (king) of O‘ahu between 1520-1540 (Cordy 2002:19). Mā‘ilikūkahi was popular during his reign and was remembered for initiating land reforms that brought about peace, and for encouraging agricultural production, which brought about prosperity. He also prohibited the chiefs from plundering the *maka‘āinana*, a prohibition that was punishable by death (Kamakau 1991b:55).

Upon consenting to become *mō‘ī* at the age of 29, Mā‘ilikūkahi was taken to Kapukapuākea Heiau at Pa‘ala‘akai in Waialua to be consecrated. Soon after becoming king, Mā‘ilikūkahi was taken by the chiefs to live at Waikīkī. He was probably one of the first chiefs to live there, as the chiefs had previously always lived at Waialua and ‘Ewa. Under his reign, the land divisions were reorganized and redefined (Pukui et al. 1974:113).

In reference to the productivity of the land and the population during Mā‘ilikūkahi’s reign, Kamakau writes,

> In the time of Mā‘ili-kūkahi, the land was full of people. From the brow, lae, of Kulihemo to the brow of Maunauna in ‘Ewa, from the brow of Maunauna to the brow of Pu‘ukua [Pu‘u Ku‘ua] the land was full of chiefs and people. From Kānewai to Halemano in Wai‘alua, from Halemano to Paupali, from Paupali to Hālawa in ‘Ewa the land was filled with chiefs and people. [Kamakau 1991b:55]

Mā‘ilikūkahi’s peaceful reign was interrupted by an invasion which would change ‘Ewa forever. Fornander describes the Battle of Kīpapa (to be paved [with the corpses of the slain]) at Kīpapa Gulch in Waipi‘o Ahupua‘a:

> I have before referred to the expedition by some Hawaii chiefs, *Hilo-a-Lakapu*, *Hilo-a-Hilo-Kapuhi*, and *Punaluu*, joined by *Luakoa* of Maui, which invaded Oahu during the reign of *Mailikukahi*. It cannot be considered as a war between the two islands, but rather as a raid by some restless and turbulent Hawaii chiefs […] The invading force landed at first at Waikiki, but, for reasons not stated in the legend, altered their mind, and proceeded up the Ewa lagoon and marched inland. At Waikakalaua they met *Mailikukahi* with his forces, and a sanguinary battle ensued. The fight continued from there to the Kipapa gulch. The invaders were thoroughly defeated, and the gulch is said to have been literally paved with the corpses of the slain, and received its name ‘Kipapa,’ from this circumstance. *Punaluu* was slain on the plain which bears his name, the fugitives were pursued as far as Waimano, and the head of *Hilo* was cut off and carried in triumph to Honouliuli, and stuck up at a place still called *Poo-Hilo*. [Fornander 1996:89–90]

Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūali‘i achieved control of all of O‘ahu by defeating the Kona chiefs. He then defeated the ‘Ewa chiefs and expanded his control on windward Kaua‘i. Peleihōlani, the heir of Kūali‘i, gained control of O‘ahu about 1740, and later conquered parts of Moloka‘i. He ruled O‘ahu until his death in about 1778 when Kahahana, of the ‘Ewa line of chiefs, was selected as the ruler of O‘ahu (Cordy 2002:24–41). Somewhere between 1883 and 1885, Kahahana was killed by Kahekili of Maui. The subsequent rebellion amongst the chiefs resulted in a near genocide of the monarchy line on O‘ahu. Oral reports also tell of the stream of Hō‘ai‘ai (Hō‘ae‘ae) in the *ahupua‘a* immediately east of Honouliuli, choked with the bodies of the slain (Fornander 1996:224–226). Kahekili and the Maui

chiefs retained control of O‘ahu until the 1790s. Kahekili died at Waikīkī in 1794. His son, Kalanikūpule, was defeated the following year at the Battle of Nu‘uanu by Kamehameha (Kamakau 1992:376–377). Thus, the supremacy of the ‘Ewa chiefs came to a final end.

4.2 Early Historic Period

4.2.1 Observations of Early Explorers and Visitors

Captain James Cook arrived in the Hawaiian Islands in 1778, and ten years later the first published description of Pearl Harbor appeared. Captain Nathaniel Portlock, observing the coast of Honolulu for Great Britain, recorded the investigation of a “fine, deep bay running well to the northward” around the west point of “King George’s Bay” in his journal (Portlock 1789:74). Portlock’s description matches the entire crescent-shaped shoreline from Barbers Point to Diamond Head.

Captain George Vancouver made three voyages to the Hawaiian Islands between 1792 and 1794. In 1793, the British captain recorded the name of the harbor opening as “O-poo-ro-ah” (Pu‘uloa) and sent several boats across the sand bar to venture into the harbor proper (Vancouver 1798:884). The area known as “Pu‘u-loa” was comprised of the eastern bank at the entrance to Pearl River. George Vancouver anchored off the entrance to West Loch in 1793, and the Hawaiians told him of the area at “a little distance from the sea, [where] the soil is rich, and all the necessaries of life are abundantly produced” (Vancouver 1798 in Sterling and Summers 1978:36). Mr. Whitbey, one of Vancouver’s crew, observed, “from the number of houses within the harbor it should seem to be very populous; but the very few inhabitants who made their appearance were an indication of the contrary” (Vancouver 1798 in Sterling and Summers 1978:36).

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

> The point is low flat land, with a reef round it […] Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few fishermen’s huts. [Vancouver 1798:1:167]
>
> […] from the commencement of the high land to the westward of Opooroah [Pu‘uloa], was composed of one barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island. [Vancouver 1798:2:217]
>
> This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced. [Vancouver 1798:3:361–363]

Henry Barber was an English sea captain who traveled around the Hawaiian Islands during 1794 to 1807. Barber is the namesake for the common place name known today as Barbers Point, traditionally Kalaeloa.

> In 1795 he left China in the ship Arthur for the northwest going again by way of Australia. In the following summer he was trading along the Alaskan and British Columbian coast. In Sept. 1796, he left Nootka Sound for Canton via ‘the Island.’ The Arthur called in at Honolulu at the end of October for provisions and re-fittings.

> At 6 p.m. on October 31, 1796, Barber sailed the Arthur out of Honolulu harbor for Kauai to get a supply of yams. Two hours later the brig hit a shoal about an acre in extent with 12 feet of water over it, and close to the breakers. The shoal was probably a little to the westward of Pearl Harbor. But as Judge Howay says, how the skipper steered his brig into such a position is a mystery. [Sterling and Summers 1978:40]

Kamakau recalls the same incident as follows:

> In October, 1796, a ship [*Arthur*, under Henry Barber] went aground at Kalaeloa, Oahu. This ship had visited the island on several occasions during the rule of Ka-lani-ku-pule. This was the first time a foreign ship had grounded on these shores, Kamehameha was on Hawaii, but Young had remained on Oahu. All the men on the ship came ashore at night in their boats. At daylight when the ship was seen ashore Ku-i-helani placed a ban on the property of the ship and took care of the foreigners. Hawaiian divers recovered the valuables, and they were given over to the care of Ku-i-helani, but part were given by Captain Barber to the men who had recovered them. [Kamakau 1992:174]

During the first decades of the nineteenth century, several western visitors described the ‘Ewa landscape near Pearl Harbor. Archibald Campbell, an English sailor, spent some time in Hawai‘i during 1809-1810. He had endured a shipwreck off the Island of Sannack on the northwest coast of America. As a result, both his feet became frostbitten and were amputated. He spent over a year recuperating in the Hawaiian Islands. His narrative is considered noteworthy because it describes life in the ‘Ewa District before the missionaries arrived. During part of his stay, he resided with King Kamehameha I, who granted him 60 acres in Waimano Ahupua‘a in 1809. Campbell described his land:

> In the month of November the king was pleased to grant me about sixty acres of land, situated upon the Wymummee [traditional Hawaiian name for Pearl River], or Pearl-water, an inlet of the sea about twelve miles to the west of Hanaroora [Honolulu]. I immediately removed thither; and it being Macaheite time [Makahiki], during which canoes are tabooed, I was carried on men’s shoulders. We passed by footpaths winding through an extensive and fertile plain, the whole of which is in the highest state of cultivation. Every stream was carefully embanked, to supply water for taro beds. Where there was no water, the land was under crops of yams and sweet potatoes. The roads and numerous houses are shaded by cocoa-nut trees, and the sides of the mountains are covered with wood to a great height. We halted two or three times, and were treated by the natives with the utmost hospitality. My farm, called Wymannoo [Waimano], was upon the east side of the river, four or five miles from its mouth. Fifteen people with their families resided upon it, who cultivated the ground as my servants. There were three houses upon the property; but I found it most agreeable to live with one of my neighbours, and get what I wanted from my own land. This person’s name was William Stevenson a native of Borrowstouness. [Campbell 1967:103–104]

Of the Pearl River area, Campbell wrote,

> Wymumme, or Pearl River, lies about seven miles farther to the westward. This inlet extends ten or twelve miles up the country. The entrance is not more than a quarter of a mile wide, and is only navigable for small craft; the depth of water on the bar, at the highest tides, not exceeding seven feet; farther up it is nearly two miles across. There is an isle in it, belonging to Manina, the king's interpreter, in which he keeps a numerous flock of sheep and goats. [Campbell 1967:114]
>
> The flat land along shore is highly cultivated; taro root, yams, and sweet potatoes, are the most common crops; but taro forms the chief object of their husbandry, being the principal article of food amongst every class of inhabitants. [Campbell 1967:115]

Botanist F.J.F. Meyen visited Hawai‘i in 1831 and writes of the abundant vegetation described by Campbell in the vicinity of Pearl Harbor. His account of large stretches of cultivated land surrounding Pearl Harbor suggests the presence of a viable population settlement in the area.

> At the mouth of the Pearl River the ground has such a slight elevation that at high tide the ocean encroaches far into the river, helping to form small lakes which are so deep, that the long boats from the ocean can penetrate far upstream. All around these water basins the land is extraordinarily low but also exceedingly fertile and nowhere else on the whole island of Oahu are such large and continuous stretches of land cultivated. The taro fields, the banana plantations, the plantations of sugar cane are immeasurable. [Meyen 1981:63]

However, a contrasting picture of ‘Ewa is recorded by the missionary William Ellis in 1823-1824, of the ‘Ewa lands away from the coast:

> The plain of Eva is nearly twenty miles in length, from the Pearl River to Waiarua [Wailua], and in some parts nine or ten miles across. The soil is fertile, and watered by a number of rivulets, which wind their way along the deep water-courses that intersect its surface, and empty themselves into the sea. Though capable of a high state of improvement, a very small portion of it is enclosed or under any kind of culture, and in travelling across it, scarce a habitation is to be seen. [Ellis 1963:7]

4.2.2 Missionaries

The first company of Protestant missionaries from America, part of the American Board of Commissioners of Foreign Missions (ABCFM), arrived in Honolulu in 1820. They quickly established churches in Kona on Hawai‘i, Waimea on Kaua‘i, and Honolulu on O‘ahu. Although the missionaries were based in Honolulu, they traveled around the islands intermittently to preach to rural Native Hawaiians and to check on the progress of English and Bible instruction schools set up by local converts.

In 1828, the missionary Levi Chamberlain (1956:39–40) made a circuit of O‘ahu, stopping wherever there was a large enough population to warrant a sermon or a school visit. In his trek through the ‘Ewa District from Wai‘anae, he stopped at Waimānalo, an *‘ili* in Honouliuli, on the western border of ‘Ewa. At around 11 o'clock the next day, on a Saturday, Chamberlain and his companions set out toward the east, reaching Waikele at three or four o'clock. The group did not

stop in Hō‘ae‘ae, suggesting that the population was too small for a school, but Waikele had two schools, an obviously larger population than Hō‘ae‘ae. In fact, Chamberlain decided to stay in Waikele until the next day, the Sabbath, and preach to the Native Hawaiians who lived there. A crowd of 150 to 200 gathered for the sermon. The next day at six o’clock they set out for the village of Waipi‘o, which had one school. They left Waipi‘o at about 8:30, and walked to Waiawa, where there were two schools. Around ten o’clock, they began their circuit again, stopping only in the *ahupua‘a* of Kalauao in the ‘Ewa District before they reached Moanalua Ahupua‘a in the Kona District. The account does not give much information on the surroundings, but does indicate the relatively populated areas of ‘Ewa, in western Honouliuli, Waikele, Waipi‘o, Waiawa, and Kalauao, and the time it took to travel by foot along the trails across the ‘Ewa District.

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

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

4.2.3 Honouliuli Taro Lands

In early historic times, the population of Honouliuli was concentrated at the western edge of West Loch in the vicinity of Kapapapuhi Point in the “Honouliuli Taro Lands.” This area was clearly a major focus of population due to the abundance of fish and shellfish resources in close proximity to a wide expanse of well-irrigated bottomland suitable for wetland taro cultivation. Dicks et al. (1987:78–79) concludes, on the basis of 19 radiocarbon dates and three volcanic glass dates that “Agricultural use of the area spans over 1,000 years.”

Undoubtedly, Honouliuli was a locus of habitation for thousands of Hawaiians. Prehistoric population estimates are a matter of some debate but it is worth pointing out that in the earliest mission census (1831-1832) the land of Honouliuli contained 1,026 men, women, and children (Schmitt 1973:19). It is not clear whether this population relates to Honouliuli Village or district but the village probably contained the vast majority of the district’s population. The nature of the reported population structure for Honouliuli (less than 20% children under 12 years of age) and the fact that the population decreased more than 15% in the next four years (Schmitt 1973:22) suggests the pre-Contact population of Honouliuli Village may well have been significantly greater than it was in the 1830s.

4.2.4 The Māhele and the Kuleana Act

During the Māhele of 1848, 99 individual land claims in the *ahupua‘a* of Honouliuli were registered and awarded by King Kamehameha III. No *kuleana* land claims were made for land within the current project area or vicinity. The vast majority of the Land Commission Awards (LCA) were located in Honouliuli near the taro lands of the *‘ili* of Pu‘uloa and the Pu‘uloa Salt

Works. The largest award (Royal Patent 6071, LCA 11216, *‘Āpana* [parcel] 8) in Honouliuli Ahupua‘a was granted to Miriam Ke‘ahi-Kuni Kekau‘onohi on January 1848 (Native Register 1848). Kekau‘onohi acquired a deed to all unclaimed land within the *ahupua‘a*, including a total of 43,250 acres encompassing the present project area.

Samuel Kamakau relates the following about Kekau‘onohi as a child:

> Kamehameha’s granddaughter, Ke-ahi-Kuni Ke-kau-‘onohi […] was also a tabu chiefess in whose presence the other chiefesses had to prostrate and uncover themselves, and Kamehameha would lie face upward while she sat on his chest. [Kamakau 1992:208–209]

Kekau‘onohi was one of Liholiho’s (Kamehameha II’s) wives, and after his death, she lived with her half-brother, Luanu‘u Kahala‘i‘a, who was governor of Kaua‘i (Kamakau 1992:346). Subsequently, Kekau‘onohi ran away with Queen Ka‘ahumanu’s stepson, Keli‘i-ahonui, and then became the wife of Chief Levi Ha‘alelea (Kamakau 1992:280). Upon her death on 2 June 1851, all her property passed to her husband and his heirs. When Levi Ha‘alelea died, the property went to his surviving wife, who in turn leased it to James Dowsett and John Meek in 1871 for stock running and grazing.

4.2.5 Population Decline

At Contact, the most populous *ahupua‘a* on the island of O‘ahu was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the population as 1,026, which represented 25% of the total ‘Ewa district population of 4,015 (Schmitt 1973:19).

Beginning with the time of Western Contact, however, Hawaiian populations were introduced to many virulent western diseases which began to decimate the native populations. Thus, four years following the 1832 census, the ‘Ewa population had dropped to 3,423 (Schmitt 1973:9, 36), “a decrease of 592 in 4 years” (Ewa Station Reports 1836). Reverend Lowell Smith noted,

> The people of Ewa are a dying people. I have not been able to obtain an exact count of all the deaths & births since the last general meeting. But my impression is that there have been as many as 8 or 10 deaths to one birth. I have heard of but 4 births on Waiawa during the year, & all of these children are dead. I have attended about 20 funerals on that one land, & 16 of these were adults. [Ewa Station Reports 1836]

Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of ‘Ewa and Wai‘anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of ‘Ewa was probably abandoned by the mid-nineteenth century due to population decline and consolidation of the remaining people in town.

4.3 Mid- to Late 1800s

4.3.1 Ranching in Lower Honouliuli

In 1871, John Coney rented the lands of Honouliuli to James Dowsett and John Meek, who used the land for cattle grazing. In 1877, James Campbell purchased most of Honouliuli Ahupua‘a, except the *‘ili* of Pu‘uloa, for a total of $95,000. He then drove off 32,347 head of cattle belonging

to Dowsett, Meek, and James Robinson, and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12), as shown in Figure 9. He let the land rest for one year and then began to restock the ranch, so that he had 5,500 head after a few years (Dillingham 1885 in Frierson 1972:14).

In 1881, a medical student providing smallpox vaccinations around the island wrote about Campbell’s property which was called the Honouliuli Ranch.

> I took a ride over the Honouliuli Ranch which is quite romantic. The soil is a deep, reddish loam, up to the highest peaks, and the country is well-grassed. Springs of water abound. The ‘ilima, which grows in endless quantities on the plains of this ranch, is considered excellent for feeding cattle; beside it grows the indigo plant, whose young shoots are also good fodder, of which the cattle are fond. Beneath these grows the manieizie grass, and Spanish clover and native grasses grow in the open; so there is abundant pasturage of various kinds here. As I rode, to the left were towering mountains and gaping gorges; ahead, undulating plains, and to the right, creeks and indentations from the sea. A wide valley of fertile land extends between the Nuuanu Range and the Waianae Mountains and thence to the coast of Waialua. There are many wild goats in this valley, which are left more or less undisturbed because they kill the growth of mimosa bushes, which would otherwise overrun the country and destroy the pasturage for cattle. [Briggs 1926:62-63]

The following excerpts were also written in 1880-1881, describing Honouliuli Ranch:

> Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet […] There are valuable fisheries attached to this estate . . . [Bowser 1880:489]

> From Mr. Campbell’s veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet […] Besides Mr. Campbell’s residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts. [Bowser 1880:495]

Most of Campbell’s lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked that “the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable” (Ewa Plantation Company 1923:6–7). In 1879, Campbell brought in a well-driller from California to search the ‘Ewa plains for water, and the well, drilled to a depth of 240 ft near Campbell’s home in ‘Ewa, resulted in “a sheet of pure water flowing like a dome of glass from all sides of the well casing” (*The Legacy of James Campbell* n.d. in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource.

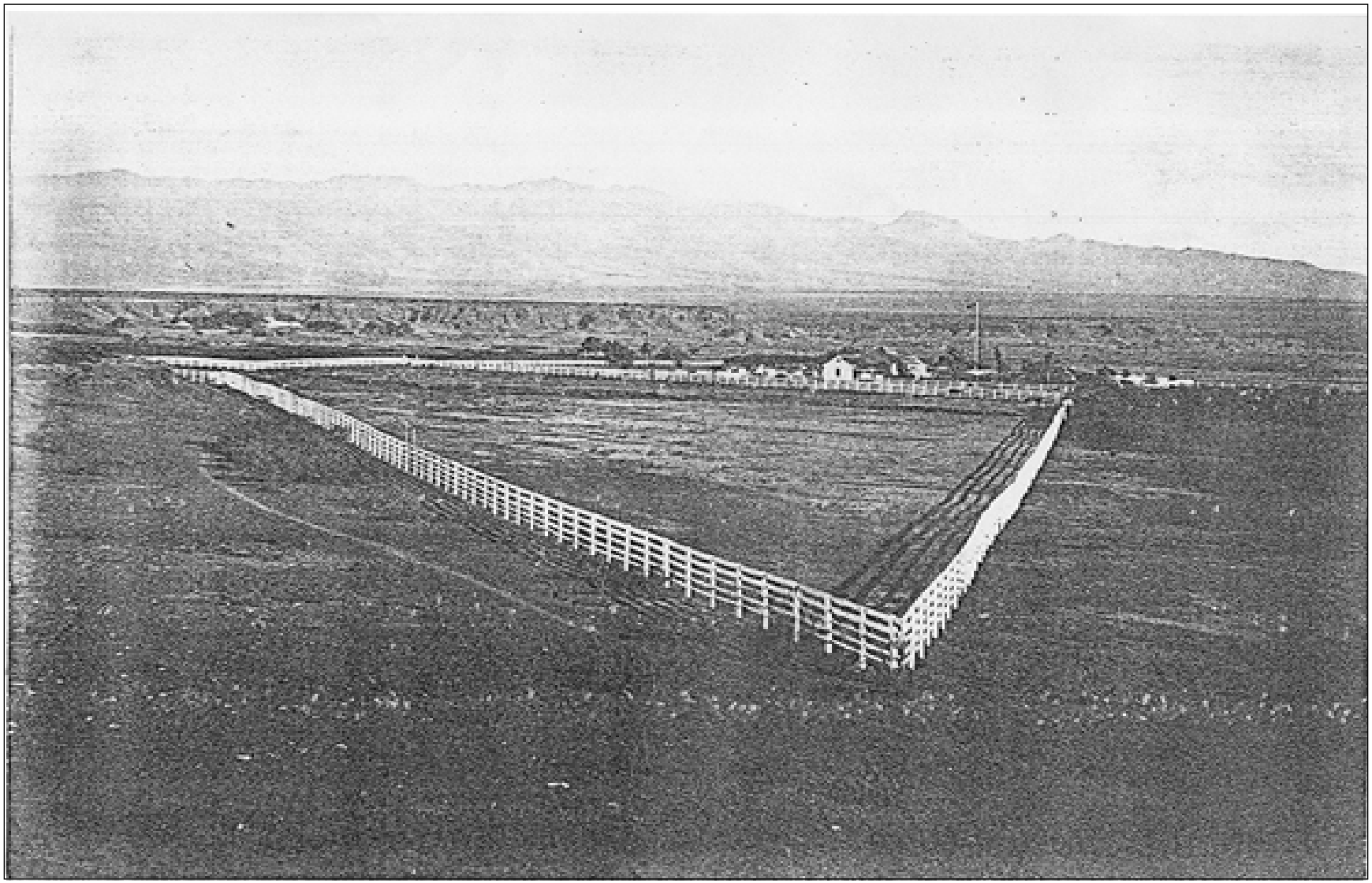

Figure 9. 1880s photograph of James Campbell‘s residence on the ‘Ewa Plain (Hawai‘i State Archives)

4.3.2 Oahu Railway and Land Company (OR&L)

In 1886, Campbell and B.F. Dillingham put together the “Great Land Colonization Scheme,” which was an attempt to sell Honouliuli land to homesteaders (Thrum 1887:74). This homestead idea failed. The failure was attributed to the lack of water and the distance from ‘Ewa to Honolulu. The water problem was solved by the drilling of artesian wells, and Dillingham decided the area could be used instead for large-scale cultivation (Pagliaro 1987:4). The transportation problem was to be solved by the construction of a railroad, which Dillingham soon began to finance under the company name Oahu Railway and Land Company (OR&L).

During the last decade of the nineteenth century, the railroad reached from Honolulu to Pearl City in 1890, Wai‘ānae in 1895, Waialua Plantation in 1898, and Kahuku in 1899 (Kuykendall 1967:III, 100). This railroad line eventually ran across the center of the ‘Ewa Plain at the lower boundary of the sugar fields (Figure 10). To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly formed Ewa Plantation Company (Frierson 1972:15). Dillingham’s Honouliuli lands above 200 ft that were suitable for sugarcane cultivation were sublet to the Oahu Sugar Company. Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch, established by Dillingham, was the “fattening” area for the other ranches (Frierson 1972:15).

Operations at the OR&L began to slow down in the 1920s, when electric streetcars were built for public transportation within the city of Honolulu and automobiles began to be used by families for transportation outside the city (Chiddix and Simpson 2004:185). The build-up to World War II turned this decline around, as the U.S. military utilized the OR&L lines to transport materials to build defense projects around the island. Historians have noted that one of the most serious mistakes made by the Japanese in their 1941 attack on Pearl Harbor was their decision not to bomb the railway infrastructure. Soon after the attack, the OR&L operated 24 hours a day, transporting war materials and troops from Honolulu to the new and expanded army, naval, and air bases. The huge navy base at Pearl Harbor had its own rail lines that connected to the OR&L rail lines.

In August 1945 the war ended, and so did OR&L’s heyday as a military transport line.

> She had served her country well and proudly during the war, but operating round-the-clock on what little maintenance could be squeezed in, had taken a prodigious hit on the locomotives and track. Traffic stayed steady for a short time, but soon dropped precipitously as soldiers and sailors went home, military posts were shrunk or razed, and civilians could again get tires, gasoline and new cars. [Chiddix and Simpson 2004:257]

There was no choice but to abandon the OR&L main line, and in 1946 Walter F. Dillingham, son of B.F. Dillingham, wrote,

> The sudden termination of the war with Japan changed not only the character of our transportation, but cut the freight tonnage to a third and the passenger business to a little above the pre-war level. With the increased cost of labor and material and the shrinkage in freight tonnage and passenger travel, it was definite that the road could not be operated as a common carrier. With no prospect of increased tonnage, and the impossibility of increasing rates against truck competition, your management

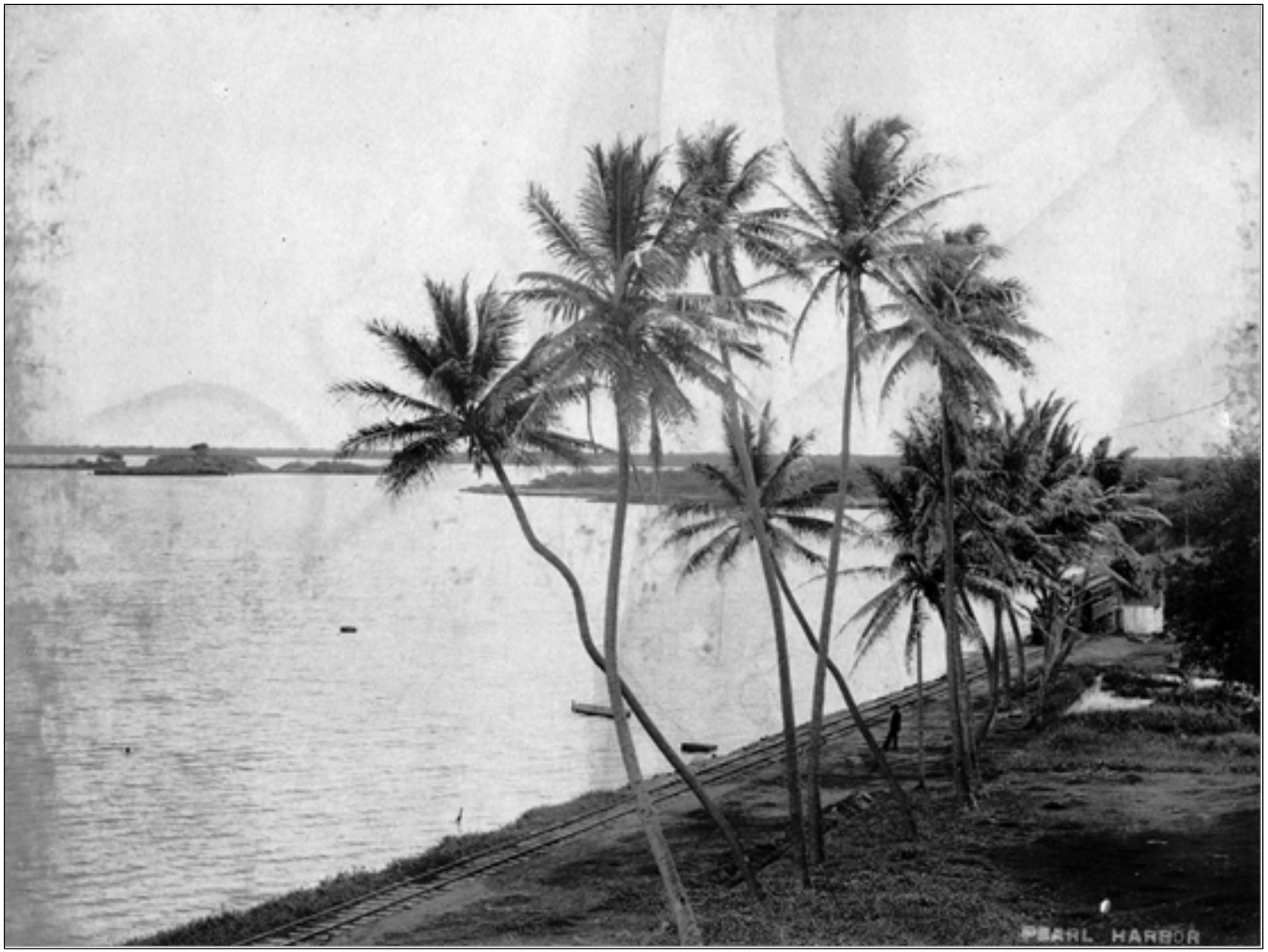

Figure 10. 1890 photograph of Pearl Harbor with OR&L railroad tracks along the coast (Honolulu Advertiser Archives)

> has applied to the Interstate Commerce for authority to abandon its mainline. [Chiddix and Simpson 2004:257]

After the war, most of the 150 miles or more of OR&L track were pried up, locomotives were sold to businesses on the U.S. mainland, and railway cars were scrapped. In 1947, the U.S. Navy took over a section of the OR&L track for their own use, to transport bombs, ammunition, and torpedoes from the ammunition magazines at Lualualei, West Loch in Pearl Harbor, and Waikele on OR&L's Wahiawā Branch to Pearl Harbor Naval Base (Treiber 2005:25–26). The track to Waipahu was abandoned in the 1950s, but the line from the magazines in Lualualei to the wharves in West Loch at Pearl Harbor remained open until 1968.

4.3.3 The Sugar Plantations of ‘Ewa

Although sugarcane was already being grown as long ago as the early 1800s, the industry revealed its economic potential in 1879 when the first artesian well was drilled in ‘Ewa (Ellis 1995:22). The availability of subsurface water resources enabled greater irrigation possibilities for expanding plantations besides the use of water diversions from the surrounding stream systems. This prompted the drilling of many other wells throughout the Hawaiian Islands, thereby commencing the Hawai‘i sugar plantation era. By the early 1900s, all of the main Hawaiian Islands had land devoted to sugarcane production.

Agricultural field systems, railroads, and residential areas in ‘Ewa were developed by three sugarcane companies, the Ewa Plantation Company, located largely in the *ahupua‘a* of Honouliuli and Hō‘ae‘ae in the western section of ‘Ewa; the Oahu Sugar Company, extending in the areas upland of the Ewa Plantation Company in central ‘Ewa, including a portion of the uplands of Waiawa; and the Honolulu Plantation Company, with fields extending through Mānana to Hālawa in the eastern section of ‘Ewa.

4.3.3.1 The Ewa Plantation Company

The Ewa Plantation Company was incorporated in 1890 for sugarcane cultivation (Figure 11). The first crop, 2,849 tons of sugar, was harvested in 1892. The Ewa Plantation Company was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967:III, 69). As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964:3). By the 1920s, Ewa Plantation Company was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific*, December 1902:19–22 in Kelly 1985:171). Figure 11 is an aerial shot taken ca. 1925.

During the twentieth century, the Ewa Plantation Company continued to grow and, by the 1930s, encompassed much of the eastern half of Honouliuli Ahupua‘a. This growth impelled the creation of plantation villages to house the growing immigrant labor force working the fields. After the outbreak of World War II, which siphoned off much of the plantation's manpower, along with the changeover to almost complete reliance on mechanical harvesting in 1938, there was little need for the large multi-racial (Japanese, Chinese, Okinawan, Korean, Portuguese, Spanish, Hawaiian,

Figure 11. Ewa Plantation Company sugar cane fields, Filipino Camp area, cs. 1925 (University of Hawai‘i at Mānoa)

Filipino, European) labor force that had characterized most of the early history of the plantation. The Oahu Sugar Company took control over the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugarcane production in the combined plantation areas (Dorrance and Morgan 2000:45, 50).

During the subsequent decades of the twentieth century, sugarcane operations in ‘Ewa phased out and, more recently, former cane lands have been rezoned for residential development. Structures in the area of the former plantation villages have fallen into disrepair or have been demolished. However, portions of the area—including Varona Village, Tenney Village, and Renton Village—have been designated the ‘Ewa Villages Historic District (SIHP # 50-80-12-9786), which has been nominated for National Historic Landmark status. Additionally, the still-existing OR&L rail line through Honouliuli has been placed on the National Register of Historic Places (Site 50-80-12-9714). The Oahu Sugar Company took control over the Ewa Plantation lands in 1970 and continued operations into the 1990s.

4.3.3.2 The Oahu Sugar Company and the Waiahole Ditch

In 1889, Benjamin Dillingham organized the OR&L Company which connected the outlying areas of O‘ahu to Honolulu. By 1890, the railroad reached from Honolulu to Pearl City and continued on to Wai‘anae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:100).

In 1897, B.F. Dillingham established the Oahu Sugar Company (OSC) on 12,000 acres leased from the estates of John Papa ‘Ī‘ī, Bishop, and Robinson. The Oahu Sugar Company had over 900 field workers, composed of 44 Hawaiians, 473 Japanese, 399 Chinese, and 57 Portuguese. The first sugar crop was harvested in 1899, ushering in the sugar plantation era in Waipahu (Ohira 1997).

Prior to commercial sugar cultivation, these lands were described as being “of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project” (Condé and Best 1973:313). Dillingham had successfully promoted the Ewa Plantation Company in 1890; the sprawling sugar company was just south of and adjacent to the OSC. Artesian wells had converted those arid ‘Ewa lands into a thriving plantation, and Dillingham recognized the same potential in the northern area.

Water to irrigate the upper cane fields was initially pumped to levels of 500 ft by some of the “largest steam pumps ever manufactured” (Dorrance and Morgan 2000:49). The expense of pumping water to the high elevations of the plantation led to the proposal to transport water from the windward side of the Ko‘olau Mountains. The Waiahole Water Company was formally incorporated in 1913 and was originally a subsidiary of the Oahu Sugar Company. The Waiahole Ditch was designed by engineer Jorgen Jorgensen, with recommendations by engineer J.B. Lippencott and assisted by W.A. Wall. The original system, when completed, included 27 tunnels connecting with 37 stream intakes on the north side of the Ko‘olau, with the main bore through Waiāhole Valley, then connecting it to the 14 tunnels on the southern side of the Ko‘olau at Waiawa, and thence by ditch westward to Honouliuli, covering a total of 13.6 km (Condé and Best 1973:37). Upon its completion in 1916, the Waiahole Ditch was 35 km (21.9 miles) long and cost $2.3 million. The 32 million gallons of daily water enabled the Oahu Sugar Company to grow to “some 20 square miles […] ranging in elevation from 10 ft at the Waipio Peninsula […] to 700 ft

at the Waiahole Ditch" (Condé and Best 1973:313). The ditch system, with some modifications, is still in use. It is included on the state inventory of historic places as SIHP # 50-80-09-2268.

This ditch complex first passed through Hō‘ae‘ae, bringing much needed water to the area. Kluegel describes the area:

> West of Waikakalaua Gulch, through Hoaeae and to the upper boundary of Oahu Plantation in Honouliuli, the conduit consists of 12,650 feet of cement-lined ditches, and three redwood pipes 5 feet in diameter, having an aggregate length of 2,830 feet. [Kluegel 1917:96]

> The Waiahole Water Co. has taken over from the Oahu Sugar Co. the Ahrens Ditch in Waiawa, the Kipapa Ditch, the Waikakalaua Ditch in Waipio, and the Hoaeae Ditch. Two redwood pipes having a total length of 1,223 feet have been laid across two gulches on the line of Hoaeae Ditch, cutting out 21/4 miles of ditch. The water delivered by the Waiahole System is chiefly used on newly planted cane on land above the lift of the pumps. [Kluegel 1917:107]

The Waiahole Ditch System crossed through the western portion of the present project area.

Dillingham's *mauka* lands in western Honouliuli that were unsuitable for commercial sugar production remained pasture for grazing livestock. From 1890 to 1892, the Ranch Department of the OR&L Company desperately sought water for their herds of cattle, tapping plantation flumes and searching for alternative sources of water. Ida von Holt shared this account of her husband Harry's (Superintendent of the OR&L Ranch Department) search for water in the foothills of the Wai‘anae Range:

> One of those places is on the old trail to Pālehua, and had evidently been a place of which the Hawaiians had known, for its name is Kalo‘i (the taro patch), and even in dry weather water would be standing in the holes made by the cattle, as they tried to get a drop or two. [von Holt 1985:136]

The spring was located along the upper slopes of the southern face of Kalo‘i Gulch. A second account is given of the discovery of spring water in an area over the ridge on the north side of Kalo‘i Gulch:

> Shouting to the men to come over with their picks and shovels, he [Harry von Holt] soon got them busy clearing away lots of small stones and earth. Almost at once they could see that there were evidences of a paved well, and at about three feet down they came upon a huge flat rock, as large around as two men could span with their arms. Digging the rock loose and lifting it to one side, what was their astonishment to find a clear bubbling spring! [von Holt 1985:138]

Following the discovery, two old Hawaiians began to explain to Von Holt about the spring:

> Finally he [Harry von Holt] got them to explain that the spring, called 'Waihuna' (Hidden Spring) had been one of the principal sources of water for all that country, which was quite heavily populated before the smallpox epidemic of 1840 […] A powerful Kahuna living at the spring had hidden it before he died of the smallpox, and had put a curse on the one who disturbed the stone, that he or she would surely die before a year was out. [von Holt 1985:138–140]

4.4 1900s

4.4.1 The U.S Military Development of Pearl Harbor

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

After Hawai‘i became a territory of the United States in 1899, a Pacific base that could be used as a staging area for the Spanish-American war began to be developed. Early in the twentieth century, the U.S. Government began acquiring the coastal lands of ‘Ewa for development of a naval base at Pearl Harbor. In 1901, the U.S. Congress formally ratified annexation of the Territory of Hawai‘i, and the first 1,356.01 acres of Pearl Harbor land were transferred to U.S. ownership. The U.S. Navy began a preliminary dredging program in 1901, which created a 30-ft-deep entrance channel measuring 200 ft wide and 3,085 ft long. In 1908, money was appropriated for 5 miles of entrance channel dredged to an additional 35 ft down (Downes 1953) (Figure 12). Funding for the construction of dry docks and other support facilities was also approved in 1908. In 1909, the government appropriated the entire Waipi‘o peninsula from the ‘Ī‘ī estate for the Pearl Harbor Naval Station and Shipyard.

Additional dredging to deepen and widen the channel was conducted in the 1920s. In 1931, the Navy built an ammunition depot at West Loch on a 213-acre parcel it had bought from the Campbell Estate. Construction of a new depot in Lualualei Valley and at West Loch Harbor began in 1931.

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

4.4.2 History of Camp Malakole

The wartime history of Camp Malakole (1940–1946) has been well described by Robert H. Albert (1980). The Camp Malakole Military Reservation, also known as the Honouliuli Military Reservation (Malakole Campsite), included 30 ha (75.01 acres) acquired by the Secretary of War in the late 1930s. In 1939, the area was chosen as a firing range for the Sixty-Fourth Coast Artillery (AA) Regiment, stationed out of Fort Shafter (Albert 1980:303). Under the command of Colonel Charles W. Wing, the regiment cleared the land and set up six batteries along the coast (Bennett 2003:50).

The camp was selected to be the base of the 251st Coast Artillery (Anti-Aircraft) Regiment on 16 September 1940. This camp was to function as a defensive gun and firing position sector for the regiment. Based out of California, this unit was the first National Guard Unit to be ordered outside the continental United States during peace time (Albert 1980:303). By the end of 1940, the

Figure 12. Dredging in Pearl Harbor ca. 1908 (Hawai‘i State Archives)

soldiers stationed at Camp Malakole spent half the day setting up the field defensive gun and half the day building the camp (Albert 1980:304) (Figure 13 and Figure 14). The camp construction was officially finished in February 1941 (Bennett 2003:55).

The camp was meant to house approximately 2,000 men and included 48 barracks buildings, 12 mess halls, nine magazines and storage houses, five officers' quarters, seven showers, latrines, dispensary, officers' mess, headquarters buildings, fire house, post office, regimental day room, movie theater, laundry, car repair shop, gas station, guard houses, and photo lab (Bennett 2003:55).

By 1941, the imminent threat of war was becoming more apparent. During the first half of 1941, the population of the camp grew from 1,200 to 2,400. On 7 December 1941, the soldiers stationed at Camp Malakole had just come back from a week-long island alert and had placed the guns and ammunition in storage bunkers (Albert 1980:304). Nevertheless, a hasty defense effort was able to defend against Japanese dive bombers attacking the camp and the unit is credited with shooting down two Japanese bombers. Three soldiers stationed at Camp Malakole—Sargent Henry Blackwell, Sargent Warren Rassmusen, and Corporal Clyde Brown—were the first American soldiers killed in the attack. They were taking private flying lessons that morning out of John Rodgers Airport (Harding 2013).

In 1942, the Regiment deployed to the Fiji Islands to establish anti-aircraft defense for the airfield there. From there, they participated in campaigns in Guadalcanal, Bougainville, and Luzon in the Philippines (Albert 1980:305).

After the Regiment left in 1942, Camp Malakole became a weapons training school for live-firing ranges of anti-aircraft and anti-tank training. By 1943, the camp became an important staging area for cargo coming into and out of O‘ahu, as well as solider replacement for personnel entering oversea theaters. Service reports from the camp report that over 43,000 troops were billeted and staged through the camp in the final 32 months of war, averaging over 1,100 troops a month (Albert 1980:306). The camp was a strategic tool during the United States' involvement in the war. It served as an important area for the logistical effort in the war and the main anti-aircraft gunnery school on O‘ahu. After the end of World War II, the camp was abandoned. There is little information available about exactly when or why the camp was abandoned. Due to the construction of the adjacent industrial park and Chevron Oil Refinery, little remains of the camp.

4.4.3 Honouliuli National Monument (Honouliuli Internment Camp)

Following the Japanese Navy's attack on Pearl Harbor on 7 December 1941, Lieutenant General Walter C. Short of the Army and Joseph Poindexter, Governor of Hawai‘i, issued a proclamation declaring the Territory of Hawai‘i under martial law and suspending the writ of *habeas corpus* (the requirement for a person under arrest to be brought before a judge or into court) (U.S. Department of the Interior 2014:6-7). Civilian courts were closed and the military established its own courts with authority over civilians (Kashima 2003:69). While under martial law, the territory of Hawai‘i was governed by Army generals Walter Short, Delos Emmons, and Robert C. Richardson, Jr. (U.S. Department of the Interior 2014:6–7).

> The military conducted some 50,000 trials of civilians throughout the islands during the war, with a 99 percent conviction rate in the 22,000 cases on the island of O‘ahu in 1942 and 1943. The average trial lasted five minutes, and legal counsel was seldom at hand once it became common knowledge that the presence of a defense

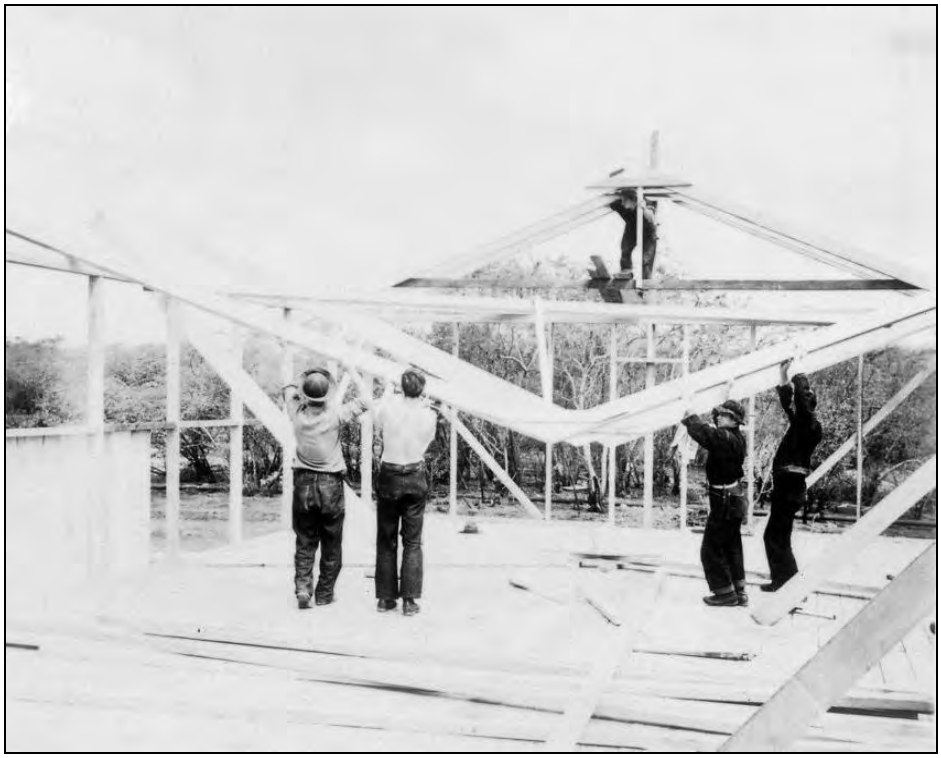

Figure 13. Camp Malakole soldiers raising the barracks roof (Bandel in Albert 1980:336)

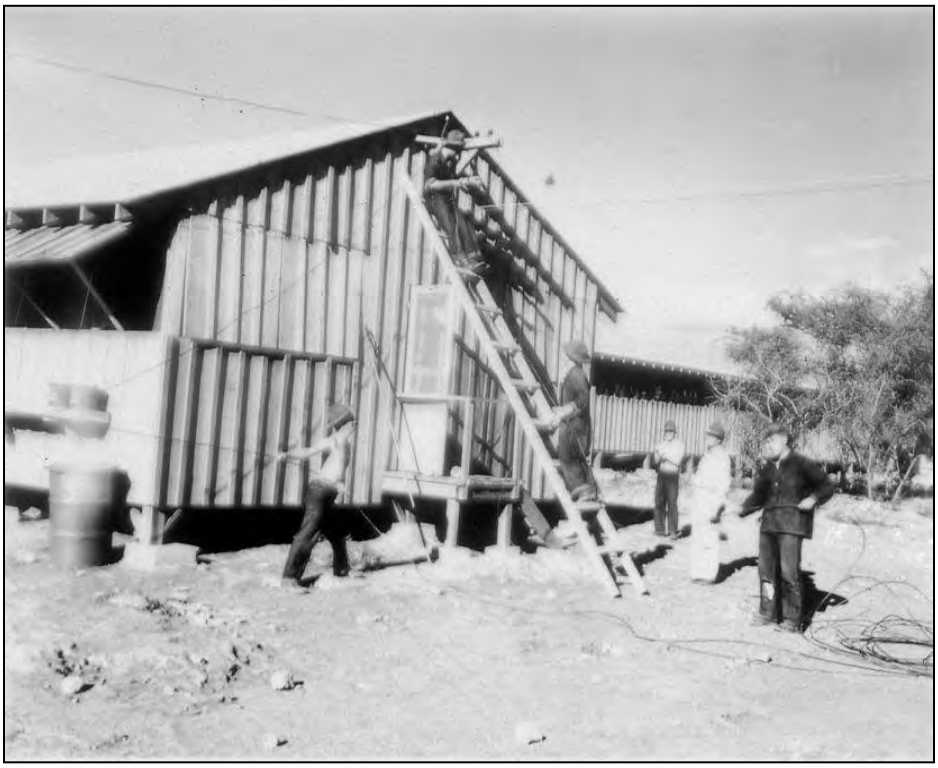

Figure 14. Camp Malakole soldiers wiring the barracks (Bandel in Albert 1980:336)

> lawyer would ensure a harsh sentence (Scheiber and Scheiber 2003). [U.S. Department of the Interior 2014:6-7]

Persons of Japanese and European ancestry in Hawai‘i suspected of disloyalty to the United States were rounded up and imprisoned by the U.S. military and the Federal Bureau of Investigations (FBI) (U.S. Department of the Interior 2014:xii). Most internees were held at the U.S. Immigration Station on O‘ahu prior to being transferred to internment camps on the U.S. mainland (U.S. Department of the Interior 2014:xii).

> The War Department ordered the internment of all individuals who had been identified on the custodial detention list (Kashima 2003, 69). These included leaders in the Japanese community who had significant community influence, were educated, were teachers, or had access to transportation or communications. They included members of the Japanese consulate, and community members who served in an unofficial consular capacity for those wanting to communicate officially with Japan on legal issues of births, deaths, marriage, and other business. They also included Shinto and Buddhist priests, Japanese language teachers, those with radios, and farmers and fishermen with access to boats and other transport. Martial arts instructors, travel agents, those with access to the press, and Kibei (American citizens of Japanese ancestry who had been educated in Japan) were also targeted. In some cases, those arrested were considered ‘guilty by association’ or were identified by informants, some without just cause. [U.S. Department of the Interior 2014:6–7]

In 1943, the Honouliuli Internment Camp was constructed to intern citizens, resident aliens, and prisoners of war. Located in Honouliuli Gulch, east of the project area, the camp was the “last, largest, and longest-used World War II confinement site in Hawai‘i,” holding approximately 320 internees and nearly 4,000 prisoners of war (U.S. Department of the Interior 2014:xiv).

4.4.4 Development in the Vicinity of the Project Area

Much of the *mauka* lands in western Honouliuli, including ridges and deep gulches, were unsuitable for commercial sugar cultivation and remained pasture land for grazing livestock. The Donn 1906 map suggests the present project area was at the edge of sugarcane cultivation at that time (Figure 15). By 1920, however, much of the lands of Honouliuli were used for commercial sugarcane cultivation (Frierson 1972:18).

A 1919 map (Figure 16) shows ditches, reservoirs, roads, and railroad lines downslope of the project area. This map shows an unimproved road alignment just south of the project area, understood as the Pālehua Road, approximating a traditional Hawaiian footpath into the uplands.

A 1922 map (Figure 17 and Figure 18 showing annotations), however, shows the called out Pālehua trail as jogging into the southwest portion of the project area. This 1922 map shows pineapple fields in at least 13 locations among the foothills of the southeast Wai‘anae Range. The nearest of these pineapple fields wrapped around Pu‘u Kapua‘i some 500 m to the northwest. At least six (typically quite small) plantation camps were scattered along the bottom of these foothills with the nearest being about 500 m to the north of the project area. The Kupihau Ranch Station is shown about 2.6 km to the north. The water troughs and tanks shown upslope of the ranch station attest to the cattle operations in the vicinity at that time.

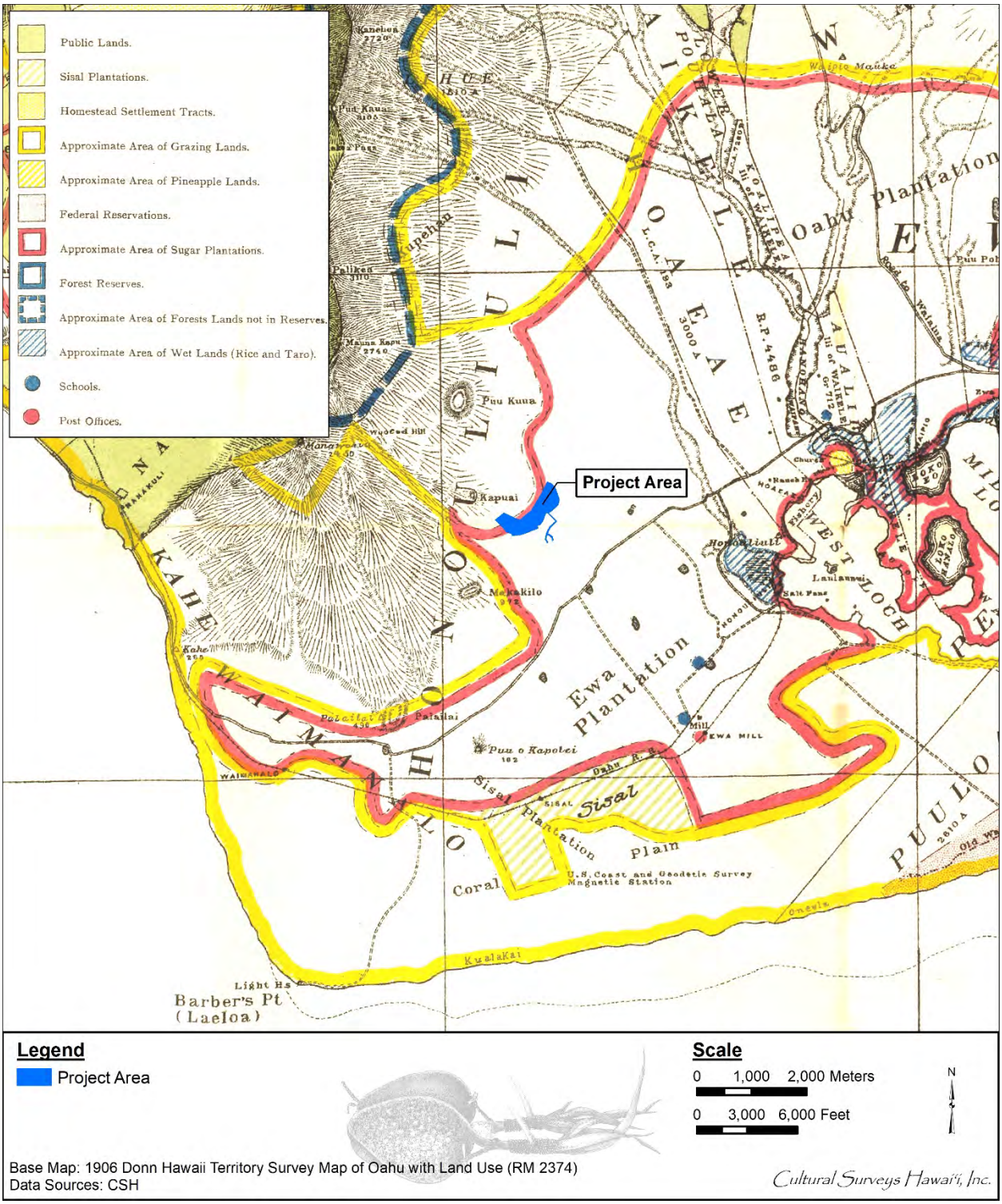

Figure 15. Portion of the 1906 Donn Hawaii Territory Survey map showing breakdown of land use in southwest O‘ahu

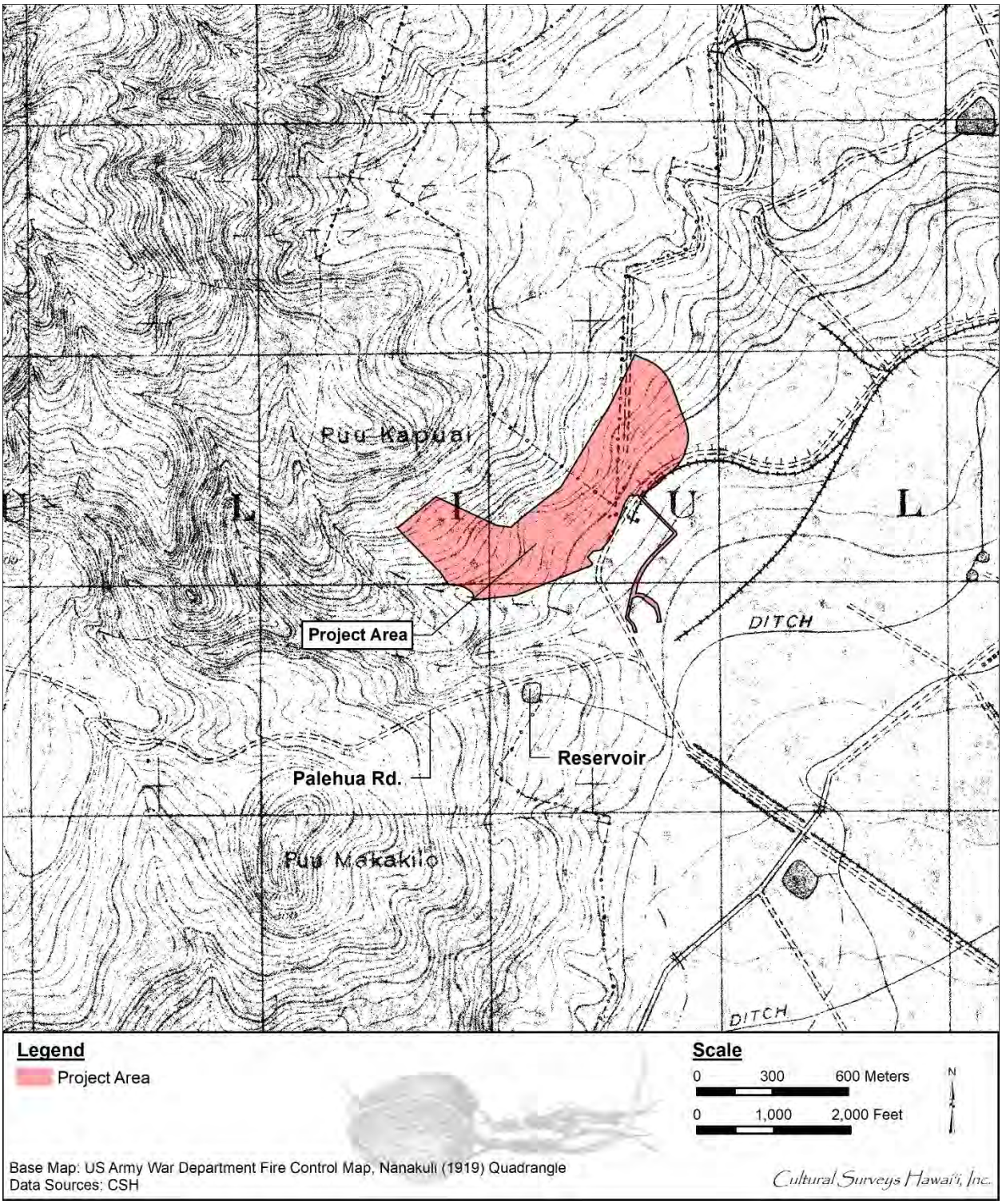

Figure 16. Portion of 1919 U.S. Army War Department fire control map, Nanakuli quadrangle showing the project area

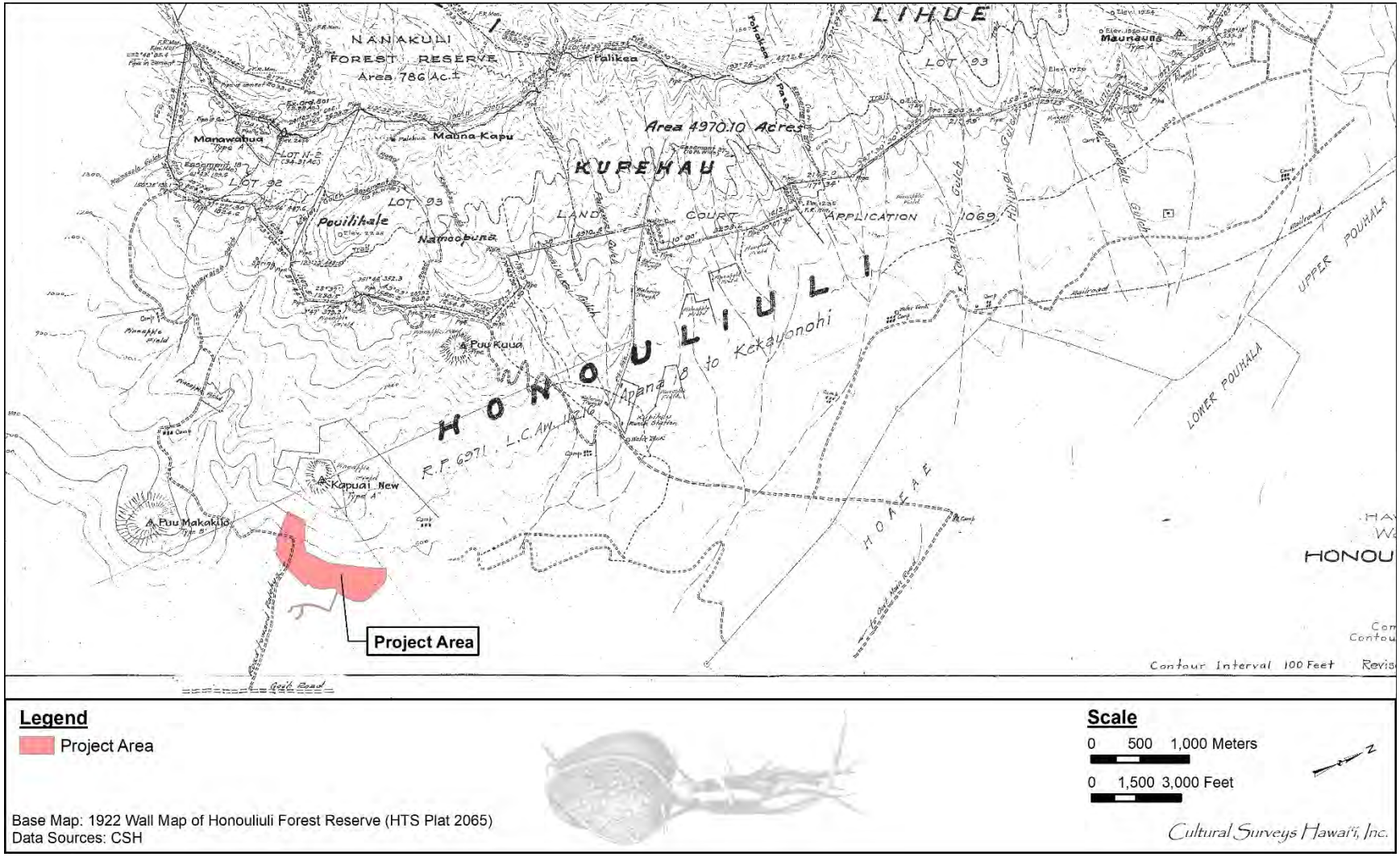

Figure 17. Portion of 1922 Wall map of Honouliuli Forest Reserve showing the location of the project area

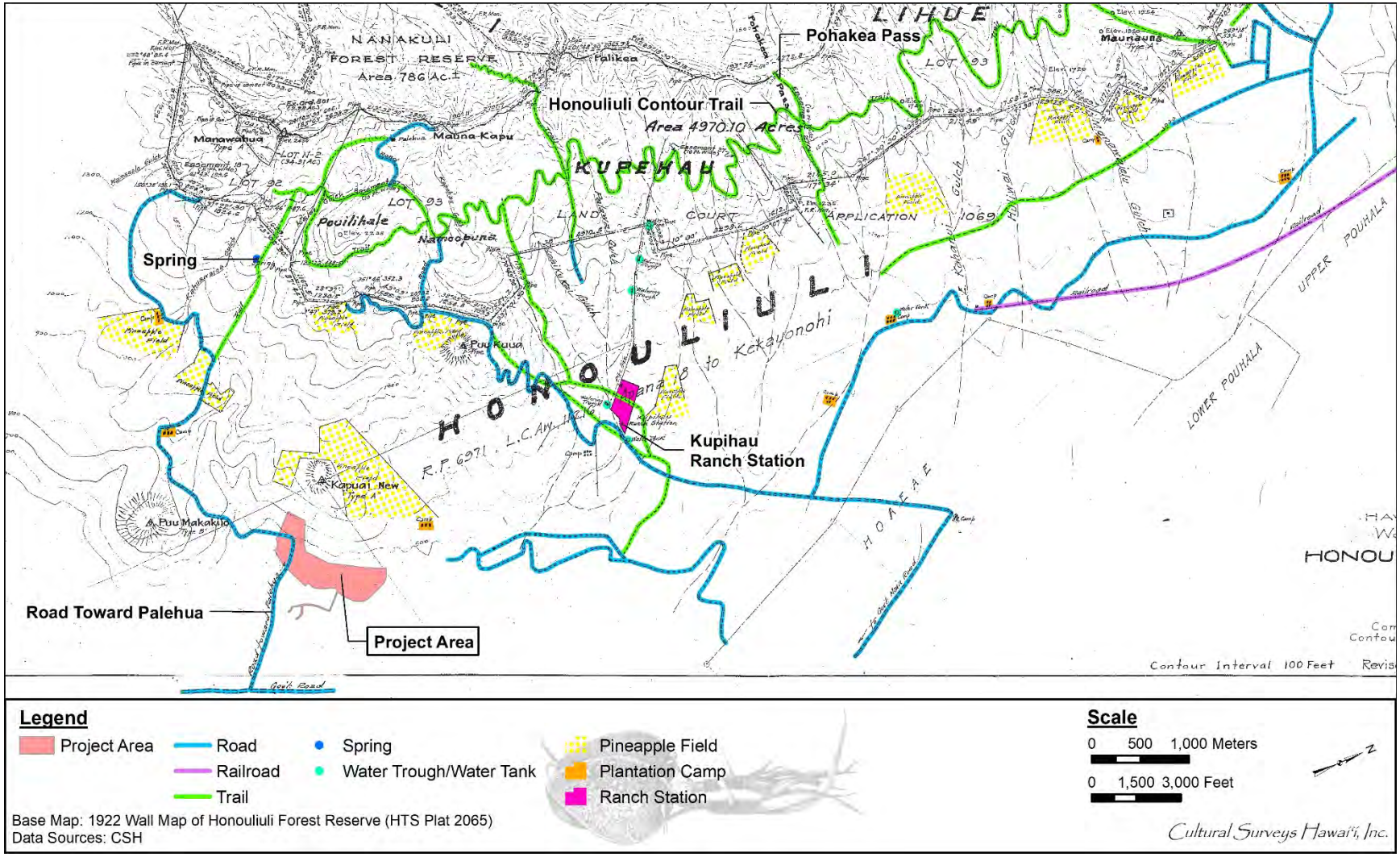

Figure 18. 1922 Wall map of Honouliuli Forest Reserve showing the location of the project area with annotations

By 1925 (Figure 19) most of the project area is depicted as within Oahu Sugar Company plantation Field 30. The extreme upslope end of the project area still appears to be outside the area of sugarcane cultivation, in keeping with the depiction on the 1906 Donn map (compare with Figure 15).

In the late 1920s, the main residential communities were at the northeast edge of the ‘Ewa Plain and the largest community was still located at Honouliuli Village. ‘Ewa was primarily a plantation town, focused around the sugar mill, with a public school as well as a Japanese school. Additional settlement, in Waipahu, centered around the Waipahu sugar mill operated by the Oahu Sugar Company. However, small plantation camps were scattered within the extensive sugarcane fields (as indicated in Figure 18).

By 1936, however, “Pump Camp 5” had been established on either side of a pipeline that bisected the present project area (Figure 20). The 1936 map indicates approximately seven houses on the northeast side of the pipeline and 17 houses on the southwest side of the pipeline within the present project area at that time. The central pipeline extended downslope from the Waiahole Ditch to a large pump house structure that still exits just southeast (outside) of the project area. The alignment of the Waiahole Ditch crossing the western portion of the project area, and a roughly parallel road just upslope, are clearly depicted. It appears that a spur plantation railroad serviced Pump Camp 5 connecting to the northeast and continued a short distance to the southeast.

The 1943 map (Figure 21) shows much the same scene, though the unimproved road crossing the west portion of the project area now wraps around Pu‘u Kapua‘i. Additional new, unimproved roads suggest the expansion of sugarcane fields. The extensive system of fences depicted upslope indicate cattle ranching was still a significant enterprise.

Historic maps of the Makakilo area indicate a lack of any other significant development in the area into the 1940s. Major land use changes came to western Honouliuli when the U.S. military began development in the area. Military installations were constructed near the coast as well as in the foothills and upland areas. Barbers Point Military Reservation (a.k.a. Battery Barbers Point from 1937–1944), located at Barbers Point Beach, was used beginning in 1921 as a training area for firing 155 mm guns (Payette 2003). Also in the vicinity were Camp Malakole Military Reservation (a.k.a. Honouliuli Military Reservation), used from 1939, and Gilbert Military Reservation, used from 1922–1944. Barbers Point Naval Air Station (NAS), in operation from 1942 into the 1990s, was the largest and most significant base built in the area. It housed numerous naval and defense organizations, including maritime surveillance and anti-submarine warfare aircraft squadrons, a U.S. Coast Guard Air Station, and components of the U.S. Pacific Fleet.

Fort Barrette (a.k.a. Kapolei Military Reservation and Battery Hatch), located atop Pu‘uokapolei to the southwest, was in use from 1931 to 1948 for housing four 3-inch anti-aircraft batteries (Payette 2003). In the 1950s, the site was used as a NIKE missile base. Palailai Military Reservation, located atop Pu‘u Pālailai in Makakilo to the west, was in service from 1921, housing Battery Palailai and Fire Control Station B (Payette 2003). Fire Control Station A was located atop Pu‘u Makakilo approximately 1.4 km to the southwest of the project area. From 1942 to 1945 the Pu‘u Makakilo Training Area, including lands in and around Pu‘u Makakilo, was used for military training during World War II (Environment Hawai‘i 1992).

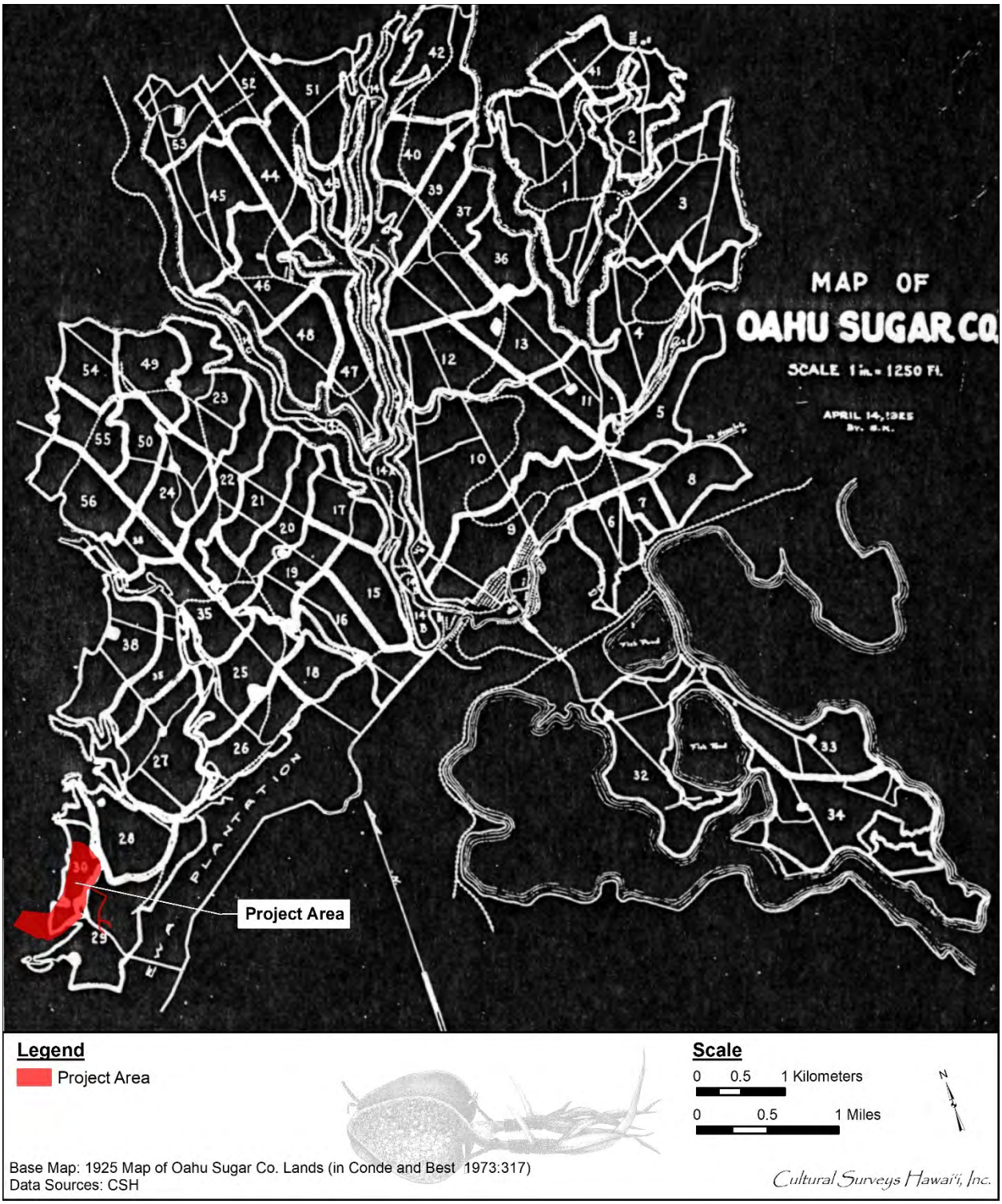

Figure 19. 1925 Oahu Sugar Company plantation map showing project area (red) as largely within former Field 30 (Condé and Best 1973:317)

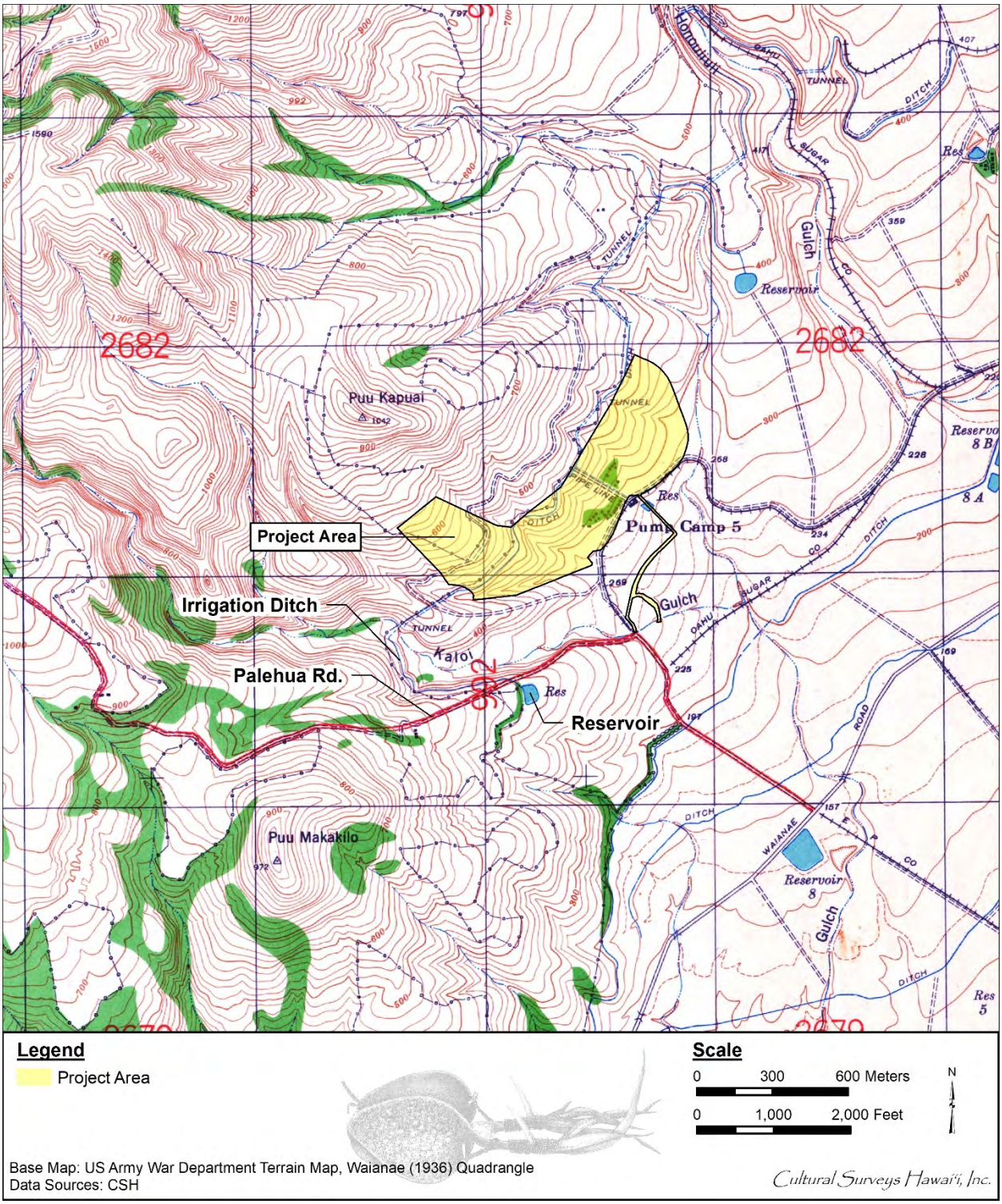

Figure 20. Portion of the 1936 U.S. Army War Department terrain map, Waianae quadrangle showing the location of the project area

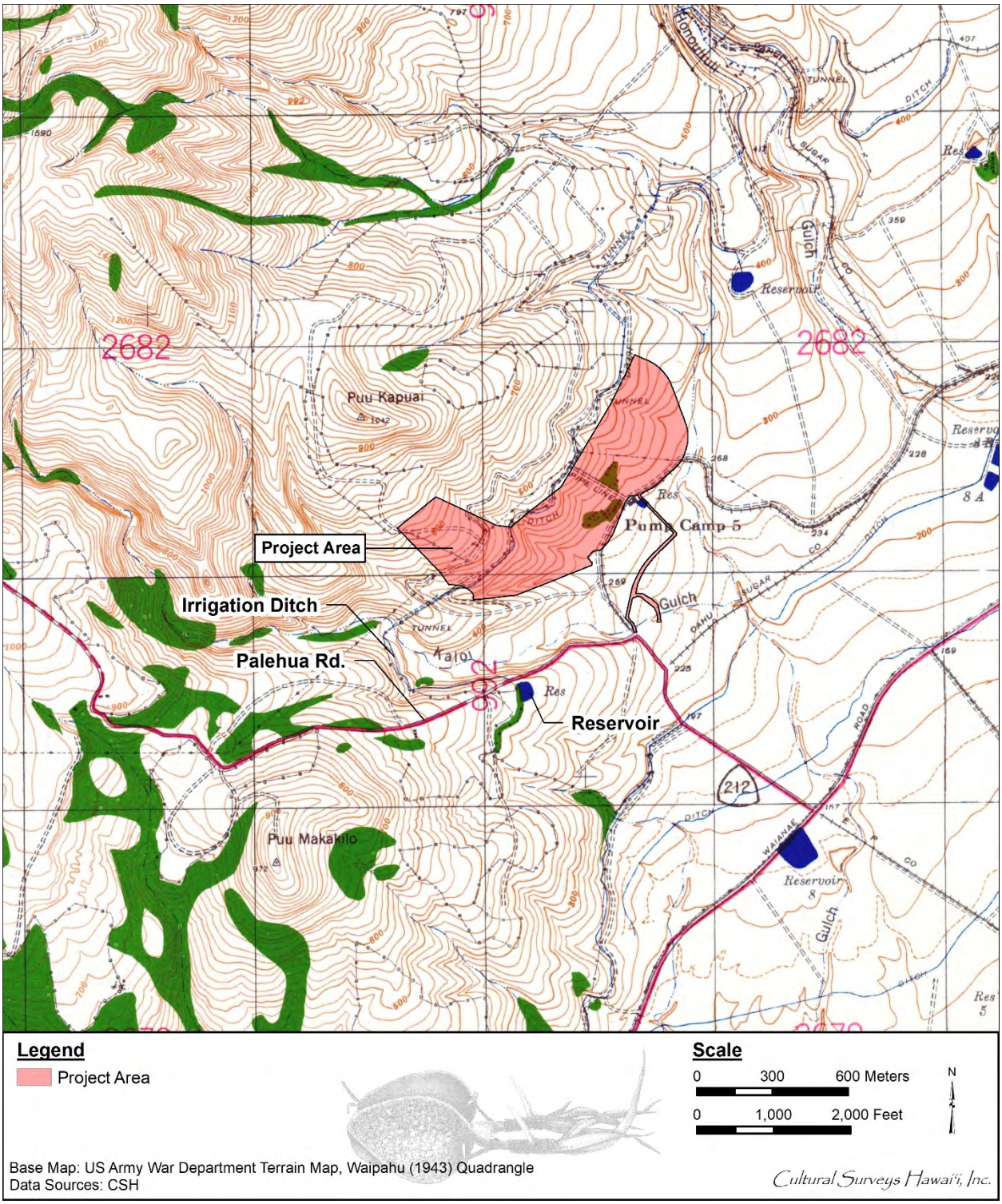

Figure 21. Portion of the 1943 U.S. Army War Department terrain map, Waipahu quadrangle showing the project area

The 1951 aerial photograph (Figure 22) clearly shows the two neighboring housing areas of Pump Camp 5 within the central portion of the project area (just northwest and southwest of the pump house building or pumping station which remains just outside the project area). While the majority of the project area was under sugarcane cultivation, it appears the southwest portion of the project area, west or upslope of the Waiahole Ditch, was not under cultivation at that time, instead used as grazing lands. The west portion of the project area appears to have been previously cultivated but appears fallow. Extensive areas north of Pu‘u Kapua‘i appear to be under pineapple cultivation.

The 1953 USGS map (Figure 23) shows much the same landscape as the 1943 map (see Figure 21) except the railroads have now all disappeared—quickly replaced by trucking after World War II. A naval reservation is shown on the southeast base of Pu‘u Makakilo. An access road is now depicted running up the mouth of Kalo‘i Gulch, parallel to and just north of the Kalo‘i Stream channel, understood to have been developed to service the present quarry. The initial date of construction of an industrial quarry within Kalo‘i Gulch—depicted to the south (outside) of the current project area—is uncertain, though historic maps indicate a construction window between 1943 and 1952. In 2004, CSH conducted an archaeological inventory survey whereby the quarry was documented and designated an historic property: SIHP # 50-80-12-6680.

The 1968/1969 USGS map (Figure 24) no longer shows Pump Camp 5, which had been prominent at least as early as 1936 (see Figure 20) and lasted until at least 1953 (see Figure 23). The “Pumping Station” immediately southeast of the project area is still labeled and in general the plantation infrastructure (other than the train lines) appears active. The road up Kalo‘i Gulch, depicted as improved in 1953, is now shown as unimproved suggesting abandonment of some quarrying operations.

4.5 Contemporary Land Use

Modern maps of the Makakilo area indicate vast changes to the project area and surrounding lands, including the retreat of the sugarcane fields, the construction of the H-1 Freeway, and the partial construction of the Pu‘u Makakilo Golf Course and Grace Pacific Makakilo Quarry.

The 1968 aerial photograph (Figure 25) shows virtually the entire project area still utilized for sugarcane, though there is no trace of the former Pump Camp 5 residential areas that appear to now be entirely covered with cane. Many of these plantation homes are understood to have been slightly raised on “tofu-block” foundations that allowed for relatively complete demolition leaving only the remnants of privies and trash pits. The 1968 USGS aerial photograph also shows new fields to the northwest (Figure 25).

In 1969 and 1970, Pacific Concrete and Rock Company, Ltd. began subsurface drilling on the southward facing slopes of Pu‘u Makakilo for a new quarry location. The company’s previous quarry in Pu‘u Pala‘ila‘i that had been in operation for the past 22 years was nearly exhausted. The newly proposed Makakilo Quarry would “encompass 72 acres of actual total quarry area and 188 acres of green belt buffer. Of the 72 acres of actual quarry area, only a maximum of 18 acres will be under active quarrying at any given time” (Cerny 1972:1).

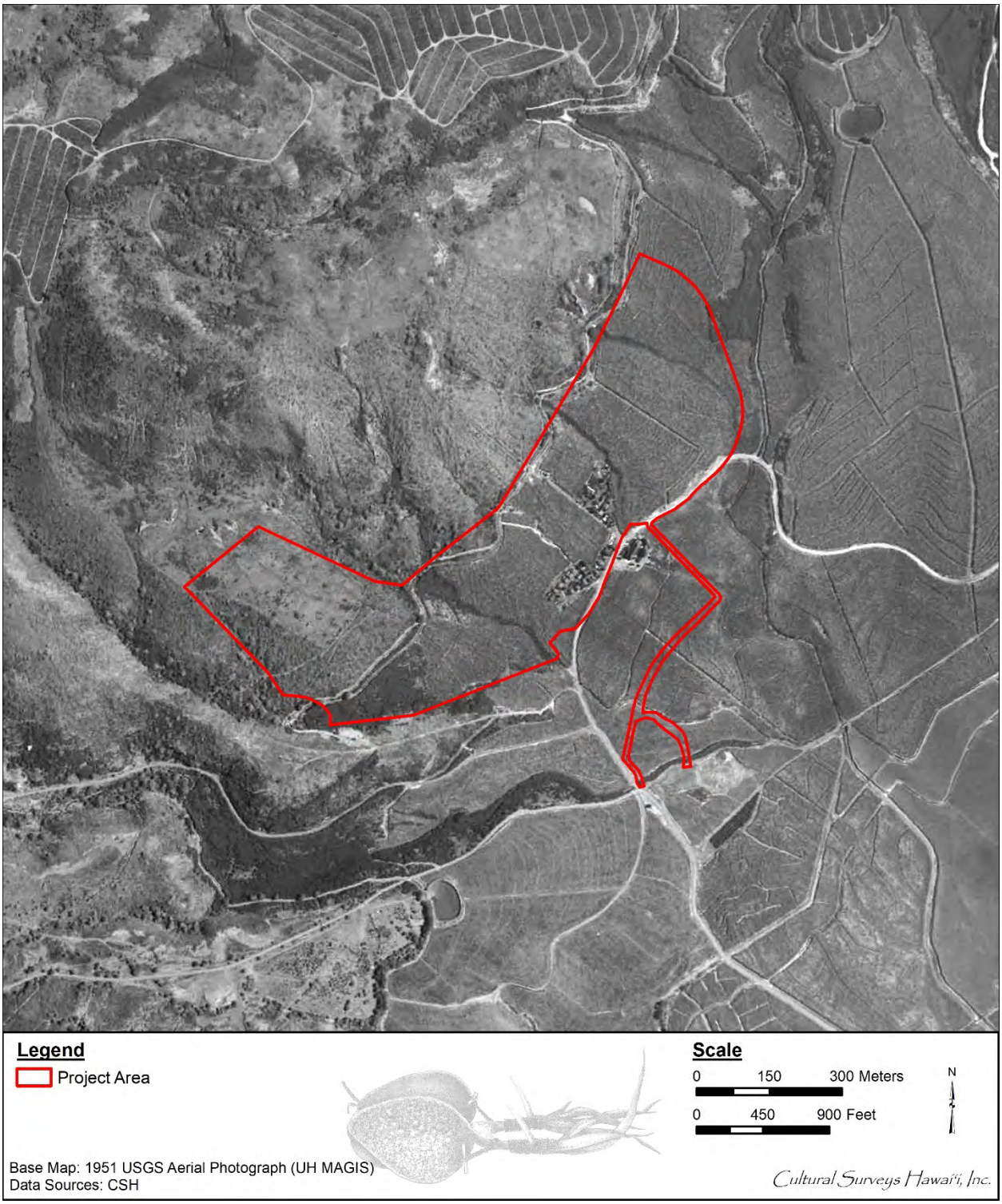

Figure 22. 1951 USGS aerial photograph (UH MAGIS) showing the project area

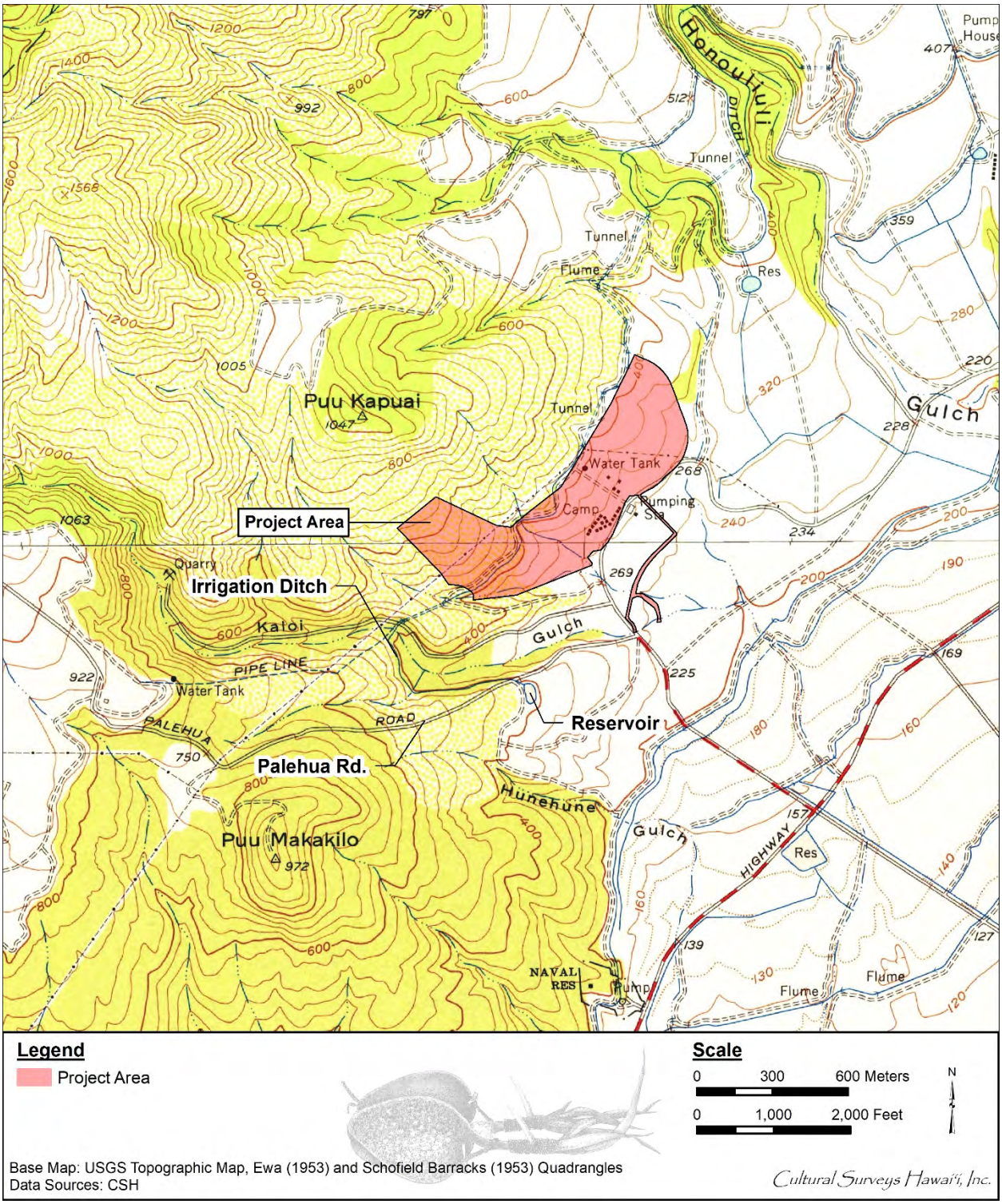

Figure 23. Portion of the 1953 Ewa and Schofield Barracks USGS topographic quadrangles showing the project area

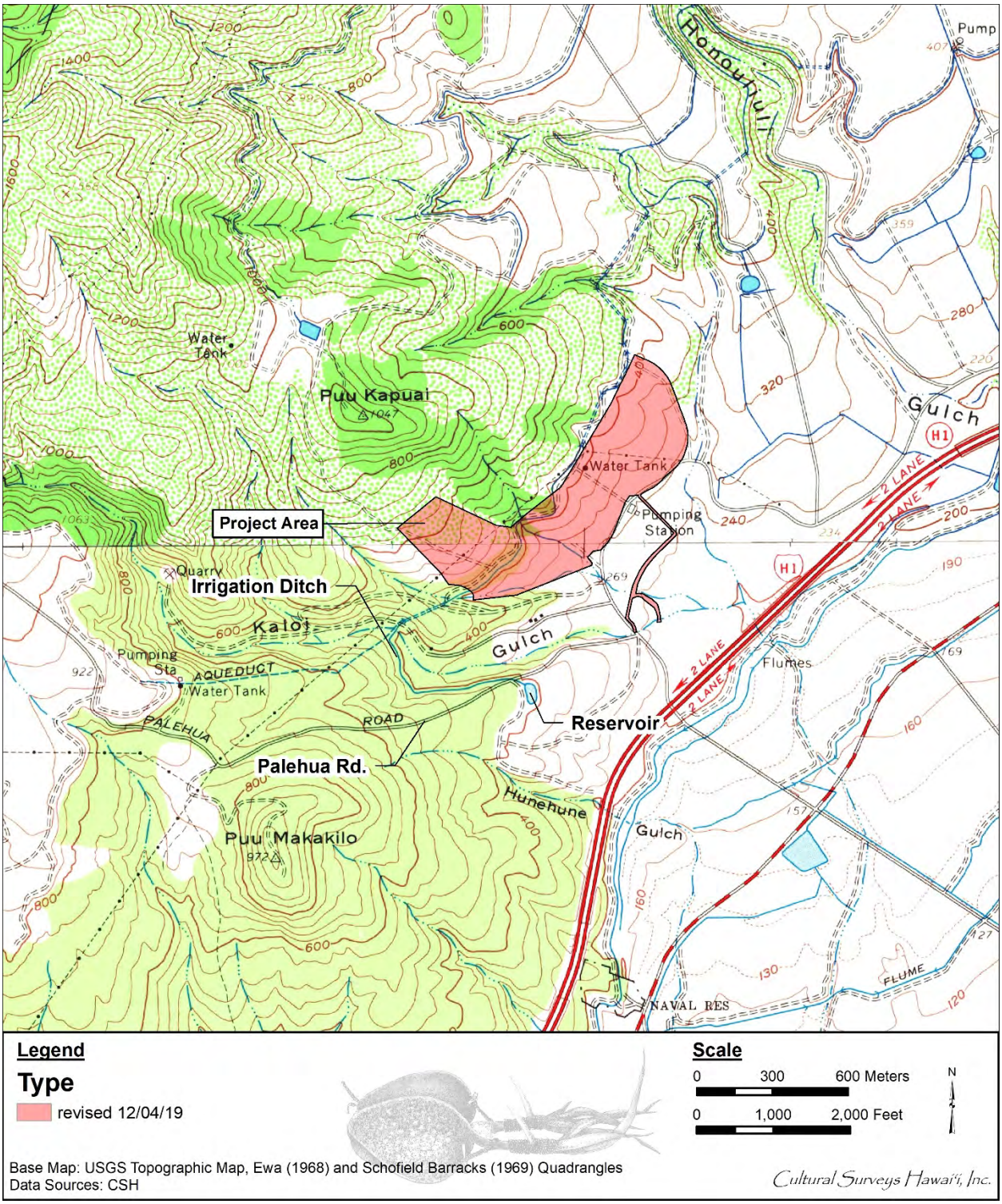

Figure 24. Portion of the 1968 Ewa and 1969 Schofield Barracks USGS topographic quadrangles showing the project area

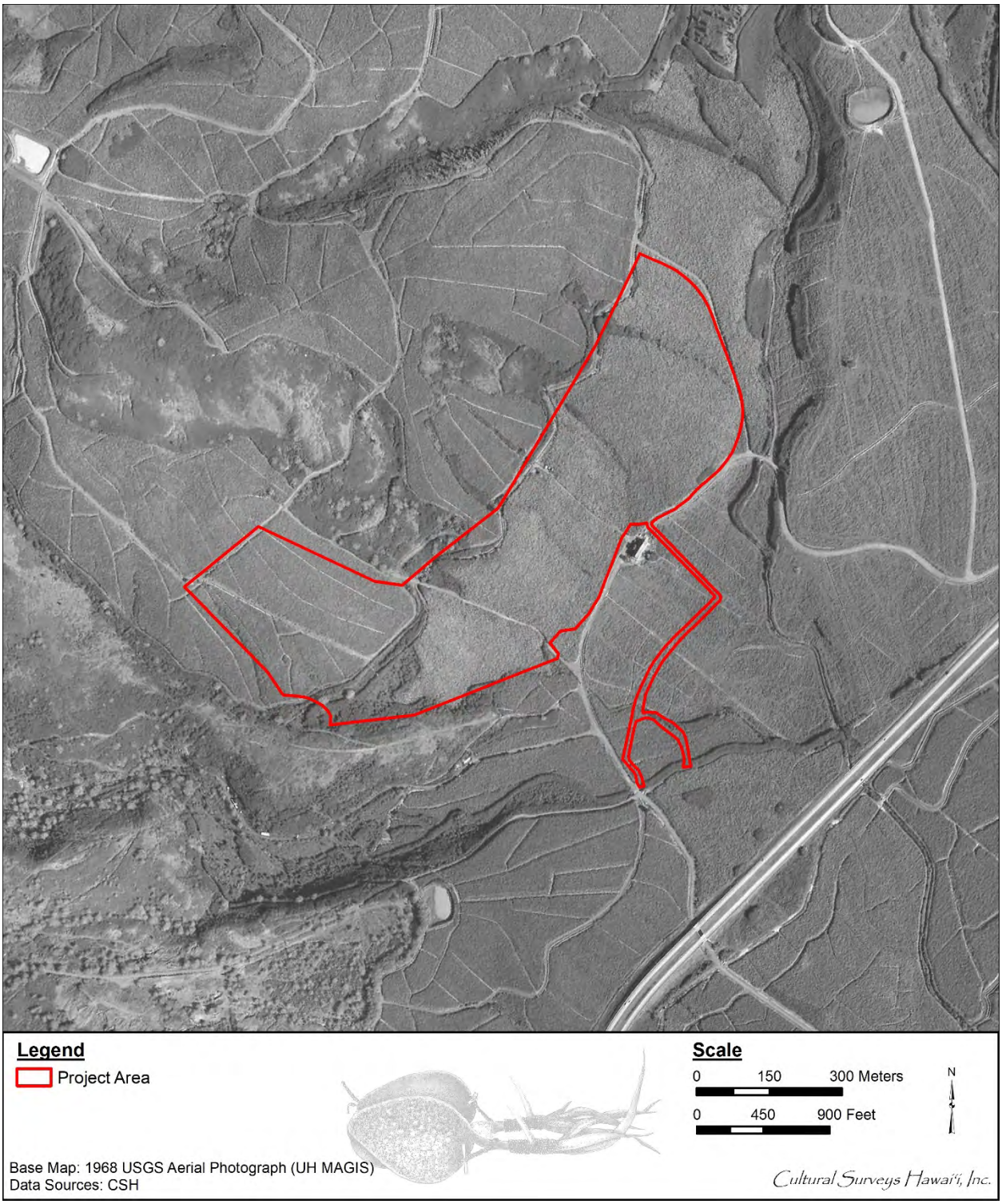

Figure 25. 1968 USGS aerial photograph (UH MAGIS) showing the project area

A 1977 USGS aerial photograph (Figure 26) appears to display decreased sugarcane cultivation in the Wai‘anae foothills. It is not clear if the project area is in active cultivation or not. Clearly by 1993 (Figure 27) sugarcane cultivation within the project area is finished, although it remains active immediately southeast of the project area.

Sometime in the early 1990s, a group of Japanese investors poured $70 million into the development of the Pu‘u Makakilo Golf Course. The golf course’s exact date of construction is unclear; however, the proposed area was surveyed by Sinoto in 1988 (Sinoto 1988). The golf course was situated on the slopes of Pu‘u Makakilo just north of the rock quarry. During a burst bubble in the Japanese investment market the project foundered, and the course and buildings were purchased by Grace Pacific in 1994 (*Honolulu Advertiser*, May 2004:31). Construction of the golf course resulted in grading and terracing of a large area just south of the present project area for fairway construction.

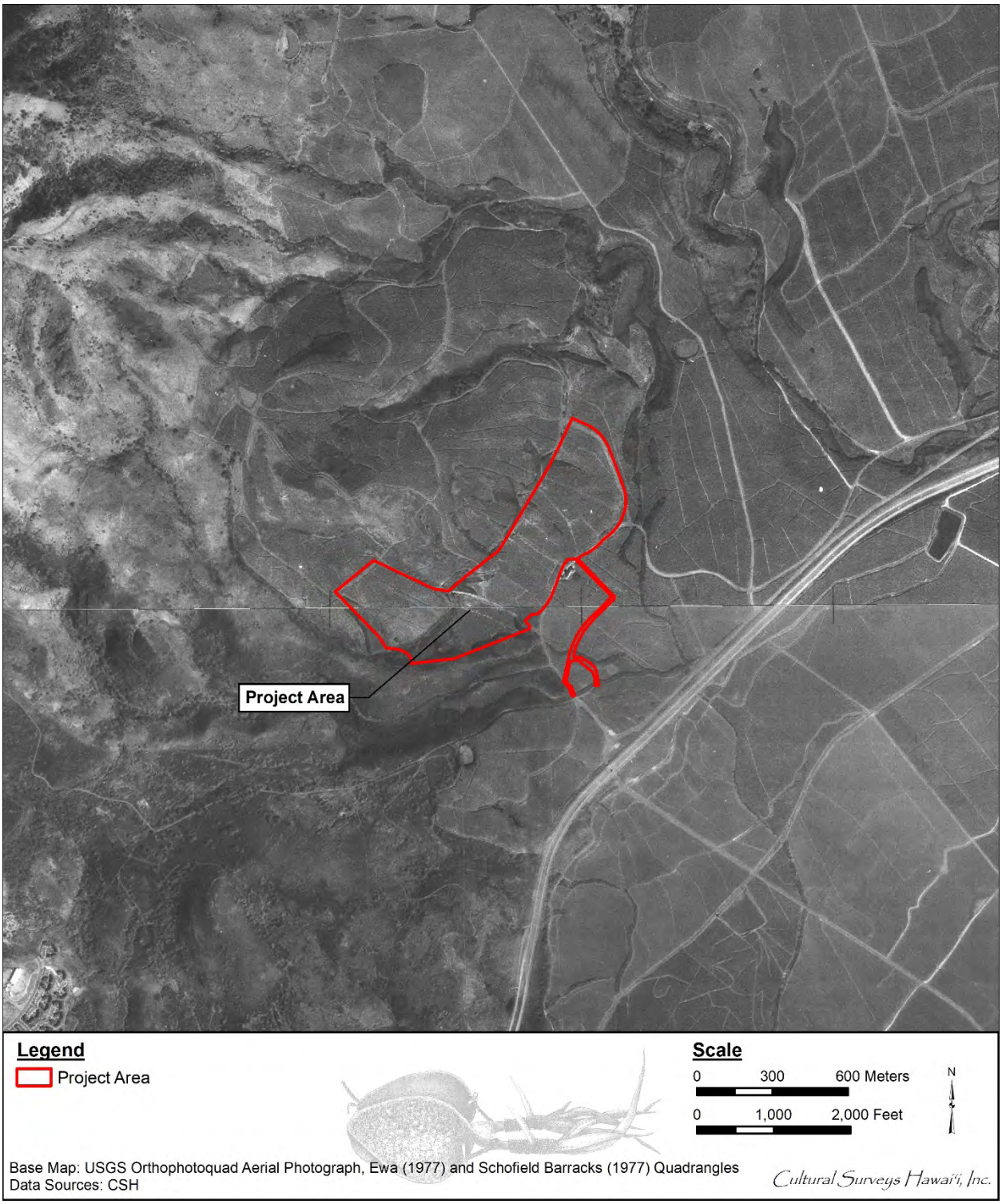

Figure 26. 1977 USGS Orthophotoquad aerial photograph, Ewa and Schofield Barracks quadrangles showing the project area

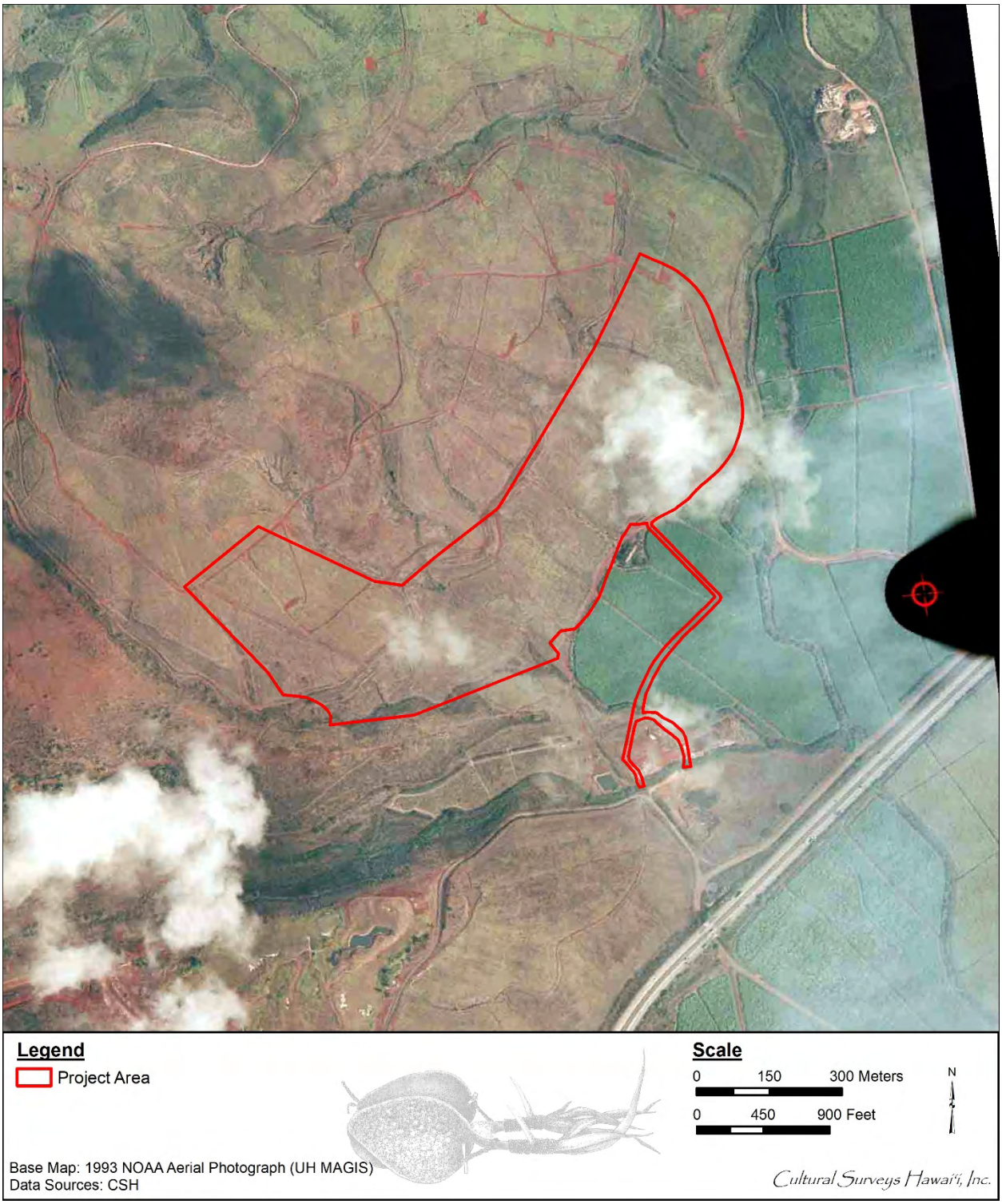

Figure 27. 1993 NOAA aerial photograph (UH MAGIS) showing the project area

Section 5 Previous Archaeological Research

Several archaeological studies have been conducted in the vicinity of the project area. This section discusses previous archaeological studies in the area (Figure 28 and Table 1) and identifies the types and locations of previously identified historic properties (Figure 29 and Table 2). There are no sites documented by McAllister (1933) in his early archaeological reconnaissance study of O‘ahu in the vicinity of the project area.

5.1 Archaeological Investigations in the Vicinity of the Project Area

5.1.1 Bordner 1977

In 1977, the Archaeological Research Center Hawaii, Inc. (Bordner 1977) conducted an archaeological reconnaissance survey of a then proposed Kalo‘i Gulch landfill location, 500 m west of the present project area. The study concluded the lower section of the gulch had been extensively modified through quarrying operations and cattle ranching. Foundations of both crushing and loading facilities were noted. In the upper reaches of the property, three walls of possible pre-Contact origin were documented between 1,250 and 1,300 ft elevation and were designated as SIHP #s 50-80-12-2600, -2601 and -2602. These three historic properties were in the extreme, upslope end of the large property more than 1.5 km from the present project area. SIHP # -2600 was a low (only 0.61 m or 2.0 ft high) wall of poorly stacked *pāhoehoe* (smooth, unbroken type of lava), approximately 7.62 m (25.00 ft) long set on top of a small knoll jutting out from the slope. SIHP # -2600 is described as a wall built on the stream terrace cut following the course of the stream, and constructed of stacked *pāhoehoe* with a total length of 67.70 m (222.1 ft), an average height of 0.91 m (3.0 ft) and incorporating in situ boulders into the wall. The wall appeared to have been constructed to protect a stream terrace from erosion. It also retained a terrace measuring approximately 12.0 m (39.4 ft) by 31.0 m (101.7 ft). SIHP # 50-80-12-2602 was a free-standing 18.2-m (59.7-ft) wall of stacked *pāhoehoe* that had the appearance of being a boundary wall. The historic properties were regarded as of “a marginal status” and no further archaeological work was recommended for the area covered in the reconnaissance survey.

5.1.2 Sinoto 1988

In 1988, the Bishop Museum Applied Research Group conducted a surface survey for a then proposed Makakilo Golf Course just southwest of the current project area (Sinoto 1988). The study concluded the majority of the project area had been damaged by severe erosion. No surface remains were documented within the project area and subsurface testing was deemed unnecessary. Just west (outside) of the golf course property, one deteriorated wall segment was documented on the northeast slope of Pu‘u Makakilo. The wall, designated SIHP # 50-80-12-1975, may have served as an “historic erosional control feature” (Sinoto 1988:1). Due to the deteriorated condition of the wall remnant, no further work was recommended.

5.1.3 Spear 1996

Scientific Consultant Services, Inc. conducted an archaeological reconnaissance survey of a large area extending from south of the H-1 freeway to the north side of Renton Road (Spear 1996). No historic properties were identified.

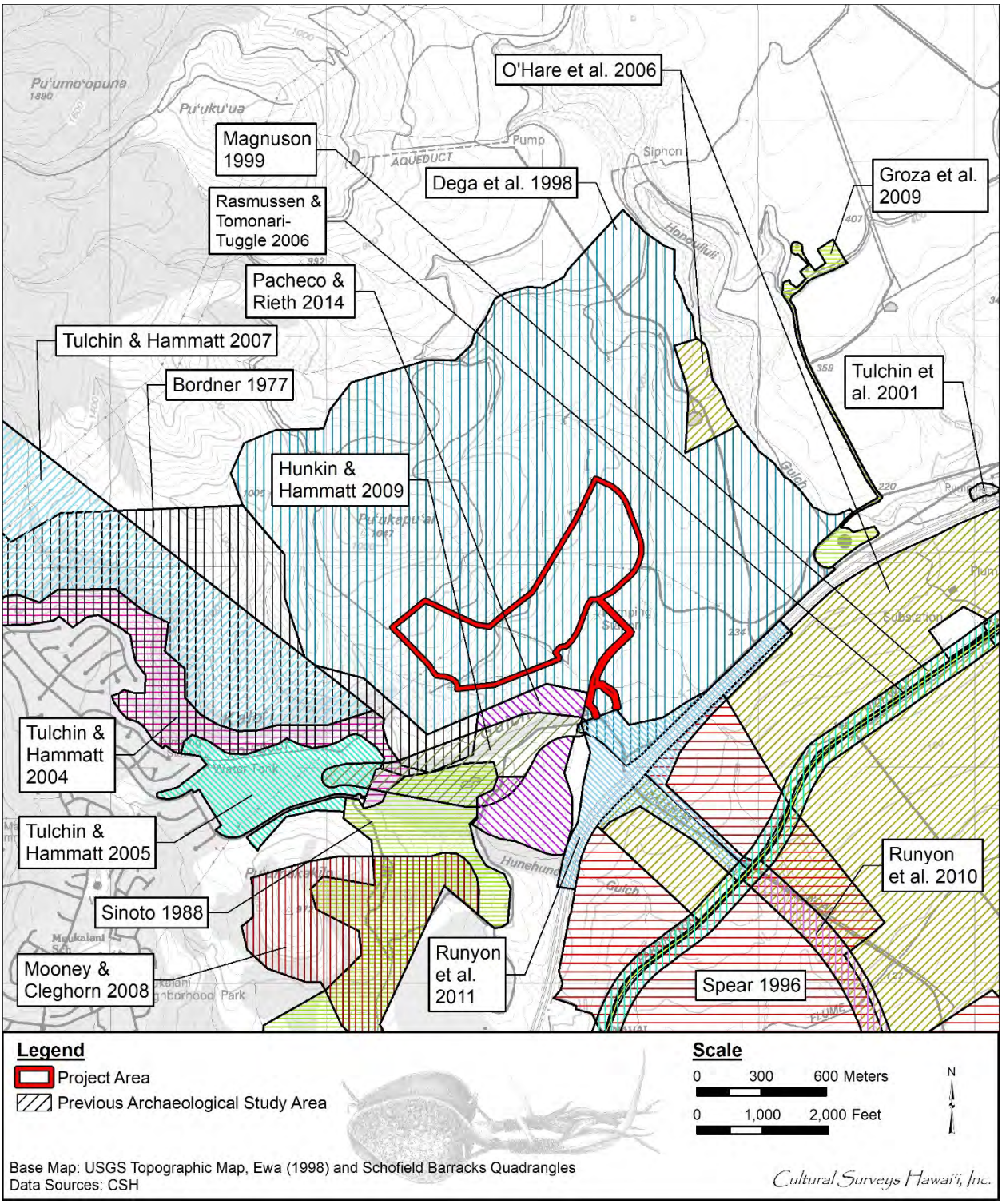

Figure 28. Portion of the 1998 Ewa and Schofield Barracks USGS topographic quadrangles showing the locations of previous archaeological studies in the vicinity (within approximately 1.5 km) of the project area

Table 1. Previous archaeological studies within the vicinity (within approximately 1.5 km) of the project area

Author	Type of Investigation	Location	Report Description and Results
Bordner 1977	Archaeological reconnaissance survey	Proposed Kalo‘i Gulch landfill location	Three walls designated as SIHP #s 50-80-12-2600, -2601 and -2602 in extreme west, upslope end of large project area, more than 1.5 km from present project area (and hence are not depicted in Figure 29)
Sinoto 1988	Archaeological reconnaissance survey	Makakilo Golf Course	Low stacked boulder wall, SIHP # 50-80-09-1975
Spear 1996	Archaeological reconnaissance survey	East Kapolei, TMK: [1] 9-1-016:017	No historic properties identified
Dega et al. 1998	Archaeological inventory survey	UH West O‘ahu, TMK: [1] 9-2-002:001	Two historic property complexes: historic irrigation and plantation infrastructure system (SIHP # 50-80-08-5593) and Waiahole Ditch System (SIHP # 50-80-09-2268)
Magnuson 1999	Archaeological reconnaissance survey	‘Ewa Plain	Identified six concrete bridges, a railroad track, and a set of unidentified concrete features; no SIHP #s assigned
Tulchin et al. 2001	Archaeological inventory survey	Proposed ‘Ewa Shaft Renovation project, Honouliuli Gulch, adjacent to west-bound lanes of H-1, TMK: [1] 9-2-001	SIHP # 50-80-08-6370, stone wall alignment; also documented large pumping station and shaft building
Tulchin and Hammatt 2004	Archaeological inventory survey	86-acre proposed Pālehua Community Association, TMKs: [1] 9-2-003:078 por. and 079	Four historic properties identified: a complex of concrete and iron structures associated with industrial rock quarry operations (SIHP # 50-80-12-6680); three boulder mounds believed to be related to land clearing or ditch construction by Oahu Sugar Co. (SIHP # 50-80-12-6681); a small terrace believed to function as a historic water diversion feature (SIHP # 50-80-12-6682); and a remnant portion of Waiahole Ditch (SIHP # 50-80-09-2268)

Author	Type of Investigation	Location	Report Description and Results
Tulchin and Hammatt 2005	Archaeological inventory survey	71-acre proposed Pālehua East B project, Makakilo, TMKs: [1] 9-2-003:076 and 078	Three historic properties identified: pre-Contact agricultural alignment and mound (SIHP # 50-80-12-6666), plantation-era stacked basalt boulder walls and a ditch (SIHP # 50-80-12-6667), and single alignment of upright basalt boulders and a small, low terrace (SIHP # 50-80-12-6668)
O’Hare et al. 2006	Archaeological inventory survey	Ho‘opili East Kapolei	Documented six previously identified historic properties: plantation infrastructure (SIHP # 50-80-12-4344); railroad berm (SIHP # 50-80-12-4345); northern pumping station (SIHP # 50-80-12-4346); central pumping station (SIHP # 50-80-12-4347); southern pumping station (SIHP # 50-80-12-4348); and documented four newly identified features of SIHP # 50-80-12-4344: a linear wall, stone-faced berm, concrete ditch, and concrete catchment
Rasmussen and Tomonari-Tuggle 2006	Archaeological monitoring	Waiau Fuel Pipeline corridor	No historic properties identified
Tulchin and Hammatt 2007	Archaeological literature review and field inspection	Approx. 790-acre parcel, TMKs: [1] 9-2-003:002 por. and 005 por.	Documented features interpreted as related to pre-Contact indigenous Hawaiian habitation (SIHP #s 50-80-08-2316 and 50-80-12-2602); historic ranching and related features (SIHP # 50-80-12-2601); and historic quarrying and related features (SIHP # 50-80-12-6680) and various pre- and post-Contact features (designated with temporary #s CSH1–CSH22)
Mooney and Cleghorn 2008	Archaeological reconnaissance survey	TMK: [1] 9-2-003:018	No historic properties identified
Groza et al. 2009	Archaeological inventory survey	TMKs: [1] 9-2-001:001 por., 004, 005, 006, 007 por.; 9-2-002:002	No historic properties identified

Author	Type of Investigation	Location	Report Description and Results
Hunkin and Hammatt 2009	Archaeological inventory survey	TMKs: [1] 9-2-002:006; 9-2-003:079	Documented two newly identified historic properties: irrigation ditches (SIHP #s 50-80-12-6950 and -6951); and one previously identified historic property, Waiahole Ditch (SIHP # 50-80-09-2268)
Runyon et al. 2010	Archaeological monitoring	TMKs: [1] 9-2-002:006; 9-2-003:079	No historic properties identified
Runyon et al. 2011	Archaeological monitoring	TMKs: [1] 9-1-018:001, 003, 004, 005; 9-2-002:001, 006	Documented two historic properties: a water diversion and a trash deposit (SIHP #s 50-80-12-4664 and -7128)
Pacheco and Rieth 2014	Archaeological inventory survey	East Kapolei Solar Farm, TMK: [1] 9-2-002:006 por.	Documented SIHP # 50-80-12-7433, an unpaved early twentieth century agricultural (ranching and/or sugarcane cultivation) road, understood as created between 1918 and 1928

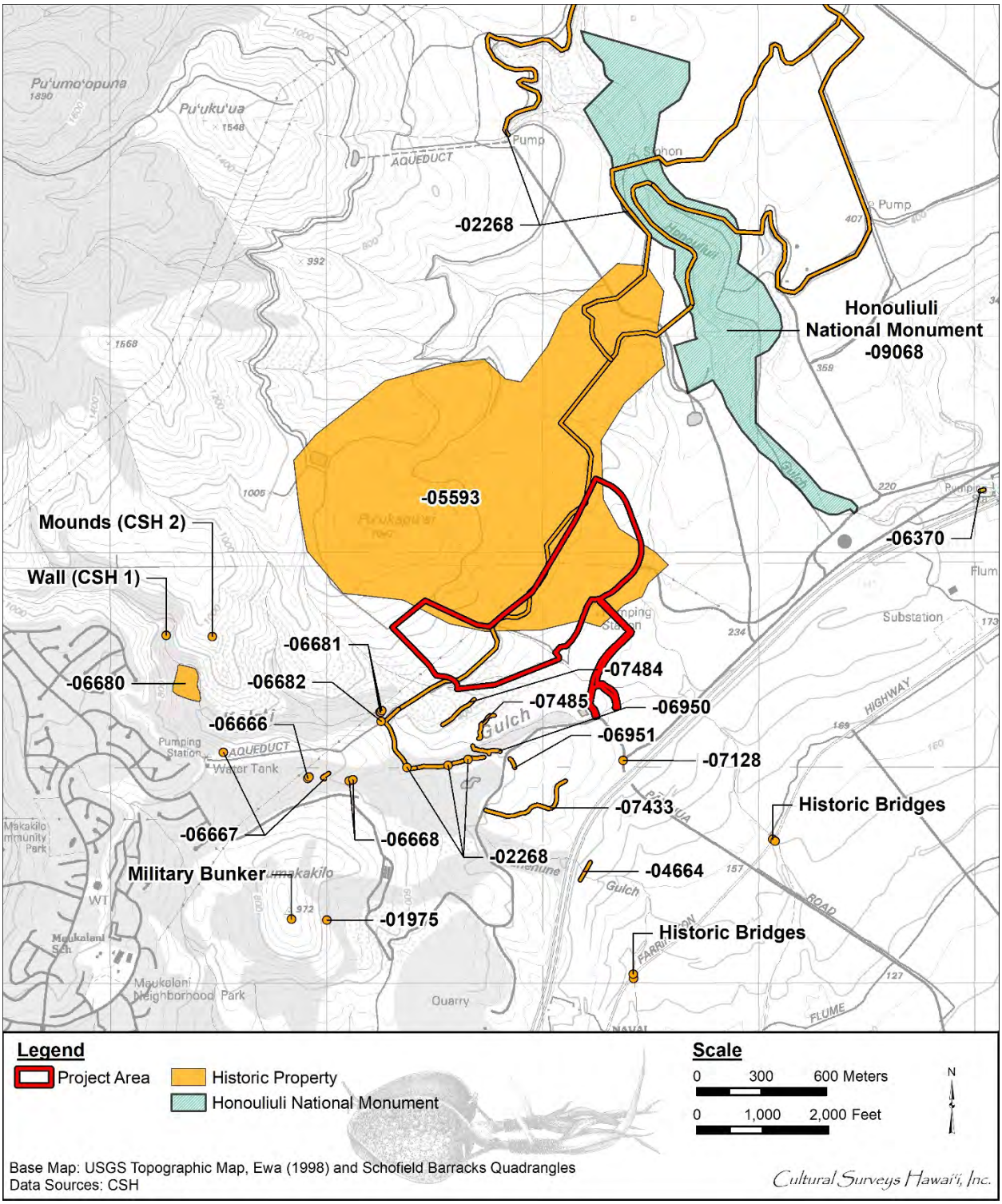

Figure 29. Portion of the 1998 Ewa and Schofield Barracks USGS topographic quadrangles showing the locations of previously identified historic properties in the immediate vicinity of the project area

Table 2. Previously identified historic properties in the vicinity of the project area

SIHP #	Description	Report Author(s)
50-80-08-5593	Plantation-era “flumes, aqueducts, ditches, pumps, and other irrigation features”	Dega et al. 1998
50-80-08-6370	Stone wall alignment, likely associated with cattle ranching or pumping station	Tulchin et al. 2001
50-80-09-2268	Waiahole Ditch System	Goodman and Nees 1991; Hammatt et al. 1996; Dega et al. 1998; Tulchin and Hammatt 2005; Hunkin and Hammatt 2009; Zapor et al. 2018; Shideler and Hammatt 2018
50-80-08-9068	Honouliuli National Monument (Internment Camp)	National Register
50-80-12-1975	Low-stacked boulder wall segment	Sinoto 1988
50-80-12-4664	Historic water diversion structure	Nakamura et al. 1993; Runyon et al. 2011
50-80-12-6666	Alignment and mound	Tulchin and Hammatt 2005
50-80-12-6667	Two walls	Tulchin and Hammatt 2005
50-80-12-6668	Alignment and terrace	Tulchin and Hammatt 2005
50-80-12-6680	Complex of concrete and iron structures associated with industrial rock quarry operations	Tulchin and Hammatt 2005
50-80-12-6681	Three boulder mounds believed to be related to land clearing or ditch construction by the Oahu Sugar Company	Tulchin and Hammatt 2005
50-80-12-6682	Terrace believed to function as an historic water diversion feature	Tulchin and Hammatt 2005
50-80-12-6950	Portion of a plantation-era irrigation ditch	Hunkin and Hammatt 2009
50-80-12-6951	Portion of a plantation-era irrigation ditch	Hunkin and Hammatt 2009
50-80-12-7128	Burned trash fill layer	Runyon et al. 2011

SIHP #	Description	Report Author(s)
50-80-12-7433	Unpaved early twentieth century agricultural (ranching and/or sugarcane cultivation) road, understood as created between 1918 and 1928	Pacheco and Rieth 2014
50-80-12-7484	Post-Contact irrigation ditch portion	Pacheco and Rieth 2014
50-80-12-7485	Post-Contact irrigation ditch portion	Pacheco and Rieth 2014
Historic Bridges	No SIHP #s assigned, no further documentation or mitigation recommended	Magnuson 1999
Military Bunker	WWII-era bunker	Mooney and Cleghorn 2008
CSH 1	Post-Contact wall related to historic ranching	Tulchin and Hammatt 2007
CSH 2 (Mounds)	Two basalt mounds interpreted as possible trail markers	Tulchin and Hammatt 2007

5.1.4 Dega et al. 1998

In 1998, Scientific Consultant Services, Inc. (SCS) conducted an archaeological inventory survey (AIS) for the University of Hawai‘i, West O‘ahu Campus project area (Dega et al. 1998). The project encompassed the entirety of the current project area. Several plantation-era “flumes, aqueducts, ditches, pumps, and other irrigation features occurring within the heavily modified landscape of the project area” were noted (Dega et al. 1998:i). The features represented an extensive complex of sugarcane irrigation features used from the 1920s through more recent times. The irrigation complex was designated SIHP # 50-80-08-5593. A portion of the Waiahole Ditch System (SIHP # 50-80-09-2268) (previously recorded by Goodman and Nees 1991) was also documented crossing through the northwest section of the subject parcel and continuing southwest through the lower agricultural fields. No artifacts were recovered from the project area. No further work was recommended for SIHP # 50-80-08-5593.

An overlay of the present project area on the Dega et al. (1998) plan map (Figure 30) indicates that it lies entirely within the south/central portion of that 1998 AIS project. While the Dega et al. (1998) plan map should probably be understood as a sketch, it does indicate certain remnants of plantation infrastructure (designated as SIHP # 50-80-08-5593) were present in the present project area in 1998.

5.1.5 Magnuson 1999

In 1999, an archaeological reconnaissance survey was completed by International Archaeological Research Institute, Inc. (IARII) for a Farrington Highway Expansion project extending along 5.3 km (3.3 miles) of Farrington Highway between Golf Course Road and Fort Weaver Road with a roughly 61-m (200-ft) wide corridor on each side (Magnuson 1999). The project identified six concrete bridges, one railroad track, and “a set of unidentified concrete features” (Magnuson 1999:17). The study concluded the following:

> The sites observed in the Farrington Highway Expansion project are neither exemplary sites of their kind nor unique. Therefore these sites have been adequately recorded during the investigations and no further work is necessary should preservation not be possible. [Magnuson 1999:25]

5.1.6 Tulchin et al. 2001

CSH archaeologists completed an AIS in support of a proposed ‘Ewa Shaft Renovation project. The ‘Ewa Shaft project is within Honouliuli Gulch, adjacent to the west-bound lanes of the H-1 Interstate Highway, approximately 1.7 km east of the present project area. That property included a pumping station enclosure and the surrounding area of approximately 1 acre. One historic property was documented, a stone wall alignment designated SIHP # 50-80-08-6370. Subsurface testing was conducted adjacent to the wall. The wall alignment was interpreted as constructed in association with cattle ranching or the pumping station. The study also documented a portion of the large pumping station and shaft building on the property.

5.1.7 Tulchin and Hammatt 2004

In 2004, CSH conducted an AIS to the west of the current project area for the Pālehua Community Association (PCA) in Makakilo (Tulchin and Hammatt 2004). Three overhang shelters were observed and tested, however, no cultural material was identified during excavation.

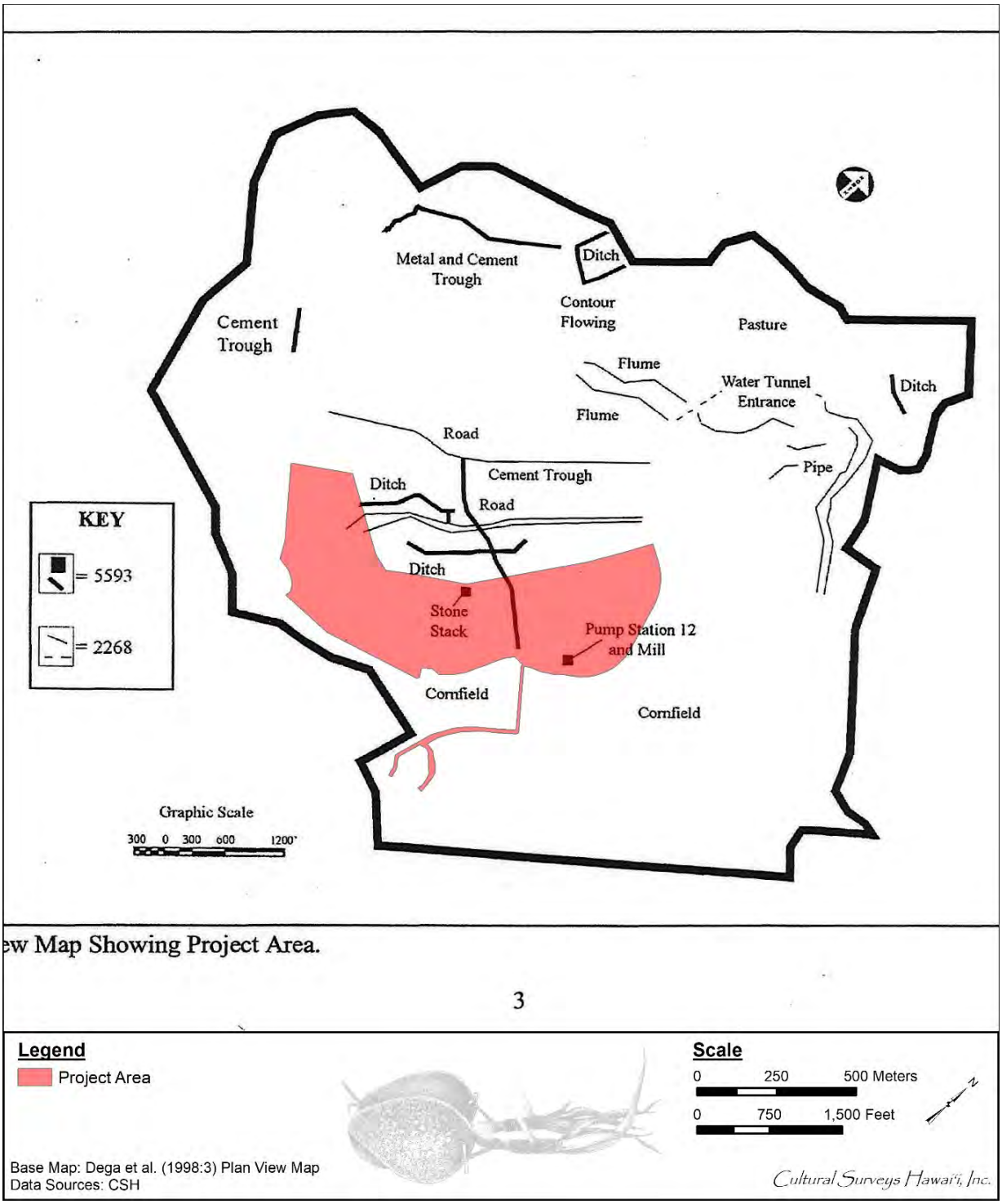

Figure 30. Plan map of the AIS for the University of Hawai‘i, West O‘ahu Campus project area showing historic properties (as of 1998) with an overlay of the current project area (adapted from Dega et al. 1998:3). This overlay suggests “Pump Station 12 and Mill” and a ditch were documented as within the present project area and another ditch and road and “Stone stack” were adjacent to the north side of the present project area.

The study documented several historic properties, including a complex of concrete and iron structures associated with industrial rock quarry operations (SIHP # 50-80-12-6680); three boulder mounds believed to be related to land clearing or ditch construction by the Oahu Sugar Company (SIHP # 50-80-12-6681); a small terrace believed to function as an historic water diversion feature (SIHP # 50-80-12-6682); and a remnant portion of the Waiahole Ditch (SIHP # 50-80-09-2268).

5.1.8 Tulchin and Hammatt 2005

In 2005, CSH conducted an AIS west of the current project area for the proposed Pālehua East B project in Makakilo (Tulchin and Hammatt 2005). The study identified three historic properties, including an alignment and a mound (SIHP #s 50-80-12-6666A and B), two walls (SIHP #s 50-80-12-6667A and B), and an alignment and terrace (SIHP #s 50-80-12-6668A and B). SIHP # 50-80-12-6667 is thought to contain remnants of plantation infrastructure. The historic properties were documented in an unnamed gully south of Kalo‘i Gulch.

5.1.9 O’Hare et al. 2006

In 2006, CSH conducted an AIS of approximately 1,600 acres for the East Kapolei project (subsequently known as the Ho‘opili project) (O’Hare et al. 2006) to the southeast of the present project area. The Ho‘opili project was bounded on the east by Fort Weaver Road, *makai* by Mango Tree Road, and *mauka* by the H-1 Freeway.

Several historic properties documented by the O’Hare et al. (2006) study were previously identified during an archaeological survey in 1990 (Hammatt and Shideler 1990). These previously identified historic properties included SIHP # 50-80-12-4344, plantation infrastructure; SIHP # 50-80-12-4345, railroad berm; SIHP # 50-80-12-4346, northern pumping station; SIHP # 50-80-12-4347, central pumping station; and SIHP # 50-80-12-4348, southern pumping station. Four additional archaeological features were documented by the O’Hare et al. (2006) study. These additional features, grouped under SIHP # 50-80-14-4344, include Feature D, a linear wall along the east bank of Honouliuli Stream; Feature E, a linear wall along the west bank of Honouliuli Stream; Feature F, a stone-faced berm constructed perpendicular to the orientation of the stream; and Feature G, a concrete ditch and concrete masonry catchment basement on the west bank of Honouliuli Gulch. None of the historic properties identified in the O’Hare et al. study (2006) were near the present project area.

5.1.10 Rasmussen and Tomonari-Tuggle 2006

In 2006, IARII conducted archaeological monitoring along the Waiau Fuel Pipeline corridor, extending from the Hawaiian Electric Company’s Barbers Point Tank Farm to the Waiau Generating Station (Rasmussen and Tomonari-Tuggle 2006). The Waiau Fuel Pipeline corridor follows Farrington Highway to Kunia Road, angles *makai* near Kunia Road, then continues east along the OR&L right-of-way near the Pearl Harbor coast. It appears no archaeological monitoring was conducted west of Waipi‘o Peninsula, as the corridor to the west had been determined to not be archaeologically sensitive. No historic properties were identified during archaeological monitoring.

5.1.11 Tulchin and Hammatt 2007

In 2007, an archaeological literature review and field inspection (Tulchin and Hammatt 2007) was done of an approximately 790-acre parcel at Pālehua, Makakilo. The inspection covered

portions of Makaīwa Gulch, Awanui Gulch, and Kalo‘i Gulch. Overall, 26 archaeological historic properties were identified during the field inspection. Four of these historic properties were identified during previous archaeological studies. SIHP # 50-80-08-2316 consists of a *ku‘ula* stone documented by the Bishop Museum (Kelly 1959). SIHP # 50-80-12-2601, a pre-Contact wall utilized as a water control feature, and SIHP # 50-80-12-2602, a pre-Contact wall possibly utilized for agriculture, were originally documented by Bordner in 1977 (Bordner 1977). SIHP # 50-80-12-6680, a complex of concrete and iron structures associated with industrial rock quarry operations was identified by CSH in 2004 (Tulchin and Hammatt 2004).

Newly identified historic features (designated with temporary CSH site #s) included CSH 1, wall; CSH 2, mounds; CSH 3, large enclosure; CSH 4, platform; CSH 5, mounds; CSH 6, adze; CSH 7, platform; CSH 8, terraces; CSH 9, enclosure and two small caves; CSH 10, enclosure; CSH 11, mound; CSH 12, platform; CSH 13, enclosure; CSH 14 terrace; CSH 15, wall remnant, hearth, and military “foxhole”; CSH 16, terrace and *hau* thicket; CSH 17, level soil along ridge; CSH 18, enclosure; CSH 19, trail; CSH 20 water tunnel; CSH 21, large boulder with petroglyphs; and CSH 22, enclosure with stone uprights. These potential historic properties were not assigned SIHP #s.

Other than the previously reported SIHP # -6680 complex of structures associated with industrial rock quarry operations, none of the identified historic properties were in the vicinity of the present project area.

5.1.12 Mooney and Cleghorn 2008

In 2008, Pacific Legacy, Inc. conducted an AIS (recorded as an archaeological assessment due to lack of finds) for the proposed Makakilo Quarry expansion (Mooney and Cleghorn 2008). No historic properties were identified; however, the remnants of a modern, abandoned golf course were noted.

5.1.13 Groza et al. 2009

In 2009, CSH conducted an AIS (recorded as an archaeological assessment) for the Ho‘opili project 440-Ft Elevation Reservoir and Water Line project (Groza et al. 2009). No historic properties were identified.

5.1.14 Hunkin and Hammatt 2009

In 2009, CSH completed an archaeological inventory survey for an approximately 62-acre Makakilo Drive extension project (Hunkin and Hammatt 2009). The project documented two newly identified historic properties (SIHP #s 50-80-12-6950 and -6951). Both historic properties are portions of plantation irrigation ditches. The ditches functioned to transport water for irrigation of the sugarcane fields.

In addition to the newly identified historic properties, a portion of the previously identified SIHP # 50-80-09-2268 alignment was documented. A meeting was held on site within the project area with CSH staff, SHPD staff, and Mr. Shad Kāne on 10 February 2009 to discuss the alignment within the project area. Mr. Kāne led the group along the graded alignment of SIHP # 50-80-09-2268, indicating the ditch had been constructed over the alignment of an ancient Hawaiian trail. SHPD staff observed the plantation irrigation ditch and associated infrastructure and concurred the alignment was a portion of the Waiahole Ditch System. SHPD staff also concluded the ditch was

most likely constructed over the alignment of a pre-Contact Hawaiian trail. SHPD staff expressed a concern that documentation make it clear the pre-Contact Hawaiian trail function was the dominant function of this designated site in the vicinity (which was then developed as the Waiahole Ditch in the early twentieth century).

Two new features (SIHP # 50-80-09-2268 Features B and C) associated with the main ditch were also documented. These features are drainage-related, with the function of preventing storm water and sediment from entering the main Waiahole Ditch.

5.1.15 Runyon et al. 2010

In 2010, CSH conducted archaeological monitoring for Phase 1B of the North-South Road project (Runyon et al. 2010). No historic properties were identified.

5.1.16 Runyon et al. 2011

In 2011, CSH completed archaeological monitoring for phase 1C of the North-South Road project (Runyon et al. 2011). Two historic properties were observed. A previously identified historic water diversion structure (SIHP # 50-80-12-4664), originally documented by Nakamura et al. (1993), was observed on the southwest edge of Ramp C. A newly identified burnt trash fill layer (SIHP # 50-80-12-7128) was documented directly under Pālehua Road on the west edge of Ramp A.

5.1.17 Pacheco and Rieth 2014

In 2014, IARII conducted an AIS (Pacheco and Rieth 2014) for an East Kapolei Solar Farm project (on approximately 19 acres of TMK: [1] 9-2-002:006).The study documented one historic property: SIHP # 50-80-12-7433, an unpaved early twentieth century road related to ranching and/or sugarcane cultivation in the area, understood as created between 1918 and 1928.

5.1.18 Zapor et al. 2018

CSH conducted a supplemental AIS for the Makakilo Drive Extension project. The survey identified two historic properties: portions of the Waiahole Ditch (SIHP # 50-80-09-2268) and irrigation ditches (SIHP # 50-80-12-6951). The project documented an additional feature of the Waiahole Ditch, an earthen mound and stacked stone wall, interpreted as likely remnants of a reservoir. SIHP # 50-80-12-6951 was observed as an irrigation ditch and associated retaining wall, pipe, valve, and sluice gate remnants.

Section 6 Community Consultation

6.1 Introduction

Throughout the course of this assessment, an effort was made to contact and consult with Native Hawaiian Organizations (NHO), agencies, and community members including descendants of the area, in order to identify individuals with cultural expertise and/or knowledge of the *ahupua‘a* of Honouliuli. CSH initiated its outreach effort in May 2019 through letters, email, telephone calls, and in-person contact. *Consultation is still on-going for this CIA.*

6.2 Community Contact Letter

Letters (Figure 31 and Figure 32) along with a map and an aerial photograph of the project were mailed with the following text:

> On behalf of AES Distributed Energy, Inc. (AES), Cultural Surveys Hawai‘i Inc. (CSH) is conducting a cultural impact assessment (CIA) for the AES West O‘ahu Solar Plus Storage Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu Island. AES is proposing a solar photovoltaic (PV) and battery energy storage system (BESS) project to be located approximately 3 miles northeast of Kapolei in West O‘ahu. The project area includes approximately 80 acres and is within a portion of tax map key (TMK) 9-2-002:007, which is owned by the University of Hawai‘i (UH) in an area commonly referred to as the UH West O‘ahu Mauka property. The project area is depicted on a portion of the 2013 Ewa and Schofield Barracks U.S. Geological Survey (USGS) 7.5-minute topographic quadrangles, and 2018 Google Earth aerial photograph.
>
> The proposed project will involve construction and operation of an approximately 12.5-megawatt (MW) ground-mounted solar PV system, coupled with a 50 MW-hour BESS and related interconnection and ancillary facilities. The solar PV panels will be arranged in a series of evenly-spaced rows across the project area. The BESS will consist of containerized lithium-ion battery units and inverters distributed across the project area. This equipment will connect with a project substation via underground electrical conduit. The substation will be constructed adjacent to an existing Hawaiian Electric Company (HECO) 46kV transmission line that traverses the project area and will facilitate interconnection of the project to the HECO grid; an overhead electrical connection between the substation and existing transmission line may be required for interconnection. The project will be accessed via the existing gated entry off Kualakai Parkway and will utilize a network of existing and new onsite access roads. Some site grading will be needed to accommodate the project facilities and to comply with stormwater and civil engineering requirements and some of the existing access roads may need to be improved to support access to the project site. The project area will be secured for use by AES through a long-term lease (or similar agreement) with UH. The Project will be owned and operated by AES, and the power generated by the Project will be sold to HECO under a new 25-year power purchase agreement (PPA). It is anticipated that construction will

Cultural Surveys Hawai'i, Inc.
Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

P.O. Box 1114 Kailua, Hawai'i 96734 Ph: (808) 262-9972 Fax: (808) 262-4950

Job code: HONOULIULI 172 ktamaka@culturalsurveys.com www.culturalsurveys.com

May 2019

Aloha,

On behalf of AES Distributed Energy, Inc. (AES), Cultural Surveys Hawai'i Inc. (CSH) is conducting a cultural impact assessment (CIA) for the AES West O'ahu Solar Plus Storage Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island. AES is proposing a solar photovoltaic (PV) and battery energy storage system (BESS) project to be located approximately 3 miles northeast of Kapolei in West O'ahu. The project area includes approximately 80 acres and is within a portion of tax map key (TMK) 9-2-002:007, which is owned by the University of Hawai'i (UH) in an area commonly referred to as the UH West O'ahu Mauka property. The project area is depicted on a portion of the 2013 Ewa and Schofield Barracks U.S. Geological Survey (USGS) 7.5-minute topographic quadrangles, and 2018 Google Earth aerial photograph (Figure 1 and Figure 2).

The proposed project will involve construction and operation of an approximately 12.5-megawatt (MW) ground-mounted solar PV system, coupled with a 50 MW-hour BESS and related interconnection and ancillary facilities. The solar PV panels will be arranged in a series of evenly-spaced rows across the project area. The BESS will consist of containerized lithium-ion battery units and inverters distributed across the project area. This equipment will connect with a project substation via underground electrical conduit. The substation will be constructed adjacent to an existing Hawaiian Electric Company (HECO) 46kV transmission line that traverses the project area and will facilitate interconnection of the project to the HECO grid; an overhead electrical connection between the substation and existing transmission line may be required for interconnection. The project will be accessed via the existing gated entry off Kualakai Parkway and will utilize a network of existing and new onsite access roads. Some site grading will be needed to accommodate the project facilities and to comply with stormwater and civil engineering requirements and some of the existing access roads may need to be improved to support access to the project site. The project area will be secured for use by AES through a long-term lease (or similar agreement) with UH. The Project will be owned and operated by AES, and the power generated by the Project will be sold to HECO under a new 25-year power purchase agreement (PPA). It is anticipated that construction will require approximately 12-15 months, with commercial operations commencing in 2021 or 2022.

The purpose of this CIA is to gather information about the project area and the surrounding area through research and interviews with individuals that are knowledgeable about this area in order to assess potential impacts to cultural resources, cultural practices, and beliefs as a result of the proposed project. We are seeking your *kōkua* and guidance regarding the following aspects of our study:

Figure 31. Community consultation letter page one

HONOULIULI 172 – CIA for AES West O‘ahu Solar Project

Page 2

- **General history as well as present and past land use of the project area**
- **Knowledge of cultural sites which may be impacted by future development of the project area—for example, historic and archaeological sites, as well as burials**
- **Knowledge of traditional gathering practices in the project area, both past and ongoing**
- **Cultural associations of the project area, such as *mo‘olelo* and traditional uses**
- **Referrals of *kūpuna* or elders and *kama‘āina* who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua‘a* lands**
- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area**

In advance, we appreciate your assistance in our research effort. If you are interested in participating in this study, please contact Kellen Tanaka at ktanaka@culturalsurveys.com. I am also available by phone at (808) 262-9972.

Mahalo nui loa,

Kellen Tanaka
Cultural Researcher

Figure 32. Community consultation letter page two

> require approximately 12-15 months, with commercial operations commencing in 2021 or 2022.
>
> The purpose of this CIA is to gather information about the project area and the surrounding area through research and interviews with individuals that are knowledgeable about this area in order to assess potential impacts to cultural resources, cultural practices, and beliefs as a result of the proposed project. We are seeking your *kōkua* and guidance regarding the following aspects of our study:
>
> - **General history as well as present and past land use of the project area**
> - **Knowledge of cultural sites which may be impacted by future development of the project area—for example, historic and archaeological sites, as well as burials**
> - **Knowledge of traditional gathering practices in the project area, both past and ongoing**
> - **Cultural associations of the project area, such as *mo‘olelo* and traditional uses**
> - **Referrals of *kūpuna* or elders and *kama‘āina* who might be willing to share their cultural knowledge of the project area and the surrounding ahupua‘a lands**
> - **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area**

In December 2019, CSH was notified of a slight modification to the project area to include additional areas along the perimeter of the project area, as well as maintenance of the existing roadways approaching the project area from the southeast. Revised letters (Figure 33 and Figure 34) along with a map and aerial photograph of the project area were mailed with the following revised text.

> In May and June 2019, Cultural Surveys Hawai‘i (CSH), on behalf of AES Distributed Energy, Inc., reached out to the Honouliuli community regarding a cultural impact assessment (CIA) for the West O‘ahu Solar Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu Island TMK: [1] 9-002:007. As the project area has changed slightly, we are seeking additional input as part of the CIA consultation process.
>
> As described in the previous consultation letter, the proposed West O‘ahu Solar project will involve construction and operation of an approximately 12.5-megawatt (MW) ground-mounted solar PV system, coupled with a 50 MW-hour BESS and related interconnection and ancillary facilities. The solar PV panels will be arranged in a series of evenly-spaced rows across the project area. The BESS will consist of containerized lithium-ion battery units and inverters distributed across the project area. This equipment will connect with a project substation via underground electrical conduit. The substation will be constructed adjacent to an existing Hawaiian Electric Company (HECO) 46kV transmission line that traverses the project area and will facilitate interconnection of the project to the HECO grid; an

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Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

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Job code: HONOULIULI 172 ktanaka@culturalsurveys.com www.culturalsurveys.com

January 2020

Aloha,

In May and June 2019, Cultural Surveys Hawai'i (CSH), on behalf of AES Distributed Energy, Inc., reached out to the Honouliuli community regarding a cultural impact assessment (CIA) for the West O'ahu Solar Project, Honouliuli Ahupua'a, 'Ewa District, O'ahu Island TMK: [1] 9-002:007. As the project area has changed slightly, we are seeking additional input as part of the CIA consultation process.

As described in the previous consultation letter, the proposed West O'ahu Solar project will involve construction and operation of an approximately 12.5-megawatt (MW) ground-mounted solar PV system, coupled with a 50 MW-hour BESS and related interconnection and ancillary facilities. The solar PV panels will be arranged in a series of evenly-spaced rows across the project area. The BESS will consist of containerized lithium-ion battery units and inverters distributed across the project area. This equipment will connect with a project substation via underground electrical conduit. The substation will be constructed adjacent to an existing Hawaiian Electric Company (HECO) 46kV transmission line that traverses the project area and will facilitate interconnection of the project to the HECO grid; an overhead electrical connection between the substation and existing transmission line may be required for interconnection. The project will be accessed via the existing gated entry off Kualaka'i Parkway and will utilize a network of existing and new onsite access roads. Some site grading will be needed to accommodate the project facilities and to comply with stormwater and civil engineering requirements and some of the existing access roads may need to be improved to support access to the project site. The project area will be secured for use by AES through a long-term lease (or similar agreement) with UH. The Project will be owned and operated by AES, and the power generated by the Project will be sold to HECO under a new 25-year power purchase agreement (PPA). It is anticipated that construction will require approximately 12-15 months, with commercial operations commencing in 2021 or 2022.

Recently, CSH was notified of a slight modification to the project area to include additional areas along the perimeter of the project area, as well as maintenance of the existing roadways approaching the project area from the southeast. Both the original project area and the revised project area are depicted in the attached figures (please refer to Figure 1 and Figure 2 noting "Original Project Area" and Figure 3 and Figure 4 noting "Revised Project Area").

The purpose of this CIA is to gather information about the project area and the surrounding area through research and interviews with individuals that are knowledgeable about this area in order to assess potential impacts to cultural resources, cultural practices, and beliefs as a result of the proposed project. Specifically, the input sought through the CIA process includes the following aspects:

Figure 33. Revised community consultation letter page one

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Page 2

- **General history as well as present and past land use of the project area**
- **Knowledge of cultural sites which may be impacted by future development of the project area—for example, historic and archaeological sites, as well as burials**
- **Knowledge of traditional gathering practices in the project area, both past and ongoing**
- **Cultural associations of the project area, such as *mo‘olelo* and traditional uses**
- **Referrals of *kūpuna* or elders and *kama‘āina* who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua‘a* lands**
- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area**

In advance, we appreciate your assistance in our research effort. Please contact us by telephone or email if your *mana‘o* has changed or been affected by the changes to the project area. Please do not hesitate to contact Kellen Tanaka at ktanaka@culturalsurveys.com or by phone at (808) 262-9972 with any questions or additional *mana‘o*.

Mahalo nui loa,

Kellen Tanaka
Cultural Researcher

Figure 34. Revised community consultation letter page two

overhead electrical connection between the substation and existing transmission line may be required for interconnection. The project will be accessed via the existing gated entry off Kualaka‘i Parkway and will utilize a network of existing and new onsite access roads. Some site grading will be needed to accommodate the project facilities and to comply with stormwater and civil engineering requirements and some of the existing access roads may need to be improved to support access to the project site. The project area will be secured for use by AES through a long-term lease (or similar agreement) with UH. The Project will be owned and operated by AES, and the power generated by the Project will be sold to HECO under a new 25-year power purchase agreement (PPA). It is anticipated that construction will require approximately 12-15 months, with commercial operations commencing in 2021 or 2022.

Recently, CSH was notified of a slight modification to the project area to include additional areas along the perimeter of the project area, as well as maintenance of the existing roadways approaching the project area from the southeast. Both the original project area and the revised project area are depicted in the attached figures (please refer to Figure 1 and Figure 2 noting “Original Project Area” and Figure 3 and Figure 4 noting “Revised Project Area”).

The purpose of this CIA is to gather information about the project area and the surrounding area through research and interviews with individuals that are knowledgeable about this area in order to assess potential impacts to cultural resources, cultural practices, and beliefs as a result of the proposed project. Specifically, the input sought through the CIA process includes the following aspects:

- **General history as well as present and past land use of the project area**
- **Knowledge of cultural sites which may be impacted by future development of the project area—for example, historic and archaeological sites, as well as burials**
- **Knowledge of traditional gathering practices in the project area, both past and ongoing**
- **Cultural associations of the project area, such as *mo‘olelo* and traditional uses**
- **Referrals of *kūpuna* or elders and *kama‘āina* who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua‘a* lands**
- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area**

In most cases, two or three attempts were made to contact individuals, organizations, and agencies. Community outreach letters were sent to a total of 70 individuals or groups, 12 responded, one provided written testimony, and three of these *kama‘āina* and/or *kupuna* met with

CSH for more in-depth interviews. The results of the community consultation process are presented in Table 3.

6.3 Community Contact Table

Below in Table 3 are names, affiliations, dates of contact, and comments from NHOs, individuals, organizations, and agencies contacted for this project. Results are presented below in alphabetical order.

Table 3. Community contact table

Name	Affiliation	Comment
Alaka‘i, Robert	Cultural practitioner	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Barbieto, Leda	Raised in Ewa Plantation (Banana / Varona Camp)	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Barbieto, Pio	Raised in Ewa Plantation (Banana / Varona Camp)	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Basham, Leilani	Associate Professor of Hawaiian-Pacific Studies, University of Hawai‘i (UHWO)	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Berg, Tom	Former Councilman, District 1	Mr. Berg contacted CSH via email 19 August 2019. His comments are provided below verbatim: *Please accept my comments for the Cultural Impact Assessment – AES West Oahu Solar and Storage Project-* *Please see attached* [Tom Berg’s letter is provided in full in Appendix A]. *In brief- I captured hundreds of sightings of pueo on camera- many are on youtubes- these pueo are along the Hunehune and Kaloi and Honouliuli Gulch Corridor which is served by the hill/slope where you favor the development.* *But with all this evidence of pueo right there on youtubes- to this day, UHWO / Attorney General / UH BOR / DLNR / USFWS / and OEQC claim in concert the videos are “fake” -*

Name	Affiliation	Comment
Berg, Tom (cont.)	Former Councilman, District 1	*How did they do that--come to the conclusion my videos of pueo are fake?* *The answer is- the proof- smoking gun if you will- whereby the Hawaii State Attorney General Claire Connors wrote a letter to State Representatives Bob McDermott and Rida Cabanilla on February 26, 2019 that reads- paraphrasing* [following bold text is in the original]*:* ***"No pueo use the property at UHWO- for no habitat is present on the property for the pueo to use- and thus, no pueo and their habitat existed or is on the property- per scientific research, surveys, and the Environmental Impact Statement done for the property."*** *Result? Entire pueo habitat destroyed. Pueo wrongfully extirpated from the property due to faulty protocol to inventory for these species from the onset.* *But alas- everyone can see with their own eyes two pueo engaged in courtship behavior at UHWO in these opening scenes* [following bold text is in the original] ***-see video link pasted below-*** *and it's a travesty our Attorney General would lie like this (and Chair DLNR Suzanne Case) and refute these scenes as rather being "fake and manufactured" and actually promote a faulty and deceptive representation of the property.* *The research/surveys that the Attorney General referenced in her letter covered up the fact the survey and research failed to include /physically go to the property for five months during the period/season when the pueo use and occupy UHWO:* [link to Chant for Pueo @ UHWO by Michael Kumukauoha Lee] *The pueo (and Hoary Bat) have been wrongfully extirpated from UHWO Makai Segment- and have henceforth, as can be proven, "transferred" their ecosystem/reliance from UHWO Makai Segment to the hill/UHWO Mauka Segment that you want to develop and place solar panels on.* *Remember now- DBEDT is bent on allowing what I have deduced to be possible illegal illumination of lighting on the Monsanto farm fields right next to your proposed solar project. The glare from these lights will most likely blind many avian species when reflected from your solar panels- at least contribute to their peril.* *Question is- are you going to adequately look for the bats and pueo or not at the solar project site before you blitz the area- what will be your protocol be to look for the endangered species on the property?*

Name	Affiliation	Comment
Berg, Tom (cont.)	Former Councilman, District 1	CSH replied via email 6 September 2019: *Mahalo for your response. We appreciate your input and acknowledge your concerns regarding the pueo and ‘ōpe‘ape‘a habitat within the project area and the importance of these species in Hawaiian culture. Your comments and concerns will be incorporated and addressed in the cultural impact assessment. Other due diligence studies that are being conducted for the project include an assessment of biological resources; your input regarding survey protocols for the two species will be shared with the biologists. The results of both the cultural and biological due diligence studies and impact analyses for the project will be included in an environmental assessment (EA) which will be published for public review.* Mr. Berg replied via email 6 September 2019: *With the assistance of Senator Mike Gabbard, we are now astute as to what the illumination of the night sky is all about near the proposed solar project @ Monsanto.* *Thank you for responding and please do include the lighting information- provided with and by Senator Gabbard’s Office/and DBEDT---Lights are used for soy bean growth and lighting are able to violate State Illumination Law as farmers were given waivers to blind migratory species.* *Please do inquire with Project Pueo Biologist Team- Dr. Melissa Price- and Dr. Javier Cotin and USFWS Jenny Hoskins- and DOFAW Biologist Afsheen Siddiqi- about pueo protocol.* *Mind you- this Pueo team approved of the FEIS (2005) for 500-acres of property known as UHWO - saying no pueo are there--* *I should say rather - these pueo experts had no objections to the FEIS protocol used at UHWO---------whereby in the biological survey for pueo at UHWO- get this---- the observer only looked for a few hours TOTAL over a period of two days within a week during the month of April when the pueo are not there.....and to cover 500-acres------and the DLNR stated in writing in the FEIS for UHWO--- “That was a thorough inventory process to search for pueo- satisfactory.”* *DLNR went on to state---* *“That’s good enough of a look for us- only 3-4 hours of observation need take place to determine on 500-acres if pueo are on the property or not.” ---And – in the FEIS for UHWO- they looked mid-morning hour- not before sunrise or at sunset when pueo are active----but mid morning when that bird ain’t to be seen.*

Name	Affiliation	Comment
Berg, Tom (cont.)	Former Councilman, District 1	*DLNR has proven they are corrupt and very dishonest indeed-----* *These Project Pueo experts know that pueo do not have a defined breeding season- and are plot hoppers- and will deploy a foraging ecology- a breeding ecology- at different times of the seasons- and hence, these experts have stated that it is prudent to have the biological survey for pueo be conducted year round.* *These same pueo experts will also state the observation needs to take place at sunset and sunrise- if to be a proper protocol deployed.* *Can you answer if that will be done on this solar property? Year round observation?* *I have CC'd the Project Pueo experts in this email to have them confirm what a proper protocol of a duration of time should be deployed in which to observe a property / conduct the inventory/survey.* *I hope a three to four hour look on one day, then another couple of hours of a look on another day is not the protocol you will be using- and to do it while sitting in a car eating a burger and sipping on a milk shake. . . . like the protocol they used for UHWO.* CSH sent summary of written testimony to Mr. Berg for approval via email on 2 October 2019 Mr. Berg replied via email 3 October 2019: *Wow- it's beautiful- your work- my verbiage was a bit sloppy- So- I found two places where I made a mistake- and two areas I lacked the supporting documentation- four points total---* *1. On page 2- I stated it was the UHWO Mauka Segement- oops- I meant the **Makai** Segment-* *And - the date the FEIS was executed- accepted and signed by the Governor was in February of 2007, and not executed in 2005 or 2006 where referenced. Maybe the inventory exercise took place in 2005/2006- but it wasn't codified until 2007-* *2. Date was 2007- date it was accepted.* *3. I should have included the video links to justify the claim of Willful Indifference, Institutional Prejudice, Administrative Bias- - I am making a serious claim here- and this two-part video is my evidence to defend and substantiate my claim- it would be appreciated if you would attach it somehow--- :* [link to Mike Lee: The Willful Indifference /Pueo Habitat @ UHWO p.1; Mike Lee Willful Indifference @ UHWO p. 2] *This is relevant for the purpose that pueo extirpated from UHWO Hunehune and Kalio Gulches - headed mauka for*

Name	Affiliation	Comment
Berg, Tom (cont.)	Former Councilman, District 1	*refuge- they can’t go east- can’t go west- can’t go south- so they went north up the gulches as this was their only option- and they need the slopes where these solar farm(s) are to be placed to have habitat for the pueo to forage- of course, only if the pueo has been determined as present via an adequate survey performed for the property ----* *4. And finally- the lights that blind the bats and owls- and others- these grow lights- may have been the cause of this barn owl to lose its eye- this owl was found dead one -half mile from the solar site- and this video is relevant as evidence - for I captured it flying back and forth under the grow lights- I have a youtube on it- not included below- and just a few weeks later- it died with this eye injury---DLNR refused to accept the carcass for a necropsy.* *I would appreciate if this evidence in the video- were too added- to support and substantiate my claim - for since no necropsy was performed, my claim in the video may be wrong- and the owl did not suffer from rat bait poison- but from the grow lights- so the evidence in the video is all we have to make a deduction- could be relevant if found to be a pattern latter on- best to include it even though my assessment may be pure conjecture- I can’t prove what killed this owl--- your call:* [link to Brought to you by RAT Bait Poison/DEAD BARN OWL 7.22.19] *Mahalo! My sentence structure is not great- plenty of errors on my end- but that’s fine - you captured my points- well done. Your work is appreciated.* Mr. Berg approved interview summary via email 3 October 2019: *There is one change--- DOFAW---- is: Division of Forestry and Wildlife- under DLNR.* *This concludes my review of the submission- however, omitted from it- is that nearby - is the Honouliuli Internment Camp US National Park Service development-* *“Who conducted the survey for pueo and bats for that project- if executed already?”* *I can’t find status on that--- to then include that subject for comment-* Revised Letter and Figures sent via email 3 January 2020 Mr. Berg replied via email 3 January 2020: *Yes- I have issues on the changes - it appears the expansion to the south encroaches upon the gulch area- and or rather erodes any current foliage buffer of the gulch that is provided to wildlife-- this buffer appears to be taken /consumed by the project---*

Name	Affiliation	Comment
Berg, Tom (cont.)	Former Councilman, District 1	*How long do I have until the deadline to get you comments on this notice?* *Why is it necessary to encroach upon the gulch?* *Is there an explanation?* *Who did the biological survey for this project- or will there be one in the future before development?* CSH replied via email 7 January 2020: *The client has provided answers to your questions regarding the gulch area and the biological survey for the proposed project.* *AES does not intend to build any project facilities within the gulch along the southern boundary; however, the project area boundary has been adjusted to provide flexibility for natural features such as landscaping if warranted (either for visual screening purposes or in response to specific comments received as part of the cultural impact assessment). The preliminary project plans include maintenance of a natural vegetative buffer along the gulch.* *As part of the due diligence studies for the project, a general biological survey was conducted by Tetra Tech. In addition, surveys have been conducted specifically for pueo based on the protocol defined for The Pueo Project. Consistent with your previous input, the team has consulted with the State of Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife (DOFAW) as well as researchers with The Pueo Project. This information will be detailed in the Draft Environmental Assessment, which is expected to be published in early 2020.* Mr Berg replied via email 8 January 2020: *I don't see any reference to any studies from Project Pueo being conducted on the property in question- do you?* *Please take a gander- see files attached* [Mr. Berg attached pdfs of The Pueo Project Final Report April 2017-March 2018; The Pueo Project Annual Report 2018; xcel file of UHWO pueo survey data] *if can- what do you conclude?* *Was there a separate commissioned exercise conducted for the solar area not in these reports- ?* CSH replied via email 10 January 2020: *Thank you for forwarding the attachments - we agree that the Pueo Project data do not appear to include surveys within the project area. The pueo surveys conducted within the project area, as referenced in our previous response, were not conducted by Pueo Project researchers as part of their research project. Rather, these were conducted as part of the due diligence efforts for the proposed solar project. These surveys were*

Name	Affiliation	Comment
Berg, Tom (cont.)	Former Councilman, District 1	*conducted by qualified biologists according to the protocol that was established for the Pueo Project (see Appendix 1 of the Final Report); DOFAW specifically references this protocol as the best methodology for pueo surveys. The results of these surveys will be included in the Draft Environmental Assessment, which is expected to be published in early 2020.* Mr. Berg replied via email 10 January 2020: *Ok- mahalo-*
Bond, John	Kanehili Cultural Hui	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Mr. Bond replied via telephone on 28 June 2019 requesting letter and figures via email CSH followed up with Mr. Bond via email 6 August 2019 Revised Letter and Figures sent via USPS 3 January 2020
Caceras, Mana Kaleilani	OIBC Representative for ‘Ewa	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Mr. Caceras replied via email on 13 August 2019: *E kala mai for not responding to your earlier request, been in the field quite a bit lately. I do not personally know of any mo‘olelo or cultural sites within the proposed project area but here is a short list of people who might. A few months ago I sat in a section 106 consultation for the Makakilo Drive Extension Project and these three gentlemen have so much knowledge of the area.* *Mr. Joseph Kūhiō Lewis, President, Kapolei Community Development Corporation* *Mr. Shad Kane, President, Kalaeloa Heritage and Legacy Foundation and Aha Moku Representative* *Mr. Douglas “McD” Philpotts, Hawaiian Cultural Practitioner* *Have a great evening.* CSH replied via email 14 August 2019 Revised Letter and Figures sent via email 3 January 2020 Mr. Caceras replied via email 15 January 2020: *Mahalo Kellen. Will look through the document and let you know if we have any information that could be useful to your CIA.* *Have a great weekend* CSH replied via email 23 January 2020
Cayan, Phyllis	Intake Specialist, SHPD	Letter and Figures sent via email 15 May 2019 DLNR.Intake.SHPD replied via email on 20 May 2019: *Aloha, your submittal is in the queue for review by the History & Culture Branch and is assigned log 2019.01148 for reference. Direct all inquiries on this matter to Regina Hilo and Hinano Rodrigues at their emails above.*

Name	Affiliation	Comment
		Revised Letter and Figures sent via email 3 January 2020
Cordy, Ross	Professor of Hawaiian-Pacific Studies, University of Hawai‘i (UHWO)	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Cox, Malia	DHHL	CSH contacted Ms. Cox via email 16 September 2019: *My name is Kellen Tanaka. I am a cultural researcher with Cultural Surveys Hawaii (CSH) and have been assisting with the cultural impact assessment for the AES West O‘ahu Solar Plus Storage Project. We were forwarded DHHL's comments for the pre-assessment for the Environmental Assessment for the AES West O‘ahu Solar Project. We would like to follow up with DHHL's recommendations of consulting with Hawaiian Homestead community associations and Native Hawaiian Organizations. In the letter, it states there are six Hawaiian Homestead communities less than three miles from the proposed project. We have reached out to the Kanehili Hawaiian Homestead Association, Kapolei Community Development Corporation, Kaupea Homestead Association, and the Malu‘ohia Residents Association which were mentioned in the letter. Could you assist us in identifying the other two Hawaiian Homestead communities and contact information so we may reach out to them?* Ms. Cox replied via email 17 September 2019: *Kauluokahai Is the newest community. I don't know that they have stood up a association at this time. KCDC might be able to help with identifying appropriate individuals in that community.* *Ill get back to you tomorrow on the remaining organization. I believe it is the undivided interests group, but will have to check my notes when I get back into the office tomorrow.* Ms. Cox replied via email 18 September 2019: *Attached, please find a copy of a portion of the latest lease report submitted to the HHC commission on 9/16/19. I've highlighted the communities identified on the report. Hoolimalima lessees are part of Maluohai resident community. If you need more information about the communities, please contact homestead services division (HSD)* Revised Letter and Figures sent via email 3 January 2020
Crabbe, Kamana‘o-pono	*Ka Pouhana* of OHA	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019

Name	Affiliation	Comment
Cullen, Ty J.K.	Representative, House District 39	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
DaMate, Leimana	Executive Director, DLNR-Aha Moku	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020 Ms. DaMate replied via email 8 January 2020: *Mahalo for contacting the Hawaii State Aha Moku and I would be happy to forward your request to our Aha Moku Representative Shad Kane, to whom I am encouraging a response to your email. Aside from being a historian of Ewa, and Honouliuli Ahupua'a, Shad is also in contact with generational cultural practitioners from the ahupua'a, including Kehaulani Lum (to whom I have also copied this email). I have also included Rocky Kaluhiwa, the Aha Moku Advisory Committee (AMAC) Chairperson for the State of Hawaii so she is aware of the activities on O'ahu. Rocky is also the AMAC rep for the Island of O'ahu. I am confident that between the three of these practitioners, you will be able to get answers and guidance for your project. Please feel free to contact me should you have any questions or concerns.* CSH replied via email 9 January 2020
De Santos, Kahulu	Cultural Advisor, Aulani, A Disney Resort and Spa	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Eaton, Ku‘uwainani	Hoakalei Cultural Foundation	Letter and Figures sent via USPS 14 May 2019 Mail returned 17 May 2019
Farden, Hailama	President, Association of Hawaiian Civic Clubs	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Faulker, Kirsten	Executive Director, Historic Hawai‘i Foundation	Letter and Figures sent via USPS 28 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Hanohano, Anolani	Kānehili Hawaiian Homestead	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020

Name	Affiliation	Comment
Hilo, Regina	Burial Sites Specialist, SHPD	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Ms. Hilo replied via email 28 June 2019: *Mahalo nui for sharing this. I'll forward to my colleagues*. CSH replied via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Holt Takamine, Victoria	Executive Director, PA‘I Foundation	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Gabbard, Mike	Senatorial District 20	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Senator Gabbard replied via email 15 May 2019: *Mahalo for the information.* CSH replied via email 9 July 2019 Revised Letter and Figures sent via email 3 January 2020
Ito, Wallace K.	KUA Ewa Limu Project	Letter and Figures sent via email 22 May 2019 CSH followed up with Mr. Ito via email 6 August 2019 Mr. Ito replied via email 21 August 2019: *Sorry for not following through sooner. I just forwarded your request to other organizations doing malama ‘aina work in the Ewa Moku. You are cc'd on that so you should have received it a few minutes ago.* CSH replied via email 21 August 2019 Revised Letter and Figures sent via email 3 January 2020
Kai, G. Umi	President, ‘Aha Kāne	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Kaleikini, Ali‘ikaua	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Kaleikini, Hāloa	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Kaleikini, Kala	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Kaleikini, Mahiamoku	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020

Name	Affiliation	Comment
Kaleikini, Moehonua	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Kaleikini, No‘eau	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Kaleikini, Paulette Ka‘anohi	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via USPS 27 June 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via USPS 3 January 2020 Revised Letter and Figures sent via email 3 January 2020
Kaleikini, Tuahine	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Kane, Shad	‘Ewa Moku Representative, Aha Moku; Kalaeloa Heritage and Legacy Foundation	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 CSH spoke with Mr. Kane via telephone 13 August 2019: *Mr. Kane stated that he is not in opposition to the proposed project. He noted the project area has been previously disturbed by sugar cane production.* Revised Letter and Figures sent via email 3 January 2020
Kanekoa, Mikiala	Hālau ‘o Kaululaua‘e	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Kauahi, R. Kaiulani Vincent	Culture and Arts Coordinator, Dept. Parks and Recreation	Letter and Figures sent via USPS 14 May 2019 Mail returned 17 May 2019
Keala, Jalna	Association of Hawaiian Civic Clubs	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Keaulana, Ha‘a	Cultural Advisor at Four Seasons Resort at Koolina	Letter and Figures sent via USPS 14 May 2019 Mail returned 17 May 2019
Keli‘inoi, Kalahikiola	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020

Name	Affiliation	Comment
Keli‘inoi, Kilinahe	Cultural descendant	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Kruse, Kehaulani	Outrigger Enterprises, Cultural Advisor	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Lee, Mike Kumukauoha	Kanehili Cultural Hui	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019
Legal, Jack	Chair, Makakilo/ Kapolei/Honokai Hale Neighborhood Board No. 34	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Lewis, Joseph Kūhiō	President, Kapolei Community Development Corporation	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Lidstone, Miki‘ala	Executive Director, Ulu A‘e Learning Center	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Lilomaiava-Doktor, Sa‘iliemanu	Associate Professor of Hawaiian-Pacific Studies, University of Hawai‘i (UHWO)	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Lopez, Kealii	Imua Hawaii	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020

Name	Affiliation	Comment
Luthy, Tamara	Ethnographer, DLNR	Letter and Figures sent via email 28 June 2019 Ms. Luthy responded via email 1 July 2019: *Good to hear from you! Thank you for letting me know about the project. I am cc'ing Kaahiki Solis and Hinano Rodrigues on this email. We request that when you finish your CIA that we may receive a copy as a professional courtesy so that we can keep it for our records in case any other archaeological, architectural, or ethnographic work in the same or adjourning regions comes through our office for review. I have also attached a few reports which may be of interest from the Ewa/Honouliouli area, though I didn't see anything from the exact TMK your project is in.* *SHPD policy dictates that we can only recommend ways to find research participants rather than pointing you to specific individuals. I would recommend putting out a notice in the Honolulu Star Advertiser, notifying OHA as well to see if anyone there can send out the information to relevant parties. It would be useful to follow up with any Hawaiian civic clubs in the area. It may be worthwhile to contact folks involved with the Ewa Limu Project, as they may know local resource users both mauka and makai. There is also an interview with Julia Powell and also one with Louis Aila Junior through the UH Oral History Project which discuss life in Ewa in the past, including some information on gathering plants. If you want to know more about ongoing gathering practices in the area, it would be worthwhile to reach out to local hula halaus and lā'au lapa'au practitioners. Hawaiian Studies and/or professors at UH Manoa and Leeward Community College may be good resources as well.* CSH replied via email 3 July 2019: *Mahalo for your quick response and all the information you provided. Those pdfs are very helpful. We will continue our outreach with those mentioned below. . .* Revised Letter and Figures sent via email 3 January 2020 Ms. Luthy replied via email 3 January 2020: *Hi there Kellen, I just got your email. I will look into it on Monday and get back to you soon.* CSH replied via email 6 January 2020
Lyman, Melissa	Kalaeloa Heritage and Legacy Foundation, President	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020

Name	Affiliation	Comment
Malama, Tesha	‘Ewa Villages Association	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
McKeague, Kawika	Cultural practitioner, Honouliuli historian and longtime resident	Letter and Figures sent via USPS 9 August 2019 Revised Letter and Figures sent via email 3 January 2020
Medeiros, Pōhai	PIKO Program Advisor, University of Hawai‘i West O‘ahu	Letter and Figures sent via USPS 9 August 2019 Revised Letter and Figures sent via email 3 January 2020
Nahulu-Mahelona, Moani	Hawaiian Studies Department, Kapolei HS	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
National Park Service Honouliuli National Monument		Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 CSH reached out the Ms. Jacqueline Ashwell via email 30 July 2019 Ms. Ashwell replied via email 30 July 2019: *I am away on detail to another agency, returning to the NPS in November of 2019.* *While I am away, please direct all matters related to Pearl Harbor National Memorial and Honouliuli National Monuments to Steve Mietz . . .* CSH reached out to Mr. Steven Mietz via email 30 July 2019 Revised Letter and Figures sent via email 3 January 2020 Hanako Wakatsuki-Chong replied on behalf of the PWR Honouliuli on 14 January 2020: *Thank you for reaching out to us about the cultural impact assessment for the West O‘ahu solar panel project. I have cc’d Katie Bojakowski, the Chief of Cultural and Natural Resources; Jacqueline Ashwell, Superintendent; and Melia Lane-Kamahele, NPS Regional Office Manager. When do you need comments by?* CSH replied via email 14 January 2020: *Mahalo for your response and for forwarding our request to those mentioned below. We look forward to hearing from them. We kindly ask for your response by February 3, 2020. Feel free to contact me if you any questions.*

Name	Affiliation	Comment
Paglinawan, Lynette	Cultural practitioner; Educator, teaches a course on Native Hawaiian Healing at University of Hawai‘i West O‘ahu	CSH met with Ms. Palignawan 14 October 2019 Interview summary sent to Ms. Palignawan via USPS 22 October 2019 Revised summary sent for review and approval via USPS 19 November 2019 CSH followed up with Ms. Paglinawan via email 27 December 2019 Revised Letter and Figures sent via USPS 3 January 2020 Revised summary sent for review and approval 14 January 2020 Ms. Paglinawan approved summary 15 January 2020
Paik, Linda Kaleo	Cultural practitioner/ Secretary/Treasurer for Koa Ike Cultural Specialist; Former History and Culture, SHPD ‘Aha Wahine Aha Moku Committee, Kona District, Oahu	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Paishon, Jr., Frank	Raised in Tenney Village	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Patterson, Kaleo	Native Hawaiian Church; Pacific Justice & Reconciliation Center	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Puahala, Roth	President, Ke One O Kakuhihewa	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Ramos, Rodolfo	President, Ewa Villages Community Association; Chair of ‘Ewa Task Force	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020

Name	Affiliation	Comment
Rodenhurst, Roda	President, ‘Ahahui Siwila Hawai‘i o Kapolei Hawai‘i O Kapolei (Kapolei Hawaiian Civic Club)	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Rodrigues, Hinano	SHPD, Interim History and Cultural Branch Chief (O‘ahu and Maui)	Mr. Rodrigues forwarded email to Ms. Regina Hilo 14 June 2019 Revised Letter and Figures sent via email 3 January 2020
Saul, Melissa	Associate Specialist, Title III PIKO Project Director, University of Hawai‘i West O‘ahu	Letter and Figures sent via USPS 9 August 2019 Revised Letter and Figures sent via email 3 January 2020
Schaedel, Homelani	President, Malu‘ōhai Residents Association	Letter and Figures sent via email 17 September 2019 Revised Letter and Figures sent via email 3 January 2020
Serrao, Marleen Kau‘i	Pelekikena, ‘Ewa-Pu‘uloa Hawaiian Civic Club	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Shibuya, Barbara	*Kama‘āina* of ‘Ewa, member of the Shibuya Dayanan Family	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Silva, Adrian Nakea	Chariman, Hui Huliau Inc.	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Solis, Ka‘āhiki	SHPD, Cultural Historian (O‘ahu)	Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020 Ms. Solis replied via email 6 January 2020: *Mahalo and good luck with your project.* CSH replied via email 9 January 2020

Name	Affiliation	Comment
Suganuma, La‘akea	President, Royal Hawaiian Academy of Traditional Arts and Nā Lei Ali‘i Kawananakoa	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Swinney, Shirley S.	Vice President, Kapolei Community Development Corporation; Hawaii Community Development Authority	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Uyeoka, Kelly	Nohopapa	Letter and Figures sent via email 22 August 2019 Revised Letter and Figures sent via email 3 January 2020
Ward, Sandy	Executive Director, Mālama Pu‘uloa	Ms. Ward was forwarded letter and figures by Mr. Wally Ito on 21 August 2019 Ms. Ward replied via email 21 August 2019: *did you follow up on the Nohopapa `Ewa Inventory I suggested? - that is the best research on cultural significance and wahi pana I have seen -. . . It‘s organized by ahupua`a so it‘s easy to find information and I suggest you contact them directly to assist you if you don‘t find the information you are looking for in their publication.* CSH replied via email 22 August 2019 Revised Letter and Figures sent via email 3 January 2020
Wong-Kalu, Hinaleimoana	OIBC Chair	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Woode Jr., Lawrence A.	Pelekikena, Hawaiian Civic Club of ‘Ewa-Pu‘uloa	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via USPS 27 June 2019 Revised Letter and Figures sent via USPS 3 January 2020
Woode, Napali	Native Hawaiian Economic Alliance	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020

Name	Affiliation	Comment
Wond, Kanani	Vice President, Kaupe‘a Homestead Association	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 Letter and Figures sent via email 28 June 2019 Revised Letter and Figures sent via email 3 January 2020
Yee, Christian	*Kama‘āina*, familiar with *wahi pana* and *mo‘olelo*	Letter and Figures sent via USPS 14 May 2019 Letter and Figures sent via email 15 May 2019 CSH spoke with Mr. Yee briefly on 18 May 2019: Mr. Yee expressed interest in visiting the Honouliuli Internment Camp. Letter and Figures sent via email 28 June 2019 CSH followed up with Mr. Yee via telephone on 9 August 2019 CSH met with Mr. Yee on 9 August 2019 CSH sent summary for approval 24 September 2019 Mr. Yee approved summary 3 October 2019 Revised Letter and Figures sent via email 3 January 2020

6.4 Written Testimony from Tom Berg

Tom Berg, former City Councilman, provided CSH with written testimony on 19 August 2019 regarding the AES West O‘ahu Solar Plus Storage Project. Mr. Berg’s entire testimony is included in Appendix A.

Mr. Berg stated that the project has been “proposed on a pueo (owl) foraging and breeding ecosystem.” The *pueo* (Hawaiian short-eared owl, *Asio flammeus sandwichensis*) are found on all of the main Hawaiian islands and are listed by the State of Hawai‘i as endangered on the island of O‘ahu (DLNR 2005). The Department of Land and Natural Resources (DLNR) states that *pueo* are most commonly found in “open habitats such as grasslands, shrublands, and montane parklands, including urban areas and those actively managed for conservation” (DLNR 2005).

Mr. Berg noted that records indicate that per earliest colonial contact, the *pueo* is most abundant on the slopes from Pu‘ukapuai to West Loch, in the area where the project is slated. He added that “Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood.” He noted tat *pueo* are not forest dwellers, preferring “scrub, open fields/dirt landscapes with some grass.” He stated that the proposed project will “encroach on prime pueo habitat-considered to be graded A+—“a ten (10)”—when it comes to the degree of pueo habitat in use on this project site.”

Mr. Berg added that the *pueo* has “a direct connection to Native Hawaiian family lineage in Ewa Beach;” the *pueo* is the *‘aumakua* for the Michael Lee family and their accounts, which go back over seven generations, are documented at the State Archives Building in Honolulu.

Mr. Berg also stated that the project site is “inhabited by the ōpe‘ape‘a [Hawaiian hoary bat, *Lasiurus cinereus semotus*] at various times of the seasons,” noting that in 1910, the State of Hawai‘i documented *‘ōpe‘ape‘a* within a half-mile of the project area. *‘Ōpe‘ape‘a* is “the only land mammal native to the Hawaiian archipelago” and is found on all of the main Hawaiian islands except for Ni‘ihau (DLNR 2005:3-13). DLNR states *‘ōpe‘ape‘a* have been “found roosting in

‘ōhi‘a (*Metrosideros polymorpha*), pu hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Proscopis pallida*), avocado (*Persea americana*), shower trees (*Cassie javanica*), pūkiawe (*Styphelia tameiameiae*), and fern clumps; they are suspected to roost in Eucalyptus (*Eucalyptus* spp.) and Sugi pine (*Cyrptomeria japonica*) stands" (DLNR 2005).

Mr. Berg stated his concern that the "property in question will not receive the proper protocol to conclude no endangered species inhabit the area." He asked "what protocol will be deployed to determine if the population of both the pueo and ‘ōpe‘ape‘a are served by habitat on the property?" He discussed five points which he felt need to be addressed:

1. Who will look for the *pueo* and *‘ōpe‘ape‘a* on the land? What is their expertise and qualifications as observers?
2. Did the observation to inventory for the species transpire before sunrise and after the sunset periods when the *‘ōpe‘ape‘a* and *pueo* are most active and can be recorded?
3. Did the observer conduct the biological survey whereby the inventory for the species was repeated year-round over the wet and dry seasons?
4. What tools were used—visual aids in the field—techniques to identify the species while observing/conducting the inventory?
5. Was the inventory to assess and survey for *pueo* and *‘ōpe‘ape‘a* done completely on foot or was a vehicle used?

Mr. Berg stated that to properly account for the *pueo* and *‘ōpe‘ape‘a*, the DLNR and United States Fish and Wildlife Service (USFWS) have developed a protocol which states inventory surveys should "be executed over the changing seasons year-round." However, Mr. Berg noted that "this practice, to deploy the protocol year-round, is not being done in either the EA [Environmental Assessment] and or EIS [Environmental Impact Statement] review processes." He added his opinion that surveys must be "undertaken after sunset and before the sunrise periods."

Mr. Berg discussed the recent population distribution survey for *pueo* on the island of O‘ahu that included the University of Hawai‘i West O‘ahu (UHWO) Makai Segment. The survey, conducted between 31 December 2017 and early August 2018, concluded no *pueo* or its habitat existed on the UHWO property, however, Mr. Berg notes that *pueo* inhabit the property "throughout the months of late August, through September, October, November, and vacate late December." He added that had the survey been conducted year-round, the survey would have "reported a pueo ecosystem thriving on the property and many Native Hawaiians' ‘aumakua would be protected rather than purged from the property."

In his statement, Mr. Berg provided links to videos of *pueo* observed on the UHWO property. He noted that despite these videos, UHWO, University of Hawai‘i (UH) Board of Regents, DLNR, and the Attorney General have stated the *pueo* "did not and have not ever existed there." He stated that this claim is "a violation of the law- HRS [Hawai‘i Revised Statutes] Ch. 343 that protects endangered species and their habitat."

He added that Governor Ige's Administration's claim that "absolutely no pueo used UHWO property," is in his opinion, "not only patently false–but a deliberate act of Administrative Bias, Institutional Prejudice—and a willful act of Malice—to cause direct harm to an endangered specie- a 100% violation of Article XII, Section VII of Hawaii's State Constitution that protects Native Hawaiian Religious and Cultural Practices and their ‘aumakua." To justify his claims, Mr. Berg

provided the links to the following videos hosted on YouTube: Mike Lee: The Willful Indifference / Pueo Habitat @ UHWO p.1 [https://www.youtube.com/watch?v=7z8-7u3Q0Bo] and Mike Lee: Willful Indifference @ UHWO p.2 [https://www.youtube.com/watch?v=Db46xPfazVQ]. He added that “pueo extirpated from UHWO Hunehune and Kaloi Gulches – headed mauka for refuge – they can’t go east- can’t go west- can’t go south- so they went north up the gulches as this was their only option- and they need the slopes where these solar farm(s) are to be placed to have habitat for the pueo to forage- of course, only of the pueo has been determined as present via an adequate survey performed for the property ----.”

Mr. Berg also expressed his concern for the possible negative aspects of light at an adjacent parcel. He expressed concern that a solar panel may reflect neighboring lighting operations into “the flight patterns of migrating birds and the *‘ōpe‘ape‘a* and *pueo* in particular need to be addressed.”

On 6 September 2019, a corresponding email was sent by Mr. Berg. He noted that information provided by Senator Mike Gabbard and the Department of Business, Economic Development, & Tourism (DBEDT) indicates the lighting at the nearby property are used for soy bean growth. Mr. Berg asserted his opinion that the lighting violates State Illumination Law. Mr. Berg expressed his opinion that “farmers were given waivers to blind migratory species.” To support his claim, Mr. Berg provided a link to a video (https://www.youtube.com/watch?v=rmVw04oWr6E&t=26s) he filmed of the carcass of a barn owl which was “found dead one -half mile from the solar site-.” He believes the owl may have died from eating vermin laced with rat bait poison. The owl was also missing an eye. Mr. Berg stated his opinion that the “grow lights- may have been the cause of this barn owl to lose its eye.” He stated that “DLNR refused to accept the carcass for a necropsy.” He also acknowledged that he “can’t prove what killed this owl,” noting that “since no necropsy was performed, my claim in the video may be wrong- and the owl did not suffer from rat bait poison- but from the grow lights- the evidence in the video is all we have to make a deduction- could be relevant if found to be a pattern later on-.”

Mr. Berg also recommended inquiring with Dr. Melissa Price and Dr. Javier Cotin of the Project Pueo Biologist Team and DLNR’s Division of Forestry and Wildlife (DOFAW) Biologist Afsheen Siddiqi regarding *pueo* protocol. He made note that “this Pueo team approved of the FEIS [Final Environmental Impact Statement] (2007) for 500-acres of property known as UHWO – saying no pueo are there—.” He added that “these pueo experts had no objections to the FEIS protocol used at UHWO” in which, according to Mr. Berg, the “observer only looked for a few hours TOTAL over a period of two days within a week during the month of April when the pueo are not here……and to cover 500-acres------.”

He noted that in the FEIS for UHWO (PBR Hawaii 2006), DLNR stated in writing “that was a thorough inventory process to search for pueo- satisfactory.” He also characterized the DLNR evaluation as, “That’s good enough of a look for us- only 3-4 hours of observation need take place to determine on 500-acres if pueo are on the property or not.”

Mr. Berg added that surveyors for the FEIS “looked mid-morning hour- not before sunrise or at sunset when pueo are active----but mid morning when that bird ain’t to be seen.” He noted,

> These Project Pueo experts know that pueo do not have a defined breeding season- and are plot hoppers- and will deploy a foraging ecology-a breeding ecology- at different times of the seasons- and hence, these experts have stated that it is prudent

> to have the biological survey for pueo be conducted year round. […] These same pueo experts will also state observation needs to take place at sunset and sunrise- if to be a proper protocol deployed.

Mr. Berg questions “if that will be done on this solar property? Year round observation?” He recommends that “a thorough and complete protocol is adopted to repeat the inventory exercise for pueo and ‘ōpe‘ape‘a over the course of a calendar year would be in order so the project does not inadvertently contribute to more endangered species habitat loss.”

6.5 *Kama‘āina* Interviews

The authors and researchers of this report extend our deep appreciation to everyone who took the time to speak and share their *mana‘o* and *‘ike* with CSH whether in interviews or brief consultations. We request that if these interviews are used in future documents, the words of contributors are reproduced accurately and in no way altered, and that if large excerpts from interviews are used, report preparers obtain the express written consent of the interviewee/s.

6.5.1 Shad Kāne

CSH spoke with Mr. Shad Kāne, member of the Kapolei Hawaiian Civic Club, Chair of the O‘ahu Council of Hawaiian Civic Clubs Committee on the Preservation of Historic Sites and Cultural Properties, Ali‘i Ai Moku of the Kapuāiwa Chapter of the Royal Order of Kamehameha Ekahi, President of Kalaeloa Heritage and Legacy Foundation, and ‘Ewa Moku Representative on the State Aha Moku Advisory Committee, via telephone on 13 August 2019. Mr. Kane stated that he is not in opposition to the proposed project. He noted the project area has been previously disturbed by sugarcane production.

6.5.2 Christian Kaimanu Yee

On 9 August 2019, CSH met with Mr. Christian Kaimanu Yee at Keaīwa Heiau State Recreation Area to discuss the AES West O‘ahu Solar Plus Storage project and to share his *‘ike* regarding *mo‘olelo* and *wahi pana* associated with the *ahupua‘a* of Honouliuli.

Mr. Yee was “made in ‘Ewa Beach, [but] born in England.” His father was a fireman for the United States Air Force and was stationed at Lakenheath Air Force Base (AFB) in England when Mr. Yee was born in 1980. His mother is a second-generation Filipina from ‘Ewa Beach. Mr. Yee lived in England until 1983 when his father got stationed at Nelles AFB in Las Vegas. In 1985, his family returned to Hawai‘i and moved to ‘Ewa Beach where he lived until 1986, when his parents “separated for a little while” and his father moved to Waimalu in ‘Aiea. After being honorably discharged from the military, Mr. Yee’s father worked for a trucking company. His father would take him on “drives” where they would visit cultural sites including *heiau* and Kūkaniloko, the sacred birthstones where the highest ranking *ali‘i* were born (Sterling and Summers 1978:139).

> Kukaniloko is considered to be the very center of the Hawaiian culture. As a person and a nation, one can come here and directly be in contact with the past, present, and future of Hawaii. Only royalty were allowed in the area of Lihue. High ranking Ali‘i were born here, and the privileged were brought here to learn aspects of Hawaiian culture such as navigation. [Yee 2013]

Mr. Yee’s father continued to share numerous *mo‘olelo* regarding the mythical and ancient past of O‘ahu. Mr. Yee began studying Hawaiian history and culture and in 2013, equipped with the

knowledge that he had inherited from his father and his *kumu* (teacher) Kaipo‘i, Mr. Yee began a blog, *Pohukaina Cave*. In this blog he shares, “Hawaiian history and places from a bicycle”:

> I am a resident of Waimalu in the moku [district] of Ewa with a fascination of history, and being a Hawaiian it’s gotta be Hawaiian history for now! […] I just want to share something that might appeal to you and hopefully things from the past will not be lost and covered by the fast present day life style! [Yee 2013]

Mr. Yee began the interview by discussing the importance of trails to the *ahupua‘a* of Honouliuli noting that trails leading to Wai‘anae and the North Shore pass through Honouliuli. He pointed out that the “north shore trail” traverses a portion of the eastern boundary of the *ahupua‘a* between Honouliuli and Hō‘ae‘ae Ahupua‘a before branching off and leading to Pōhākea Pass and traversing through the Wai‘anae Mountain Range to Lualualei Ahupua‘a in the *moku* of Wai‘anae.

Mr. Yee added that Pōhākea Pass is associated with the goddess Hi‘iakaikapoliopele, sister of volcano goddess Pele, and her epic journey across the Hawaiian Islands. Mr. Yee noted that from Pōhākea Pass, Hi‘iaka could see the entire *moku* of ‘Ewa.

> Hi‘iaka actually stands there and sees the whole *moku* of ‘Ewa and pointed it out cause she stood there and seen Leilono from there. She stands at Pōhākea Pass and defines the entire *moku* of ‘Ewa at that moment.

He also stated that from Pōhākea Pass, Hi‘iaka could see her traveling companions, Lohi‘au and Wahine‘ōma‘o, as they traveled by canoe to the harbor of Kou (Honolulu) (Ho‘oulumahiehie 2008b:260): “I think Hi‘iaka went this way and the guy’s in the canoe went this way, Lohi‘au and Wahine‘ōma‘o, that’s when they first started falling for each other. She’s like ‘eh, no talk to my husband […] No talking over there,’ from the mountains, eh.”

Pōhākea Pass is also the location where Hi‘iaka chanted as she “gazed toward Hawai‘i, and saw that her aikāne [friend], Hōpoe, had died in the fires of her elder sister Pele” (Ho‘oulumahiehie 2008b:262).

Mr. Yee also noted that Pōhākea Pass is associated with the famous warrior, Palila. Mr. Yee referred to Palila as the “Hawaiian Thor,” due to his supernatural war club which he could throw a long distance and fly along the club’s path as he held on to the end of it. According to *mo‘olelo*, Palila used his supernatural war club to carry himself from Ka‘ena Point at Wai‘anae, east across the *moku* of ‘Ewa, landing in a number of places in Honouliuli including Pōhākea Pass, the peaks of Manuauna and Kānehoa, and the plain of Keahumoa (Fornander 1918:5[1]:142–143).

Mr. Yee stated the *‘ili* of Līhue which is located in the northern region of Honouliuli Ahupua‘a was associated with a class of chiefs known as the *lo ali‘i*. Mr. Yee noted, “The *lo ali‘i* were the highest ranking chiefs but then they were hidden so they were like the poorest at the same time. In the rain, eating ferns and stuff cause they were so sacred. It’s a curse, blessing and a curse at the same time.”

Samuel Kamakau discussed the *lo ali‘i*:

> The chiefs of Lihue, Wahiawa, and Halemano on Oahu were called *Lo* chiefs, *po‘e Lo Ali‘i* [“people from whom to obtain a chief”], because they preserved their chiefly kapus. The men had kapus, and the women had kapus, and when they joined their kapus and children were born, the children preserved their kapus. They lived

> in the mountains (*i kuahiu‘i*); and if the kingdom was without a chief, there in the mountains could be found a high chief (*ali‘i nui*) for the kingdom. Or if a chief was without a wife, there one could be found-one from chiefly ancestors. [Kamakau 1991a:6]

He also discussed the *mo‘olelo* of Kelea, a chiefess of Maui, who was kidnapped and brought to O‘ahu to marry Lō Lale, a *lo ali‘i* from Līhue in Honouliuli (Kamakau 1991b:46).

> There’s a story about that one Maui chiefess, the one who got kidnapped by the canoe guys and took to live over there. But she ends up being the female progenitor of most chiefs, like in Hawai‘i, cause they had like the highest *mana* [spiritual power], cause she mated with the *lo ali‘i* and the *ali‘i nui* [high chief] of Waikīkī […] She was like a surfer, but she lived up in the mountains, that’s why they kidnapped her. […] She wanted to go surf again, she asked him if she could go but then he knew that she was gonna leave forever cause she was gonna be out of his watch. And it says something like, ‘she washes the red dirt of Līhue off’ when she enters Waikīkī.

A version of the *mo‘olelo*, which appears in Samuel Kamakau’s *Tales & Traditions of the People of Old*, states that Kelea lived with Lō Lale for ten years in the uplands of Līhue. They had three children, Kaholi-a-Lale, Luli-wahine, and Luli-kāne, who were among “the ancestral chiefs of O‘ahu” (Kamakau 1991b:46–47). Kelea was unhappy living in Līhue, longing for the ocean and her favorite pastime of surfing (Kamakau 1991b:47). She left Līhue to “go down to the seashore of ‘Ewa to go sightseeing,” traveling through the plain of Keahumoa, to Waipahu, ‘Ewa-uli, and Hālawa before reaching Waikīkī.

When Kelea and her companions reached the coconut grove of Kawehewehe in Waikīkī, they were welcomed by the *kama‘āina* of Waikīkī who stated “this is a place for enjoyment. Over there is the *kou* [Cordian subcordata] grove of Kahaloa where one may view the surfing of the chiefs and the *ali‘i nui* Kalamakua” (Kamakau 1991b:48). Kamakau describes Kalamakua:

> KALAMAKUA-A-KAIPŪHŌLUA was a good chief. He was noted for cultivating, and it was he who constructed the large pond fields Ke‘okea, Kualulua, Kalamanamana, and the other *lo‘i* [irrigated terrace] in Waikīkī. He traveled about his chiefdom with his chiefs and household companions to cultivate the land and gave the produce to the commoners, the *maka‘ainana.* They loved him. [Kamakau 1991b:45]

Kelea proceeded to borrow a surfboard and before entering the ocean she “rubbed the red dirt of ‘Ewa from her feet so as to look fresh” (Kamakau 1991b:48). She jumped on her board and paddled out past the “place where the surf broke” and waited for a wave to rise.

> When Kelea reached the place where the surf broke, she left that place to the *kama‘āina* and paddled on out to wait for a wave to rise. As she floated there, the first wave rose up but she did not take it, nor did she take the second or third wave, but when the fourth wave swelled up, she caught it and rode it to shore. As she caught the wave, she showed herself unsurpassed in skill and grace. The chiefs and people who were watching burst out in cheering the cheering rising and falling, rising and falling. [Kamakau 1991b:48–49]

Kalamakua was working in his fields when he was startled by loud shouts coming from the shoreline. He asked his men, “What is that shouting reverberating from the seashore?” They replied, “It is probably because of a skilled woman surfer.” Kalamakua realized that the “skilled woman surfer” was Kelea, a chiefess of Maui, and left his work to stand on the shore and watch. When Kelea came ashore, Kalamakua wrapped his *kīhei* (cape) around her and made her his wife (Kamakau 1991b:49).

> As Kelea rode in on a wave, the *mōʻī* ran to the edge of the sea and stood there. When the chiefess reached the sand, he took hold of her board and asked, ‘Are you Kelea?’ ‘Yes,’ she answered. She stood up, naked. The *mōʻī* removed his *kihei* shoulder covering and wrapped it around her as a *pāʻū* [skirt] and took her to a *kapu* place. That was the beginning of her life as the *aliʻi wahine moʻi* [queen] and she married (*hoʻiio mal-e*) the *mōʻī* Kalamakua. [Kamakau 1991b:49]

In another version of the *moʻolelo*, which appears in David Kalākaua’s *The Legends and Myths of Hawaii*, Kalamakua is described as “Lo-Lale’s cousin […] a noble of high rank whose lands were on the coast of the Ewa district” (Kalākaua 1990:233). In this version, Kalamakua is sent on the mission to find Lō Lale a wife. On the voyage returning to Oʻahu, Kalamakua had “become very much interested in Kelea” (Kalākaua 1990:240). Kelea lived with Lō Lale for a while, however, she longed for Kalamakua. When Kelea decided to leave Lō Lale, he voiced no “spoken bitterness;” however, after she left, he sang this lament:

> Farewell, my partner of the lowland plains,
>
> On the waters of Pohakeo, above Kanehoa,
>
> On the dark mountain spur of Mauna-una!
>
> O, Lihue, she is gone!
>
> Sniff the sweet scent of the grass,
>
> The sweet scent of the wild vines
>
> That are twisted by Waikoloa,
>
> By the winds of Waiopua,
>
> My flower!
>
> As if a mote were in my eye.
>
> The pupil of my eye is troubled.
>
> Dimness covers my eyes. Woe is me!
>
> [Kalākaua 1990:224–245]

When Kelea left Līhue, she traveled to ‘Ewa where she “found a large number of nobles and retainers of Kalamakua, the high chief of the district, amusing themselves in the surf” (Kalākaua 1990:245). Kelea borrowed a surfboard and “joined the party of surf-riders beyond the breakers” (Kalākaua 1990:245). Upon hearing that “a beautiful woman from Lihue had beaten all the chiefs at surf-riding,” Kalamakua realizes that the woman is Kelea and proceeds to the beach, greeting Kelea by placing his *kihei* over her shoulders (Kalakaua 1990:245). Kalakaua notes that Kelea and

Kalamakua “lived happily together, and were blessed with a daughter Laielohelohe, who inherited her mother’s beauty, and became the wife of her cousin Piilani, son and successor of Kawao, moi of Maui […]” (Kalākaua 1990:246).

Mr. Yee also discussed Kūali‘i, a “celebrated chief […] noted for his strength and bravery” who defeated the chiefs of Ko‘olauloa on the plains of Keahumoa (Fornander 1917b:4[2]:364). When the chiefs of Ko‘olauloa and their army of twelve hundred arrived in Honouliuli, they were outnumbered by Kūali‘i’s army of twelve thousand, however, the battle was averted when a *mele* in honor of Kūali‘i was chanted and the chief of Ko‘olauloa ceded the districts of Ko‘olauloa, Ko‘olaupoko, Waialua and Wai‘anae to Kūali‘i (Fornander 1917b:4[2]:400).

Mr. Yee stressed the importance of two brothers, Kapa‘ahulani and Kamaka‘aulani, who were on opposing sides of the battle. According to the *mo‘olelo*, Kapa‘ahulani and Kamaka‘aulani composed the *mele* in honor of Kūali‘i and devised a plan in which Kapa‘ahulani would go to Waialua where the chief of Ko‘olauloa was residing and urge him to make war on Kūali‘i, and Kamaka‘aulani would take Kūali‘i and “conceal yourselves in the bushes” at the place where the battle is to be fought (Fornander 1917b:4[2]:366). When the forces of Ko‘olauloa arrived in Honouliuli at the location which the brothers have agreed upon, Kapa‘ahulani tells the chief of Ko‘olauloa that their army is surrounded, and states that “I will chant my prayer, and if it should be acceptable this morning, we will be saved” (Fornander 1917b:4[2]:368). As Kapa‘ahulani chanted the *mele* which he had composed in honor of Kūali‘i, Kamaka‘aulani convinces Kūali‘i to delay the battle (Fornander 1917b:4[2]:380). When the chant was finished the “two armies came together and the battle was declared off” (Fornander 1917b:4[2]:400).

Mr. Yee also pointed out Mauna Kapu, a peak located in the Wai‘anae Mountain Range bordering the *ahupua‘a* of Nānākuli. The name Mauna Kapu translates to “sacred mountain” (Pukui et al. 1974:148). He believes “Mauna Kapus” were “meeting places, or something like that, for the chiefs,” noting that another Mauna Kapu is located in the *ahupua‘a* of Moanalua. Sterling and Summers describe Pu‘u Kapu (sacred hill) in Moanalua Ahupua‘a, noting that “this was where the chiefs and commoners met to discuss matters of importance” (Sterling and Summers 1978:334). There is also a hill named Mauna Kapu located in Līhue on the island of Kaua‘i (Pukui et al. 1974:148).

Mr. Yee discussed the hill of Pu‘uokapolei, stating that during the summer solstice, the sun sets over Pu‘uokapolei. He noted that the pathway of the sun aligns a *heiau* located on Pu‘uokapolei with Papa‘ena‘ena Heiau located in the *ahupua‘a* of Waikīkī.

> Pu‘uokapolei. Supposedly, that has an alignment with a *heiau* where, is it Papa‘ena‘ena Heiau, I think it lines up with that, or if there was another *heiau*. […] ‘Ōlelo Hawai‘i class […] they go there, that class goes there on one of the solstices or something like that and they chant for the sunset because the sun sets on Pu‘uokapolei at a certain time, as viewed from Papa‘ena‘ena Heiau […]

Sterling and Summers also stated that Pu‘uokapolei was used by ancient Hawaiians as an astronomical marker to designate the seasons, noting that the annual season of Kau which is marked by a high-sun period and corresponds with warmer temperatures and steady trade winds begins when the sun sets over Pu‘uokapolei.

> […] the people of Oahu reckoned from the time when the sun set over Pu‘uokapolei until it set in the hollow of Mahinaona and called this period Kau, and when it moved south again from Pu‘uokapolei and·it grew cold and the time came when young sprouts started, the season was called from their germination (oilo) the season of Ho-‘oilo. [Sterling and Summers 1978:34]

Mr. Yee also noted the possibility of a burial cave located on Pu‘uokapolei which contained a canoe inside of it: “Supposedly, what the guy told me is that there’s a burial cave in Pu‘uokapolei that has a canoe inside of it. But that’s probably long gone cause if you look at it, it’s all leveled already, on the *makai* side.”

Mr. Yee also noted the area where the ‘Ewa by Gentry subdivision is located was once the site of the largest grove of *wiliwili* trees on the island of O‘ahu.

> My most beloved thing ever, the *wiliwili* tree. There was a *wiliwili* grove over there cause that’s ‘Ewa […] there was a *wiliwili* grove there, where ‘Ewa by Gentry is now. The biggest one on the island, and that’s why all the birds. The land birds lived over there. The extinct ones, the flightless birds.

Traditional accounts (Kamakau 1991a:47–49) associate the *ao kuewa* with a grove of *wiliwili* trees on the plains of Kaupe‘a in Honouliuli.

> When a man who had no rightful place in the *‘aumakua* [family or personal gods] realm (*kanaka kuleana ‘ole*) died, his soul would wander about and stray amongst the underbrush on the plain of Kama‘oma‘o on Maui, or in the *wiliwili* grove of Kaupe‘a on Oahu.
>
> On the plain of Kaupe‘a beside Pu‘uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by *‘aumakua* souls, and be helped to escape […] [Kamakau 1991a:47–49]

Mr. Yee also stated “there was those two ladies who were down by the archery, that’s two *pōhaku*, the lizards in the Hi‘iaka story.” According to the *mo‘olelo*, as Hi‘iaka traveled toward the ‘Ewa coast, two women, who were also *mo‘o* (lizard or water spirit), saw Hi‘aka coming. Fearing that Hi‘iaka would kill them, the women changed into their lizard form and hid from her. One of the lizards hid in a little space on a stone along the coastal trail, and the other hid nearby. (*Ka Hōkū o Hawai‘i*, 15 February 1927, translated in Maly 1997:19). This stone is known as Pe‘ekāua which translates to “we two hidden.” Hi‘iaka greeted the two women and passed on without hurting them.

Mr. Yee discussed visiting Kalaeloa Heritage Park which is located in the coastal region of Honouliuli. He described observing a *heiau* that was partially underground and built using upright coral stones. He noted that Shad Kāne, *kahu* (caretaker) of Kalaeloa Heritage Park, believes the *heiau* is of Tahitian descent. He also noted the presence of a trail marked by upright coral slabs that “supposedly led all the way to another *heiau* that was by Laulaunui Island” near the West Loch of Pu‘uloa (Pearl Harbor).

He also noted that Ko‘olina is the site of one of the oldest fishing encampments on the island of O‘ahu.

> At Ko‘olina is one of the oldest fishing encampments, or even oldest carbon dates, on Oahu. Cause there’s like some fishing cave near Ko‘olina or those cliffs by Tracks [Beach Park] before this side of the island was inhabited, people from the Ko‘olau were going on fishing expeditions and coming all the way over here. Camping out.

In *The Rise and Fall of the O‘ahu Kingdom*, Ross Cordy discussed evidence of early settlement at “sites on the arid western fringe of the ‘Ewa Plain in today’s Ko Olina Resort” (Cordy 2002:13–14).

> Apparent human manipulation of the inland marsh’s (site 3357) flora dates to at least A.D. 225-565. Backhoe trenches uncovered a buried habitation deposit (site 1446-1) at the base of the low limestone escarpment next to the marsh. This site has complex stratigraphy with overlapping firepits, midden deposits, and intervening non-cultural alluvium. Fishbone, shellfish, bird bone (flightless goose, etc.), early types of one-piece bone and pearlshell fishhooks, and basalt adze blanks of unusual and often early forms were found. This site yielded an initial use date of A.D. 145-600. Rockshelters (site 3355) in the escarpment across the marsh were also excavated, and deposits dated back to the A.D. 600s-1000s. Also, the coastal dune had subsurface deposits (site 1438-1) with one date of A.D. 410-660, but most post-1200s. The dune deposits contained food remains (fish, molluscs, sea birds and extinct geese), postholes, firepits and fishhooks of early type. The researchers concluded that these three sites reflected ‘very dispersed’ ‘temporary encampments utilized by fishermen and bird collectors’. [Cordy 2002:13–14]

Mr. Yee stated that as a child his favorite beach, which he referred to as “Hamburgers,” was located at Ko‘olina. He believes the beach was “annihilated” during the development of Ko‘olina.

> I get my own *mo‘olelo*, brah, here we go, so my favorite beach as a child, try find out where this place is, it’s this place called Hamburgers. I think the whole Ko‘olina development or the harbor that they made, the fake harbor, just totally annihilated it. I didn’t even know what road we took off, which led us there, but it was a beach that we could play as a kid cause the water would come around this rock, you couldn’t jump off of it cause the rock was huge, brah, like two stories, as a child, I believe. And it looked like a hamburger, like of sand, sandstone, and the waves would hit it and come around and it would have this little pond. Kind of felt like Magic Island, but it was smaller than that, but you couldn’t jump in cause it’s like six inches deep, like and it’s like super high.

The *wahi pana* and *mo‘olelo* associated with Honouliuli which were shared by Mr. Yee demonstrate the importance of Honouliuli in traditional Hawaiian times. Honouliuli was the largest *ahupua‘a* on O‘ahu. *Kama‘āina* travelling from the *moku* of Kona to the *moku* of Wai‘anae and Waialua crossed through the *ahupua‘a* of Honouliuli through a network of trails. Numerous *mo‘olelo* and *wahi pana* associate Honouliuli with the *akua* including Hi‘iaka and Pālila, as well as the *ali‘i,* including a class of chiefs known as the *lo ali‘i* who lived in the *‘ili* of Līhue located in the northern region of Honouliuli and the *ali‘i* Kūali‘i who defeated the chiefs of Ko‘olauloa on the plains of Keahuamoa when a *mele* honoring Kū‘ali‘i was chanted.

6.5.3 Lynette Paglinawan

On 14 October 2019, CSH met with Ms. Lynette K. Kaopuiki Paglinawan at her home to discuss the West Oahu Solar Project and to share her *‘ike* of the traditional cultural practice of *ho‘oponopono* (to correct) and the *ao kuewa* in the *ahupua‘a* of Honouliuli.

Ms. Paglinawan is a social worker. For about eight years, she was on the Historic Sites Review Board. She is also an educator, teaching a class at the University of Hawai‘i West O‘ahu (UHWO) about Native Hawaiian healing which includes the traditional cultural practices of *ho‘oponopono*, *lomilomi* (massage), and *lā‘au lapa‘au* (herbal medicines). She discussed *ho‘oponopono* which is the process of setting things right within the context of a family. She explained:

> In *ho‘oponopono*, which is what I practice, if you do transgressions and if I broke the glass pane in a picture window of a house, my going up to them and just apologizing and saying I’m sorry is not going to make them happy, I have to replace it or give them monetary value to have it replaced. When I do that, then the relationship becomes harmonious.

Since Ms. Paglinawan began working at UHWO, she has “come to learn about the area and the cultural impact that has happened in the *moku* of ‘Ewa and [*ahupua‘a* of] Honouliuli […]” Through her research of the works of Mary Kawena Pukui, she has learned that “the area from Waimānalo Gulch over to Kapolei to the location of UHWO was known by very early residents there to be the place where “*ao kuewa*,” wandering spirits, congregated from *makai* to *mauka* up Pālehua and especially near the cluster of *wiliwili* trees in Kaupe‘a.” She noted that “families in the Hawaiian definition includes the souls of these families.” She added:

> The souls of deceased individuals have three areas to go to, one to *pō* [the realm of the gods] which is like heaven, to be with ancestors, one to *milu* [underworld] which is like hell, the other one is to designated areas within a district and it happens to be in the area of Waimānalo Gulch on over as you go *mauka*.

Ms. Paglinawan’s great-great-grandparents were “born and reared in Honouliuli.” She added:

> If my great-grandparents were born and reared there and my great-grandfather had inherited land and was reared in the area, I can surmise that my *‘ohana* [family], my relatives, the big branch of relatives, some of them when they died, they went to heaven, some of them when they died might have gone to hell, but possibly there were some who just were not good enough to go to heaven so they were relegated to roam in this area […]

She stated that she has heard numerous stories of “strange happenings” which are “due to the presence of spirits.” She noted that “this is their territory.” She mentioned that “there are stories of them being known to go down to the oceanside and cause havoc with the living” and “even going up into the mountain of Pālehua beyond Makakilo,” noting “the families who live there talk about ghosts and strange happenings […]” She stated:

> I’ve had discussions with some people who live up Makakilo and they finally had to leave because things happened and when I talk about it with my students, some of them are residents in the Hawaiian Homes subdivision, they have given me examples of their kids screaming because they see things in the house.

She also recalled an experience Mary Kawena Pukui had when she was a teenager walking on the beach in ‘Ewa with her dog. As she walked to visit her relatives in Kalaeloa, Ms. Pukui’s dog was attacked by an *‘uhane* (spirit) who wanted to eat the animal.

> Tutu Pukui said, she was about a teenager, went to visit the relatives, they were walking on the beach, ‘Ewa Beach, going to Kalaeloa, they had the dog with them, the dog suddenly started growling and jumped up and the next thing they saw was the dog fell down, frothing and the heart pounding. Her aunty said to her, “Take this, go get salt water, bring it back.” The aunty sprinkled the salt water on the dog. She talked to the spirits and scolded the spirits, “This animal is not ready to die, you folks leave him alone, you go look for something else, he needs to live yet.” And then she prayed. By the time she got finished, he could bring his body upright, but they had to walk slowly. Because this was an animal and in the old days, Hawaiians ate dog. So they used to what they ate in real life, but because her aunty lives that area, she knows how to deal with it. After that she asked the aunty, “Why the dog was like that?” The aunty explained to her about the *ao kuewa*.

Ms. Paglinawan expressed her concerns regarding the effects that the proposed project will have on the *ao kuewa*, noting her belief that ghosts are attracted at night to lights and to energy. She stated that “the building that has the most energy, electrical energy is our library, it is temperature and humidity controlled, it has all the electronic equipment for media and dispersal of information.” She recalled speaking with staff at the UHWO library:

> So, the stories that have been told to me is staff turned off the lights and everything in the library [when] they leave. When the guard make their round again, even before midnight, the huge monitor is lit up. Who turned it on? They have constant problems with the elevators on campus and the newest building on campus that was just completed about a year ago has had electrical difficulties “left and right.”

She added that, “on top of the library we have this huge art piece that is highlighted at night and our chancellor says, “It’s a beacon for the people, Nānākuli, Wai‘anae,” but hell, it’s a beacon for the ghosts, too. Because they’re energy, they seek the thrill of electricity.”

She also noted that “we’ve had documentation of the double pane picture windows in the library for humidity control and temperature control, they had an incident where somebody from the inside was trying to break their way out. The inner panel was broken, they hadn’t gotten to the outer panel. So, it was from the inside going out, and yet, staff will swear nobody was in the building.”

She also stated that people “have seen lights coming from the second floor ground, lights from the carpet shining up and they’re wondering, “What the hell is that?” They go down, there is nothing underneath.”

She noted that these “strange happenings” are not limited to the library. She stated that:

> […] every single building, the workers, they work late, they feel it and we have in the back of [UH] West O‘ahu towards this end, we have the housing of the electrical unit. The ones who work there during the day say it is spooky, so you know what they have, Hawaiian salt, if they feel a presence, they eat some Hawaiian salt and they sprinkle, so they have to contend with that.

She also expressed her concerns of the effect of the *‘uhane* on the solar panels, noting “that’s high energy. It will be like going to the game room.” She also noted her concerns regarding the Honolulu Rail Transit System, stating that:

> I hate to think what it’s going to be like when the rail comes on. This thing lit up at night going zoom, zoom. They gonna be on it, but there’s going to be a lot electrical outage cause the more power the faster the excitement.

She also stated that she expects to “see a lot of repair and maintenance on electrical parts.” She stated that following exam periods when there is a “high utilization of night classes, night classrooms and study areas,” they experience “things breaking down or burning out.” She added that “in the long run, the cost for electrical repair and maintenance is a heavy burden for the contractor, but once that contract has finished the problem still remains […]”

Ms. Paglinawan stated that “spirits travel on ancient trails” noting that “they go from *mauka* going down to *makai*” and that, “ancient trails were there to go up and down, and so, *lōlō* [crazy] for them [ghosts] to just stay one place when they don’t have to.” She added that these “ancient trails are still in use,” stating that:

> The people who have residence in Kapolei area tell me the stories about somebody trying to enter the house and break the door down. And when they swear, and they go to the front door, they going fight with them, they open the door, no more nothing. And I asked them, “How often does this happen?” They said, “Not that often, once in a while.” But that’s the ghost who walked the trails on certain nights.

She also discussed an old home on Hawaiian Home Lands in the *ahupua‘a* of Waimānalo, Ko‘olaupoko. She noted that this house has “never ever been completed” because the residents built the home on the ancient pathway to the beach and they were getting “bothered all the time.”

> […] you know down Waimānalo [Ahupua‘a], […] across from the beach is Hawaiian Home Lands, there’s one old house that has never ever been completed. It’s because the residents built that house right on the beach pathway and they get bothered all the time, so they’ve given it up.

She also recalled that while her husband, the late Richard K. Paglinawan, was a student at the University of Hawai‘i, he heard spirits travelling on the ancient pathways “coming from the ocean going up Waiāhole Road into the mountains.”

> My husband lived in Waiāhole and when he studied for the University it would be like 2-3 o’clock in the morning, as soon as he hears the drums, he turn off all the lights, he put his head under the pillow and he will himself to go sleep because he can hear it coming from the oceanside going up Waiāhole Road into the mountains.

She added that “this area where the University [of Hawai‘i West O‘ahu] is located has a lot of trails that go from *mauka-makai*, come from Honolulu going towards Nānākuli.” She asked, “Is this going to be built on ancient trails?” She added that the project proponents should be “mindful of the ancient trails because when the ghosts march, they begin from the mountain, but they also begin from the oceanside and they go into the valley.”

Ms. Paglinawan stated that the development of the *moku* of ‘Ewa including the *ahupua‘a* of Honouliuli resulted in the displacement of the *ao kuewa*. She noted that “we destroyed the habitat

of the *ao kuewa* which is the *wiliwili* trees." She added that "if we destroy the habitat of the ghosts, they have no place to go but into the facilities."

> […] if we recognize we destroyed their habitat, we are making restitution cause we know we did that. It is reciprocal *aloha* [love]. So we do this with the right intentions, righting the wrong that we have done and they will respond in right ways. We have the saying, "When *aloha* is given unconditionally, you never know when, but it comes back to you." So, I really believe in that and because I believe that these may be the spirits of my ancestors, I lay my genealogy on the line to reach out to them. That with *aloha* we want to rectify our sins, our transgressions.

To illustrate reciprocal *aloha*, Ms. Paglinawan shared a *mo‘olelo* of the goddess Hi‘iakaikapoliopele who passed through the ‘Ewa District. She stated:

> […] Hi‘iakaikapoliopele, who traveled through from Ka‘ena Point across the west side and then from Pu‘u Kapu and descended down into the ‘Ewa District. She as a goddess can see if you're human or you're a ghost. She saw in the distance, two women, they were stringing *leis* [garlands]. She thought in her mind, "I wonder if they still remember *aloha*?" Now for a Hawaiian, *aloha* is your behavior that is hospitable, it is welcome. And the practices during that time, if you were a stranger coming through that desolate area, you're invited to partake in whatever water you have and whatever limited food you have. So she said, "I wonder if they still remember *aloha*?" So she did an *oli* [chant], *oli aloha*, and as soon as they heard it, they looked up and they saw that's a *malihini* [stranger] and the smile just graced their faces. Hi‘iaka said, "they still know *aloha*." They stopped everything, the *leis* that they had, they rushed to her and said, "Welcome," and bedecked her with the *leis*. So, the lesson for us, the living, if our intentions is good, if it is *pono* [proper], it increases the opportunity for *aloha* to be reciprocal.

Ms. Paglinawan recommended planting "a wall of trees" surrounding the proposed project area which would provide a home for the displaced spirits. She asked, "Can we entice them to go there?" She went on to state that:

> I'm also very mindful that any kind of tree that we put there, that produces food, not just for the living but for the ghosts cause you know if you get *‘ulu* [breadfruit, *Artocarpus altilis*], you get coconut, not everybody picks up everything, some go on the ground. Coconut leaves, if you leave it on the ground, it begins to be a cover that bugs begin to cluster, the bugs are also the things the ghosts ate. They also ate whatever foods fell down, but they were Hawaiian so they went *makai* and they go catch crab and they eat crab, they eat the seaweed.

She added that:

> I'm thinking we're gonna have a conference in January and Kūkaniloko, the birthing stones, were promised a donation of 10,000 Hawaiian plants. They've offered as many of the *wiliwili* trees as I want, so I want to start a campaign that, like Hawaiian Home Lands, they allow their residents to plant a tree and maybe it might be a border of the road, plant a whole row of trees and that way they have their own houses, man have their own houses. And Hawaiian's have rituals that can

> clear them [ghosts] out of the house and prevent them from entering again with bamboo.

She added that, “I’d like to see us repair the habitat, so in our rituals and in our belief in the gods listening to our plea, our needs, they would consider that these souls want to live with *aloha*, with man, the living man, cause for me it’s family. I want them to live with *aloha*, so if they sacrifice and having to move outside so that man is comfortable in his area, let’s set aside a wall of trees.”

Ms. Paglinawan discussed the types of plants that were previously found in the area which include *noni* (Indian mulberry, *Morinda citrifolia*) plants, coconut trees, *lauhala* (*Pandanus tectorius*) trees, and *‘ulu* trees. She noted that these plants were “very plentiful but sparse not like a big grove where it’s like a park of trees, it was interspersed throughout.” She also noted that the destruction of the foliage has also “affected the number of Hawaiian birds who no longer come around.” She noted:

> There used to be *noni* trees in the area and it was known that the birds sought the nectar from the *noni* flower, now they don’t have this around. As a result, the count of the Hawaiian birds has really diminished.

Ms. Paglinawan stated that she would like to “reverse the negative impact and do restitution.” She noted that “if you have a border of trees that’s long, it meets the needs for life, you have physical food, you have supplies that you use for making crafts and getting along, and you create habitat, not just for the *ao kuewa*, but for birds, as well, who used to be a larger number of them there like the *pueo* (Hawaiian short-eared owl; *Asio flammeus sandwichensis*) and *‘i‘iwi* (Scarlet Hawaiian honey creeper; *Vestiaria coccinea*).”

She also mentioned that she wanted to do plantings in the gulch which is located near the UHWO campus, noting that “we wanted to do plantings, keep the ravine clear, but on the sides we do the plantings, so that they [ghosts] leave [UH] West O‘ahu and they go to the plants […]”

She also noted that planting of “a wall of trees” around the proposed project area would have other benefits including the production of oxygen. She stated that “we need to create this area to have an opportunity to equalize the airspace that’s going to reduce carbon dioxide but can we replace it with oxygen.” She noted that,

> [Solar] Energy is a replacement of carbon dioxide emission but what are we promoting to occupy the space carbon dioxide had because trees produce oxygen, we need oxygen for living.

Ms. Paglinawan also noted that,

> For me, it’s *ho‘oponopono*. If you destroy a part of an ecosystem, how do you bring it back to retain balance? Otherwise it will always be uneven, you remove the oxygen from fossil fuel emission, what are you gonna replace with it? Other chemicals, well, what about oxygen that we need to live and survive on.

Ms. Paglinawan also expressed her concerns about the psychological impacts on the people who encounter these spirits, asking, “What kind of psychological impact is being created when we occupy certain space and then the spirits have to cluster?” She noted her belief that “children who are more pure and more innocent, they see many more things than we do.” She added that:

> Mary Kawena Pukui says, “if you talk to the ghosts and they know what’s happening, if they know they’re not wanted there cause they’re making people scared. You ask them to go back where they belong, they will go.” But, that is an act of *aloha* because they making life good for the living. The children not going get scared.

Ms. Paglinawan also noted that each island has areas which are home to the *ao kuewa*. She stated:

> […] like on Maui, you know where the sand dunes are, lot of bones yeah, Hawaiian Home Lands had land right at the edge of the sand dunes, they built a subdivision, the grandchildren see ghosts. Kaua‘i has Manā (sands of Manā) by Polihale, the cliffs of Polihale. That is where the good spirits are judged to leap off and to join their ancestors and they go, but there’s also some that never make that jump. So, it happens over there. So, Hawaiians have the leaping off place to get to *pō*, so that area means there are pathways that you shouldn’t build houses on because it’s gonna happen with Hawaiian deaths.

Ms. Paglinawan would like to use the traditional cultural practice of *ho‘oponopono* to make things right with the *‘uhane* who have been displaced by the development of the *moku* of ‘Ewa and in the *ahupua‘a* of Honouliuli. She recommends planting “a wall of trees” around the proposed project area as restitution to the *‘uhane* who may be displaced by the proposed project. She expressed concerns regarding the effects that the *‘uhane* will have on the solar panels, noting the numerous electrical problems experienced by the UHWO due to the presence of the *‘uhane*. She stated that planting of “a wall of trees” around the proposed project area would provide a home for the *‘uhane* who may be attracted to the energy being generated by the proposed solar farm, as well as, providing a habitat for Native Hawaiian birds and producing oxygen.

She would also like the project proponents to be mindful of the locations of ancient trails which she noted are still in use by the *‘uhane* to travel from *mauka* to *makai* in Honouliuli Ahupua‘a with less worry about money.

Ms. Paglinawan also expressed her concerns for the people that encounter the *‘uhane*. She noted the psychological trauma on workers at the UHWO, as well as, families who live in the area. She was particularly concerned for the children who encounter these spirits, noting her belief that children “see many more things than adults do.”

6.6 Summary of *Kama‘āina* Interviews

Based on reviewed and approved interview summaries of Tom Berg, Shad Kāne, Christian Kaimanu Yee, and Lynette Paglinawan, the following is a synthesis of findings within Honouliuli Ahupua‘a.

CSH met with Mr. Christian Kaimanu Yee on 9 August 2019 to share his extensive *‘ike* of *wahi pana* and *mo‘olelo* associated with the *ahupua‘a* of Honouliuli. Mr. Yee discussed several *wahi pana* in the *ahupua‘a* of Honouliuli including Pōhakea Pass, Mauna Kapu, Pu‘uokapolei, a *wiliwili* grove and a *pōhaku* known as Pe‘ekāua on the plains of Kaupe‘a, and a *heiau* and trail located at Kalaeloa Heritage Park. He also noted that one of the oldest fishing encampments on the island of O‘ahu was found at Ko‘olina.

Mr. Yee noted the importance of trails to the *ahupua‘a* of Honouliuli pointing out that trails leading to Wai‘anae and the North Shore pass through Honouliuli. He stated that the “north shore trail” travels along the boundary between Honouliuli and Hō‘ae‘ae Ahupua‘a before branching off and leading to Pōhākea Pass where it continues through the Wai‘anae Mountain Range to Lualualei Ahupua‘a in the *moku* of Wai‘anae. Mr. Yee added that Pōhākea Pass is associated with the goddess Hi‘iakaikapoliopele and her epic journey across the Hawaiian Islands, as well as the famous warrior, Palila, who Mr. Yee referred to as the “Hawaiian Thor.”

Mr. Yee also discussed the *‘ili* of Līhue which was associated with a class of chiefs known as the *lo ali‘i*. He shared the *mo‘olelo* of Kelea, a chiefess of Maui, who was kidnapped and brought to O‘ahu to marry Lō Lale, a *lo ali‘i* from Līhue in Honouliuli (Kamakau 1991b:46).

He also discussed Kūali‘i, a chief who defeated the chiefs of Ko‘olauloa on the plains of Keahumoa (Fornander 1917:364) when a *mele* in honor of Kūali‘i was chanted and the chief of Ko‘olauloa ceded the districts of Ko‘olauloa, Ko‘olaupoko, Waialua, and Wai‘anae to Kūali‘i (Fornander 1917:400). He noted that the *mele* in honor of Kūali‘i was composed by Kapa‘ahulani and Kamaka‘aulani, two brothers who were on opposing sides of the battle.

On 13 August 2019, CSH spoke with Mr. Shad Kāne via telephone. Mr. Kane stated he is not in opposition to the proposed project, noting that the project area has been previously disturbed by sugarcane production.

In written testimony provided to CSH on 19 August 2019, Mr. Berg stated that the project has been “proposed on a pueo (owl) foraging and breeding ecosystem.” He noted that records indicate that per earliest colonial contact, the *pueo* is most abundant on the slopes from Pu‘u Kapua‘i to West Loch, adding that “Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood.” He stated the proposed project will “encroach on prime pueo habitat-considered to be graded A+—“a ten (10)”—when it comes to the degree of pueo habitat in use on this project site.” Mr. Berg also stated the project site is also “inhabited by the ōpe‘ape‘a at various times of the seasons,” noting that in 1910, the State of Hawai‘i documented *‘ōpe‘ape‘a* within a half-mile of the project area.

Mr. Berg also stated that the *pueo* has “a direct connection to Native Hawaiian family lineage in Ewa Beach,” noting the *pueo* is the *‘aumakua* for the Michael Lee family and their accounts, which go back over seven generations, are documented at the State Archives Building in Honolulu.

Mr. Berg stated his concern that the “property in question will not receive the proper protocol to conclude no endangered species inhabit the area.” He recommended that “a thorough and complete protocol is adopted to repeat the inventory exercise for pueo and ‘ōpe‘ape‘a over the course of a calendar year would be in order so the project does not inadvertently contribute to more endangered species habitat loss.” He added that “this practice, to deploy the protocol year-round, is not being done in either the EA and or EIS review processes.” Mr. Berg also recommended consulting with Dr. Melissa Price and Dr. Javier Cotin of the Project Pueo Biologist Team and DOFAW Biologist Afsheen Siddiqi regarding *pueo* protocol.

Mr. Berg also expressed his concern for the possible negative aspects of neighboring lighting operations at an adjacent parcel which may reflect off a solar panel into “the flight patterns of migrating birds and the *‘ōpe‘ape‘a* and *pueo* in particular need to be addressed.”

Ms. Lynette Paglinawan stated that “whole area in Honouliuli going *mauka* is the space that was occupied by the *ao kuewa*” which she defined as the “ghosts or spirits of the deceased relatives that belong in a family.” She expressed her concerns regarding the effects that the proposed project will have on the *ao kuewa*, which she believes are attracted to energy. She also expressed her concerns of the effect of the spirits on the solar panels, noting “that’s high energy. It will be like going to the game room.” She also noted that UHWO experiences numerous electrical problems due to the presence of these spirits.

Ms. Paglinawan noted that “this area where the University [of Hawai‘i West O‘ahu] is located has a lot of trails that come from *mauka-makai*, come from Honolulu going towards Nānākuli.” She stated that project proponents should be mindful of the locations of ancient trails, noting that the ancient trails are still used by spirits to travel from *mauka* to *makai* within Honuliuli Ahupua‘a.

Ms. Paglinawan recommended planting “a wall of trees” surrounding the proposed project area as restitution to the spirits who may be displaced by the proposed project. She also noted that planting of “a wall of trees” around the proposed project area would have other benefits including the production of oxygen and providing a habitat for Native Hawaiian birds.

Ms. Paglinawan also expressed her concerns regarding the psychological impacts for the people that encounter the spirits, noting trauma on workers at the UHWO, as well as, families who live in the area. She was particularly concerned for the children who encounter these spirits, noting her belief that children “see many more things than we do.”

Section 7 Traditional Cultural Practices

Timothy R. Pauketat succinctly describes the importance of traditions, especially in regards to the active manifestation of one's culture or aspects thereof. According to Pauketat,

> People have always had traditions, practiced traditions, resisted traditions, or created traditions […] Power, plurality, and human agency are all a part of how traditions come about. Traditions do not simply exist without people and their struggles involved every step of the way. [Pauketat 2001:1]

It is understood that traditional practices are developed within the group, in this case, within the Hawaiian culture. These traditions are meant to mark or represent aspects of Hawaiian culture that have been practiced since ancient times. As with most human constructs, traditions are evolving and prone to change resulting from multiple influences, including modernization as well as other cultures. It is well known that within Hawai‘i, a "broader 'local' multicultural perspective exists" (Kawelu 2015:3). While this "local" multicultural culture is deservedly celebrated, it must be noted that it has often come into contact with "traditional Hawaiian culture." This contact between cultures and traditions has undoubtedly resulted in numerous cultural entanglements. These cultural entanglements have prompted questions regarding the legitimacy of newly evolved traditional practices. The influences of "local" culture are well noted throughout this section and understood to represent survivance or "the active sense of presence, the continuance of native stories, not a mere reaction, or a survivable name. Native survivance stories are renunciations of dominance, tragedy and victimry" (Vizenor 1999:vii). Acknowledgement of these "local" influences help to inform nuanced understandings of entanglement and of a "living [Hawaiian] contemporary culture" (Kawelu 2015:3). This section strives to articulate traditional Hawaiian cultural practices as were practiced within the *ahupua‘a* in ancient times, and the aspects of these traditional practices that continue to be practiced today; however, this section also challenges "tropes of authenticity," (Cipolla 2013) and acknowledges the multicultural influences and entanglements that may "change" or "create" a tradition.

This section integrates information from Sections 3–6 in examining cultural resources and practices identified within or in proximity of the project area in the broader context of the encompassing Honouliuli landscape. Excerpts from interviews are incorporated throughout this section where applicable.

7.1 Gathering of Plant and Aquatic Resources

Lying in the lee of the Wai‘anae Mountain Range, Honouliuli is one of the driest areas of O‘ahu with most of the area averaging about 550 mm (22 inches) of rain on the coastal and inland region of the *ahupua‘a* and about 1,200 mm (39 inches) in the northern region up into the Wai‘anae Mountain Range (Giambelluca 2013). Despite the relative lack of rainfall in this area, there exists a traditional rain name associated with the *ahupua‘a* of Honouliuli. This rain, known as the Nāulu, is described as a sudden shower and is more commonly associated with other notoriously dry locations, such as Kawaihae, Hawai‘i and Ni‘ihau (Akana and Gonzalez 2015:187). The general lack of distinctive, traditional rain names is indicative of historic environmental conditions within the *ahupua‘a*. Due to these conditions, *maka‘āinana* living within the *ahupua‘a* were forced to modify or utilize freshwater resources in innovative ways.

No natural streams are located in the vicinity of the project area. However, fresh water remains available below the surface of Honouliuli. Dissolution “pit caves” (Mylroie and Carew 1995) or “sink holes” would accumulate water within them via a subterranean water or karst system; this water also contained nutrient-rich sediment that allowed for the cultivation of significant plant resources such as *kalo, kī*, and *noni*. McAllister (1933) documented examples of traditional agricultural activity in Honouliuli, writing that the *kama‘āina* of the *ahupua‘a* utilized the soil on the floor of caves for cultivation. At the time of his survey in 1930 both *mai‘a* (bananas) and *kō* (sugarcane) were still being cultivated within these pits.

The lowlands fronting the west loch of Pearl Harbor (Kaihuopala‘ai) were suitable for the cultivation of the traditional Hawaiian staple crop, *kalo*. The production (and consumption) of *kalo* was vitally important to many communities of Native Hawaiians living in ‘Ewa. Captain James King, visiting Hawai‘i in 1779, noted that “the natives of these islands are, in general, above the middle size and well made; they walk very gracefully, run nimbly and are capable of bearing great fatigue” (Shintani 1993:10). Accordingly, the high level of physical activity and physical fitness described by Captain King was a normal part of Hawaiian life and was largely attributable to the availability of plant and food resources such as *kalo*, *‘uala* (sweet potato; *Ipomoea batatas*), *niu*, *mai‘a*, *limu* (seaweed), and *i‘a* (fish). Besides the observed contributions to stamina and health, *kalo* was also a revered staple food, believed to have derived from the first-born son of Wakea and Papa.

> […] the supreme god Kane ‘in the form of Wakea (a form associated with the earth) produced two sequential offspring: the first became kalo (taro) plant, the second became Hāloa, the ancestor of man […] thus, in kinship terms, the taro is the elder brother and the senior branch of the family tree, mankind belongs to the junior branch, stemming from the younger brother.’ [Trask 2012:75]

‘Ewa was also famous for a rare taro called the “*kāī o ‘Ewa*,” which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying, “*Ua ‘ai i ke kāī-koi o ‘Ewa*, He has eaten the Kāī-koi taro of ‘Ewa” (Pukui 1983:305).

Traditional Hawaiian diets were also supplemented with ocean-based proteins. Native Hawaiians historically fished the reefs, farmed fishponds, and utilized the freshwater springs in the *ahupua‘a* of Honouliuli. The lochs of Pearl Harbor were ideal for the construction of fishponds and fish traps. References to the abundance of ocean resources can be found within *mo‘olelo*, *wahi pana*, and *‘ōlelo no‘eau* associated with Honouliuli Ahupua‘a.

The *mo‘olelo* “Legend of the Children” describes the coastal area of Kūalaka‘i as being plentiful in fish. Clark (1977:74) and Pukui et al. (1974:119) describe Kūalaka‘i as a type of sea cucumber (*Tethys*) that squirts purple fluid when squeezed. The *‘ōlelo no‘eau,* “*Kai a hali a ka makani*,” translates to “the fish fetched by the wind” which describes the migration of the *‘anae* that travels from the leeward coast to the windward coast of O‘ahu.

Interviewee Christian Kaimanu Yee noted that the site of one of the oldest fishing encampments on the island of O‘ahu was discovered at Ko‘olina. Ross Cordy (2002:13–14) discussed evidence of early settlement at “sites on the arid western fringe of the ‘Ewa Plain in today’s Ko Olina Resort,” which included “fishbone, shellfish, bird bone (flightless goose, etc.), early types of one-piece bone and pearlshell fishhooks, and basalt adze blanks” which date back to AD 145-600.

7.2 Faunal Resources

The *pueo (Asio flammeus sandwichensis* or short-eared owl), which is endemic to Hawai‘i, are found on all of the main Hawaiian islands and are listed by the State of Hawai‘i as endangered on the island of O‘ahu (DLNR 2005). The DLNR states that *pueo* are most commonly found in “open habitats such as grasslands, shrublands, and montane parklands, including urban areas and those actively managed for conservation” (DLNR 2005).

In written testimony provided to CSH via email on 19 August 2019, Mr. Tom Berg stated that the project has been “proposed on a pueo (owl) foraging and breeding ecosystem.” He noted that historic records indicate the *pueo* is most abundant on the slopes from Pu‘u Kapua‘i to West Loch. He added that “Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood.” He also stated the proposed project will “encroach on prime pueo habitat-considered to be graded A+—“a ten (10)”—when it comes to the degree of pueo habitat in use on this project site.”

The *pueo* is one of the most important *‘aumākua* gods and ancestral deities of the family (Valeri 1985:19, 21). Mr. Berg noted the *pueo* has “a direct connection to Native Hawaiian family lineage in Ewa Beach,” noting that the *pueo* is the *‘aumakua* for the Michael Lee family and their accounts, which go back over seven generations, are documented at the State Archives Building in Honolulu.

Mr. Berg also stated that the project site is “inhabited by the ōpe‘ape‘a [Hawaiian hoary bat, *Lasiurus cinereus semotus*] at various times of the seasons,” noting that in 1910, the State of Hawai‘i documented *‘ōpe‘ape‘a* within a half-mile of the project area. “The only land mammal native to the Hawaiian archipelago,” *‘ōpe‘ape‘a* are found on all of the main Hawaiian islands except for Ni‘ihau (DLNR 2005:3-13) and have been “found roosting in ‘ōhi‘a (*Metrosideros polymorpha*), pu hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Proscopis pallida*), avocado (*Persea americana*), shower trees (*Cassie javanica*), pūkiawe (*Styphelia tameiameiae*), and fern clumps; they are suspected to roost in Eucalyptus (*Eucalyptus* spp.) and Sugi pine (*Cyrptomeria japonica*) stands” (DLNR 2005). The *‘ōpe‘ape‘a* was listed as an endangered species under the Endangered Species Conservation Act of 1969.

7.3 Wahi Pana

There exist a myriad of cultural sites or *wahi pana* for ‘Ewa Moku, however, for the *ahupua‘a* of Honouliuli trails, plains, and temples were of particular importance.

Trails were and continue to be valuable resources for Native Hawaiian culture and life ways. In the past, trails were well used for travel within the *ahupua‘a*, between *mauka* and *makai* and laterally between *ahupua‘a*. A historical trail system existed in O‘ahu extending from Honolulu to Wai‘anae. A cross-*ahupua‘a* (east-west) trail that bordered Pearl Harbor passed through Honouliuli north of Pu‘uokapolei and continued along the coast to Wai‘anae. Mr. Yee pointed out that the “north shore trail,” which branches off the cross-*ahupua‘a* trail, traverses a portion of the eastern boundary of the *ahupua‘a* between Honouliuli and Hō‘ae‘ae Ahupua‘a before branching off and leading to Pōhākea Pass and traversing through the Wai‘anae Mountain Range to Lualualei Ahupua‘a in the *moku* of Wai‘anae.

Mr. Yee noted that Pōhākea Pass is associated with the goddess Hi‘iakaikapoliopele, sister of volcano goddess Pele, and her epic journey across the Hawaiian Islands. He noted that from Pōhākea Pass, Hi‘iaka could see the entire *moku* of ‘Ewa. From Pōhākea Pass, Hi‘iaka also saw her traveling companions, Lohi‘au and Wahine‘ōma‘o, as they traveled by canoe to the harbor of Kou (Honolulu) (Ho‘oulumahiehie 2008b:260). She also saw that her *aikāne*, Hōpoe, had “died in the fires of her elder sister Pele” as she “gazed towards Hawai‘i” from Pōhākea Pass (Ho‘oulumahiehie 2008b:260).

Mr. Yee also noted that Pōhākea Pass is associated with the famous warrior, Palila, who could throw his supernatural war club a long distance and fly along the club’s path as he held on to the end of it. According to the *mo‘olelo*, Palila used his supernatural war club to carry himself from Ka‘ena Point at Wai‘anae, before landing at Pōhākea Pass and continuing east across the *moku* of ‘Ewa.

Ms. Paglinawan stated that “this area where the University [of Hawai‘i West O‘ahu] is located has a lot of trails that go from *mauka-makai*, come from Honolulu going towards Nānākuli.” She noted that the ancient trails are still used by spirits to travel from *mauka* to *makai* within Honuliuli Ahupua‘a. She mentioned that “there are stories of them being known to go down to the oceanside and cause havoc with the living” and “even going up into the mountain of Pālehua beyond Makakilo,” noting “the families who live there talk about ghosts and strange happenings […]” Ms. Paglinawan asked, “Is this going to be built on ancient trails?” She stated that the project proponents should be “mindful of the ancient trails because when the ghosts march, they begin from the mountain, but they also begin from the oceanside and they go into the valley.”

Mr. Yee stated the *‘ili* of Līhue, which is located in the northern region of Honouliuli Ahupua‘a, was associated with a class of chiefs known as the *lo ali‘i*. Mr. Yee noted the “*lo ali‘i* were the highest ranking chiefs but then they were hidden so they were like the poorest at the same time.” He also discussed the *mo‘olelo* of Kelea, a chiefess of Maui, who was kidnapped and brought to O‘ahu to marry Lō Lale, a *lo ali‘i* from Līhue in Honouliuli (Kamakau 1991b:46).

Mr. Yee pointed out Mauna Kapu, a peak located in the Wai‘anae Mountain Range bordering the *ahupua‘a* of Nānākuli. He noted the existence of another Mauna Kapu in the *ahupua‘a* of Moanalua, adding that he believes that Mauna Kapu were “meeting places, or something like that, for the chiefs.”

The ‘Ewa coastal plain was also a place of spiritual significance as it was associated with the *ao kuewa*, the realm of the homeless souls. According to Samuel Kamakau, there existed three spirit realms, the *ao kuewa*, *ao ‘aumakua*, and *ke ao o milu*. Upon death, the spirit of the recently deceased was said to leave the body and then proceed toward a *leina* where they would leap into Pō, the world of the unseen (Handy and Pukui 1972:146). The spirit was guided to and over the *leina* and into Pō by their *‘aumakua* (Handy and Pukui 1972:146), however, if the soul of the deceased had no place in the *‘aumakua* realm, or was abandoned by an *‘aumakua*, they were destined to wander the *wiliwili* grove of Kaupe‘a until such time that they were rescued by their *‘aumakua*. Mr. Yee also noted largest grove of *wiliwili* trees on the island of O‘ahu was once located in the area where the ‘Ewa by Gentry subdivision is now. Fornander (1919a:6[2]:292) states that Pu‘uokapolei may have been a *leina*, jumping off point associated with the wandering souls who roamed the plains of Kaupe‘a and Kānehili, *makai* of the hill.

Pu‘uokapolei was also known to be the home of Kamapua‘a’s grandmother, Kamaunuaniho, (Nakuina 1904:50). After conquering the majority of O‘ahu, he established his grandmother as queen (Pukui 1974:203). There was once a large rock shelter on the *makai* side said to have been the residence of Kamapua‘a and his grandmother (McAllister 1933:108). Another account (*Ka Loea Kālai‘āina*, 13 January 1900 in Sterling and Summers 1978:34) stated that Kekele‘aikū, the older brother of Kamapua‘a, also lived on Pu‘uokapolei.

The plain of Pukaua is also located near Pu‘uokapolei, northwest of the project area. Two distinct *mo‘olelo* are connected with this cultural site. The first of these two stories was presented within a 13 January 1900 edition of *Ka Loea Kālai‘āina* which states that two old women with supernatural powers were heading to their home to Pukaua following an evening of fishing at the village of Kualaka‘i. As the sun began to rise, the women hid to avoid being seen and their bodies turned to stone. The second *mo‘olelo* involves Hi‘iaka, and was spread across several daily editions of *Ka Hōkū o Hawai‘i* from February 1927. According to the *mo‘olelo*, the two women were *mo‘o*. The women saw Hi‘iaka as she journeyed toward the ‘Ewa coast. They were afraid that Hi‘iaka would kill them, so they transformed into their lizard form and hid from Hi‘iaka (*Ka Hōkū o Hawai‘i*, 15 February 1927, translated in Maly 1997:19). This stone was known as “Pe‘e-kāua,” which translates to “we two hidden.” Mr. Yee also discussed the plain of Pukaua, mentioning that “there was those two ladies who were down by the archery, that’s two *pōhaku*, the lizards in the Hi‘iaka story.”

Mr. Yee also discussed Kūali‘i, a “celebrated chief […] noted for his strength and bravery” who defeated the chiefs of Ko‘olauloa on the plains of Keahumoa (Fornander 1917b:4[2]:364). Mr. Yee stressed the importance of two brothers, Kapa‘ahulani and Kamaka‘aulani, who were on opposing sides of the battle. According to the *mo‘olelo*, Kapa‘ahulani and Kamaka‘aulani composed the *mele* in honor of Kūali‘i and devised a plan in which Kapa‘ahulani would urge the chief of Ko‘olauloa to make war on Kūali‘i, and Kamaka‘aulani would take Kūali‘i and “conceal yourselves in the bushes” at the place where the battle is to be fought (Fornander 1917b:4[2]:366). When the forces of Ko‘olauloa arrived in Honouliuli, their army of twelve hundred were outnumbered by Kūali‘i’s army of twelve thousand, however, the battle was averted when the *mele*, which was composed by Kapa‘ahulani and Kamaka‘aulani in honor of Kūali‘i was chanted and the chief of Ko‘olauloa surrendered, ceding the districts of Ko‘olauloa, Ko‘olaupoko, Waialua and Wai‘anae to Kūali‘i (Fornander 1917b:4[2]:400).

Kūalaka‘i is the name of an ancient fishing village located on the southwestern side of Honouliuli Ahupua‘a, southwest of the project area. Kūalaka‘i is mentioned in the “Legend of the Children” which foretells the breaking of the eating *kapu* by the *ali‘i* (*Ka Loea Kālai‘āina*, 22 July 1899:15; translation in Sterling and Summers 1978:7). This area was also once the site of a spring called Hoaka-lei (“lei reflection”), where according to *mo‘olelo*, Hi‘iaka picked *lehua* and saw her reflection in the water (Pukui et al. 1974:119).

Kalaeloa is an area located at the southwestern point of O‘ahu. Kalaeloa Point was the home of Uhu Makaikai, a *kupua* who could take the form of a man or a giant parrotfish (*uhu)*. He is mentioned in several legends concerning the hero Kawelo and with Kawelo’s struggles with ‘Aikanaka, the ruling chief of Kaua‘i (Hawaiian Ethnological Notes, Bishop Museum Vol. II:114, translation in Sterling and Summers 1978:41).

Cultural practices within Honouliuli of late have been inspired by traditional understandings of caring for natural and cultural resources. The Kalaeloa Heritage and Legacy Foundation has adopted practices wherein the community can *mālama* (care for) cultural sites, and in turn benefit from the knowledge inherent in such sites. Previously documented cultural sites within the Kalaeloa Heritage Park are actively cared for while also the subject of numerous university-level studies. These sites have been established as important centers for an *‘āina*-based education. Mr. Yee recalled visiting Kalaeloa Heritage Park where he observed a *heiau* which was partially underground and built using upright coral stones. He also observed a trail marked by upright coral slabs which “supposedly led all the way to another *heiau* that was by Laulaunui Island” near the West Loch of Pu‘uloa (Pearl Harbor).

7.4 Religious Practice

Several *heiau* stood in Honouliuli Ahupua‘a including Pu‘uokapolei Heiau, Pu‘u Ku‘ua Heiau, and two unidentified *heiau* located at the foot of Pu‘u Kanehoa and Pu‘u Kuina, respectively. Each year, a ceremony commemorating the changing of the seasons is still observed in the beginning of May at Waikīkī and Honouliuli. Sam ‘Ohukani‘ōhi‘a Gon III, Na Wa‘a Lalani Kahuna O Pu‘u Koholā, and the late Kumu Hula John Keola Lake’s *hula hālau* perform *oli* and *hula* during the ceremony (Genz et al. 2012). The ceremony occurs at Pu‘uokapolei Heiau which is oriented so that it views the setting of the sun behind Pu‘ula‘ila‘i farther west, and maintains a line of sight extending eastward from Pu‘ula‘ila‘i toward Papa‘ena‘ena Heiau located in Waikīkī. Mr. Yee also noted that during the summer solstice, the sun sets over Pu‘uokapolei, adding that the pathway of the sun aligns a *heiau* located on Pu‘uokapolei with Papa‘ena‘ena Heiau.

Interviewee Lynette Paglinawan stated that “the area from Waimānalo Gulch over to Kapolei to the location of UHWO was known by very early residents there to be the place where “*ao kuewa*,” wandering spirits, congregated from *makai* to *mauka* up Pālehua and especially near the cluster of *wiliwili* trees in Kaupe‘a.” Ms. Paglinawan stated that the development of the *moku* of ‘Ewa including the *ahupua‘a* of Honouliuli resulted in the displacement of the *ao kuewa*. She noted that “we destroyed the habitat of the *ao kuewa* which is the *wiliwili* trees.” She added that “if we destroy the habitat of the ghosts, they have no place to go but into the facilities.” She would like to use the traditional cultural practice of *ho‘oponopono* to make things right with the spirits who have been displaced. Ms. Paglinawan suggests planting “a wall of trees” surrounding the proposed project area which would provide a home for the displaced spirits.

7.5 Burials

‘Ewa was famous for the many limestone caves formed in the uplifted coral, called the “Ewa Karst.” In traditional Hawaiian times, the areas of exposed coral outcrop were undoubtedly more extensive. Where not covered by alluvium or stockpiled material, this Pleistocene limestone outcrop has characteristic dissolution “pit caves” (Mylroie and Carew 1995). The caves of Pu‘uloa were sometimes also used as burial caves. Following the death of Keali‘iahonui, son of Kaua‘i’s last king, Kaumuali‘i, in 1849, his body was buried in Pu‘uloa (Alexander 1907:27). Burials have been encountered in the coastal areas of the *ahupua‘a*, however, no burials have been encountered within the project area nor within the vicinity of the project area.

Mr. Yee noted the possibility of a burial cave located on Pu‘uokapolei which contained a canoe inside of it, however, he added that it’s “probably long gone cause if you look at it, it’s all leveled already, on the *makai* side.”

Section 8 Results and Analysis

CSH undertook this CIA at the request of Tetra Tech, Inc., and on behalf of AES Distributed Energy. The research broadly covered the entire *ahupua‘a* of Honouliuli, including the current project area.

8.1 Results of Background Research

Background research for this study yielded the following results, presented in approximate chronological order:

1. Honouliuli is the largest *ahupua‘a* in the *moku* of ‘Ewa. Honouliuli translates literally as “dark water,” “dark bay,” or “blue harbor,” and thus is named for the waters of Pearl Harbor which marks the eastern boundary of the *ahupua‘a* (Jarrett 1930:22). Another source translates Honouliuli as “unequal” (*Saturday Press*, 11 August 1883). Honouliuli appears in the “Mo‘olelo of Lepeamoa,” the chicken-girl of Pālama, where Honouliuli is the name of the husband of the chiefess Kapālama, and grandfather of Lepeamoa (Westervelt 1923:164–184).
2. Generally, Honouliuli was described as very hot and dry. Evidence for drought-like conditions are further supported by the relative lack of traditional rain names associated with Honouliuli Ahupua‘a. The Nāulu rain is the only known associated rain name for Honouliuli. Due to the lack of rainwater, freshwater resources were accessed via a karstic system.
3. In traditional Hawaiian times, the areas of exposed coral (Pleistocene limestone) outcrop were undoubtedly more extensive. According to McAllister (1933), holes and pits in the coral were generally accessed for water while larger pits, often containing soil, were used for cultivation. McAllister additionally remarked that even “today” (McAllister began his survey work in 1930, and thus his comments are a reflection of the Honouliuli environment during the early twentieth century), *mai‘a* (banana; *Musaceae*) and *kō* (sugarcane; *Saccharum officinarum*) were being cultivated within the pit caves (sink holes) (McAllister 1933:109).
4. The traditional *ka‘ao* associated with the area speak of the *akua* brothers, Kāne and Kanaloa. It was their supernatural feat of hurling *pōhaku* across the island that determined the boundaries of land divisions (Sterling and Summers 1987:1). Additional *mo‘olelo* speak of Hi‘iaka and her travels across the plains of ‘Ewa. In particular, the *wahi pana* of Kaupe‘a (located south of the current project area) is described. Kamakau describes Kaupe‘a as a wide plain where a grove of *wiliwili* (*Erythrina sandwicensis*) stands (Kamakau 1991a:47). This plain is an *ao kuewa*, a realm belonging to homeless souls. In general, the *kama‘āina* of both Honouliuli Ahupua‘a and ‘Ewa District made a point to avoid this place.
5. Pu‘uokapolei is a prominent hill located on the ‘Ewa coastal plain that was the primary landmark for travelers on the trail running from Pearl Harbor to Wai‘anae. A *heiau* was

once on the summit of the hill, however, by the time of McAllister’s survey of O‘ahu it had been destroyed (McAllister 1933:108). The hill was also used as a point of solar reference or as a place for celestial observations of the winter and summer solstice. A ceremony at a *heiau* on Pu‘uokapolei provides a vantage point to capture the sun setting directly behind Pu‘ula‘ila‘i, a peak farther west in the Wai‘anae Range. A coinciding ceremony at Kūpalaha Heiau in Waikīkī captures the same essence as the sun sets behind Pu‘uokapolei.

6. Additional *heiau* located within Honouliuli included Pu‘u Ku‘ua located at Palikea, in addition to two unidentified *heiau*. These two unidentified *heiau* are located at the foot of Pu‘u Kanehoa and Pu‘u Kuina, respectively.
7. In later historic times, a network of trails encircled and crossed the Wai‘anae Range, allowing passage from West Loch to the Honouliuli lowlands, past Pu‘uokapolei and Waimānalo Gulch to the Wai‘anae coast and onward circumscribing the shoreline of O‘ahu (‘Ī‘ī 1959:96–98). The main trail along the south shore of O‘ahu would have been approximately 1.5 km to the southeast. A main trail extending up the central valley of O‘ahu would have been approximately 3 km to the east. The 1825 Malden map shows a trail extending from the main trail along the south shore of O‘ahu into the uplands in the Pālehua area as passing just a couple hundred meters to the southwest of the project area.
8. The rich resources of Pu‘uloa—the fisheries in the lochs, the shoreline fishponds, the numerous springs, and the irrigated lands along the streams—made ‘Ewa a prize for competing chiefs. ‘Ewa Moku was also a political center and home to many chiefs in its day. Oral accounts of *ali‘i* recorded by Hawaiian historian Samuel Kamakau date back to at least the twelfth century. *Ali‘i* associated with Honouliuli and greater ‘Ewa Moku included Kākuhihewa, Keaunui, Lakona, Mā‘ilikūkahi, and Kahahana.
9. In early historic times, the population of Honouliuli was concentrated at the western edge of West Loch in the vicinity of Kapapapuhi Point in the “Honouliuli Taro Lands.” This area was clearly a major focus of population due to the abundance of fish and shellfish resources in close proximity to a wide expanse of well-irrigated bottomland suitable for wetland taro cultivation.
10. Early foreign accounts describe the southwest coast of O‘ahu, including Honouliuli Ahupua‘a, as an area “a little distance from the sea, [where] the soil is rich and all the necessaries of life are abundantly produced” (Vancouver 1798 in Sterling and Summers 1978:36). A sailor among Vancouver’s crew observed, however, that “from the number of houses within the harbor it should seem to be very populous; but the very few inhabitants who made their appearance were an indication of the contrary” (Vancouver 1798 in Sterling and Summers 1978:36).
11. Following the Māhele of 1848, 99 individual land claims in the *ahupua‘a* of Honouliuli were registered and awarded by King Kamehameha III. No *kuleana* land claims were made for land within the current project area or vicinity. The vast majority of the LCA parcels were located in Honouliuli near the taro lands of the *‘ili* of Pu‘uloa and the Pu‘uloa Salt Works. The largest award (Royal Patent 6071, LCA 11216, *‘Āpana* 8) in Honouliuli

Ahupua‘a was granted to Miriam Ke‘ahi-Kuni Kekau‘onohi on January 1848 (Native Register 1848) who acquired a deed to all unclaimed land within the *ahupua‘a*, including the present project area.

12. Beginning with the time of Western Contact, however, Hawaiian populations were introduced to many virulent western diseases which began to decimate the native populations. Thus, four years following the 1832 census, the ‘Ewa population had dropped to 3,423 (Schmitt 1973:9, 36), “a decrease of 592 in 4 years” (Ewa Station Reports 1836). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages.

13. With the increasing foreign interests on O‘ahu Island during the last half of the nineteenth century, an array of agricultural enterprises were attempted. In 1871, John Coney rented the lands of Honouliuli to James Dowsett and John Meek, who used the land for cattle grazing. In 1877, James Campbell purchased most of Honouliuli Ahupua‘a for a total of $95,000.

14. By 1889, the Ewa Plantation Company was established and lands throughout Honouliuli were designated for sugarcane cultivation. Sugar production exploded with the successful drilling of an artesian well by James Campbell on the ‘Ewa Plain. Campbell’s first well was named Waianiani (“crystal waters”) by the *kama‘āina* of Honouliuli (Nellist 1925). By 1930, Ewa Plantation had drilled 70 artesian wells to irrigate cane lands; artesian wells provided fresh water to Honouliuli for nearly 60 years (Ho‘okuleana 2014).

15. In 1897, B.F. Dillingham established the Oahu Sugar Company (OSC) on 12,000 acres leased from the estates of John Papa ‘Ī‘ī, Bishop, and Robinson. The Oahu Sugar Company had over 900 field workers, composed of 44 Hawaiians, 473 Japanese, 399 Chinese, and 57 Portuguese. The first sugar crop was harvested in 1899, ushering in the sugar plantation era in Waipahu (Ohira 1997). Prior to commercial sugar cultivation, these lands were described as being “of near desert proportion until water was supplied from drilled artesian wells and the Waiahole Water project” (Condé and Best 1973:313).

16. The Waiahole Water Company was formally incorporated in 1913 and was originally a subsidiary of the Oahu Sugar Company. The Waiahole Ditch was designed by engineer Jorgen Jorgensen, with recommendations by engineer J.B. Lippencott and assisted by W.A. Wall. Upon its completion in 1916, the Waiahole Ditch was 35 km (21.9 miles) long and cost $2.3 million. The 32 million gallons of daily water enabled the O‘ahu Sugar Company to grow to “some 20 square miles […] ranging in elevation from 10 ft at the Waipio Peninsula […] to 700 ft at the Waiahole Ditch” (Condé and Best 1973:313). The ditch system is included on the state inventory of archaeological sites as SIHP # 50-80-09-2268. The Waiahole Ditch System crossed through the western portion of the present project area.

17. The early twentieth century saw the lands of Honouliuli heavily utilized by both civilians and the U.S. military for transportation. The U.S. Government began acquiring the coastal lands of ‘Ewa for development of a naval base at Pearl Harbor. In 1901, the U.S. Congress

formally ratified annexation of the Territory of Hawaii, and the first 1,356.01 acres of Pearl Harbor land were transferred to U.S. ownership.

18. In 1937, 18 miles of roads were built in the coastal Honouliuli area, and in 1939-1940 the U.S. bought 3,500 acres of land in this area (Landrum et al 1997:62–67), to build several other military camps and installations, including Barbers Point Naval Air Station.

19. Following the Japanese Navy’s attack on Pearl Harbor on 7 December 1941, the Territory of Hawaii was declared under martial law and the writ of *habeas corpus* (the requirement for a person under arrest to be brought before a judge or into court) was suspended (U.S. Department of the Interior 2014:6–7). Persons of Japanese and European ancestry in Hawai‘i suspected of disloyalty to the United States were rounded up and imprisoned by the U.S. military and the FBI (U.S. Department of the Interior 2014:xii). In 1943, the Honouliuli Internment Camp was constructed to intern citizens, resident aliens, and prisoners of war. Located in Honouliuli Gulch, east of the project area, the camp was the “last, largest, and longest-used World War II confinement site in Hawai‘i,” holding approximately 320 internees and nearly 4,000 prisoners of war (U.S. Department of the Interior 2014:xiv).

8.2 Results of Community Consultations

CSH attempted to contact Hawaiian organizations, agencies, and community members as well as cultural and lineal descendants in order to identify individuals with cultural expertise and/or knowledge of the project area and vicinity. Community outreach letters were sent to a total of 70 individuals or groups; 12 responded, one provided written testimony, and three of these *kama‘āina* and/or *kūpuna* met with CSH for more in-depth interview. Consultation was received from community members as follows:

1. Christian Kaimanu Yee, *kama‘āina* and knowledgeable of mo‘olelo and wahi pana
2. Shad Kāne, member of Kapolei Hawaiian Civic Club, Chair of the O‘ahu Council of Hawaiian Civic Clubs Committee on the Preservation of Historic Sites and Cultural Properties, Ali‘i Ai Moku of the Kapuāiwa Chapter of the Royal Order of Kamehameha Ekahi, and ‘Ewa Moku Representative on the State Aha Moku Advisory Committee.
3. Tom Berg, former Councilman, District 1
4. Lynette Paglinawan, cultural practitioner; educator, teaches a course on Native Hawaiian Healing at University of Hawai‘i West O‘ahu

8.3 Impacts and Recommendations

Based on information gathered from the community consultation, participants voiced and framed their concerns in a cultural context.

1. Mr. Shad Kāne stated he is not in opposition to the proposed project. He noted the project area has been previously disturbed by sugarcane production.
2. Mr. Tom Berg stated that the project has been “proposed on a pueo (owl) foraging and breeding ecosystem.” He noted records indicate that per earliest colonial contact, the *pueo*

is most abundant on the slopes from Pu‘u Kapua‘i to West Loch, in the area where the project is slated. He added that “Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood.” He stated the proposed project will “encroach on prime pueo habitat-considered to be graded A+—“a ten (10)”—when it comes to the degree of pueo habitat in use on this project site.”

3. Mr. Berg added that the *pueo* has “a direct connection to Native Hawaiian family lineage in Ewa Beach,” noting the *pueo* is the *‘aumakua* for the Michael Lee family and their accounts, which go back over seven generations, are documented at the State Archives Building in Honolulu.
4. Mr. Berg also stated that the project site is “inhabited by the ōpe‘ape‘a at various times of the seasons,” noting that in 1910, the State of Hawai‘i documented *‘ōpe‘ape‘a* within a half-mile of the project area.
5. Mr. Berg stated his concern that the “property in question will not receive the proper protocol to conclude no endangered species inhabit the area.” He recommended that “a thorough and complete protocol is adopted to repeat the inventory exercise for pueo and ‘ōpe‘ape‘a over the course of a calendar year would be in order so the project does not inadvertently contribute to more endangered species habitat loss.” He also recommended consulting with Dr. Melissa Price and Dr. Javier Cotin of the Project Pueo Biologist Team and DLNR’s Division of Forestry and Wildlife (DOFAW) Biologist Afsheen Siddiqi regarding pueo protocol.
6. Mr. Berg also expressed his concern over the possible negative aspects of light at an adjacent parcel. He expressed concern that a solar panel may be reflecting neighboring lighting operations into “the flight patterns of migrating birds and the ‘ōpe‘ape‘a and pueo in particular need to be addressed.”
7. Ms. Lynette Paglinawan stated that “the area from Waimānalo Gulch over to Kapolei to the location of UHWO was known by very early residents there to be the place where “*ao kuewa*,” wandering spirits, congregated from *makai* to *mauka* up Pālehua and especially near the cluster of *wiliwili* trees in Kaupe‘a.” She expressed her concerns regarding the effects that the proposed project will have on the *ao kuewa*, which she believes are attracted to energy. She also expressed her concerns of the effect of the spirits on the solar panels, noting “that’s high energy. It will be like going to the game room.” She also noted that UHWO experiences numerous electrical problems due to the presence of these spirits.
8. Ms. Paglinawan noted that “this area where the University [of Hawai‘i West O‘ahu] is located has a lot of trails that go from *mauka-makai*, come from Honolulu going towards Nānākuli.” She stated that project proponents should be mindful of the locations of ancient trails, noting that the ancient trails are still used by spirits to travel from *mauka* to *makai* within Honuliuli Ahupua‘a.
9. Ms. Paglinawan recommended planting “a wall of trees” surrounding the proposed project area as restitution to the spirits who may be displaced by the proposed project. She also

noted that planting of “a wall of trees” around the proposed project area would have other benefits including the production of oxygen and providing a habitat for Native Hawaiian birds.

10. Ms. Paglinawan also expressed her concerns regarding the psychological impacts for the people that encounter the spirits, noting trauma on workers at the UHWO, as well as, families who live in the area. She was particularly concerned for the children who encounter these spirits, noting her belief that children “see many more things than adults do.”
11. Project construction workers and all other personnel involved in the construction and related activities of the project should be informed of the possibility of inadvertent cultural finds, including human remains. In the event that any potential historic properties are identified during construction activities, all activities will cease and the SHPD will be notified pursuant to HAR §13-280-3. In the event that *iwi kūpuna* are identified, all earth moving activities in the area will stop, the area will be cordoned off, and the SHPD and Police Department will be notified pursuant to HAR §13-300-40. In addition, in the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR §13-300 and HRS §6E-43, is recommended.
12. In the event that *iwi kūpuna* and/or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinterment plan and cultural preservation plan for proper cultural protocol, curation, and long-term maintenance

8.4 *Ka Pa‘akai* Analysis

In Ka Pa‘akai vs Land Use Commission, 94 Hawai‘i (2000) the Court held the following analysis also be conducted:

1. The identity and scope of valued cultural, historical, or natural resources in the project area, including the extent to which traditional and customary native Hawaiian rights are exercised in the project area;
2. The extent to which those resources—including traditional and customary native Hawaiian rights—will be affected or impaired by the proposed action; and
3. The feasible action, if any, to be taken by the LUC to reasonably protect native Hawaiian Rights if they are found to exist.

Based on information gathered from the cultural and historical background, and community consultation of the CIA for this project, no culturally significant resources were identified within the project area. At present, there is no documentation or testimony indicating traditional or customary Native Hawaiian rights are currently being exercised “for subsistence, cultural and religious purposes and possessed by *ahupua‘a* tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778” (Hawai‘i State Constitution, Article XII, Section 7) within the project area. While no cultural resources, practices, or beliefs were identified as currently existing within the project area, Honouliuli Ahupua‘a maintains a rich cultural history in the exercise of traditional or customary Native Hawaiian rights within the project *ahupua‘a*.

Honouliuli Ahupua‘a is the largest *ahupua‘a* in the *moku* of ‘Ewa (and on the island of O‘ahu). The environment of Honouliuli is very hot and dry. These environmental limitations forced ingenuity and innovation. *Kama‘āina* of Honouliuli used agricultural sinkholes that accumulated water within them via a subterranean water or karst system; this water also contained nutrient-rich sediment allowing plants such as *kalo, kī*, and *noni* to survive.

The post-Contact period brought numerous changes to the *ahupua‘a* of Honouliuli. Traditional agricultural was rapidly replaced by large-scale commercial ventures. The discovery of artesian water beneath the ‘Ewa plains by James Campbell in 1879 led to the establishment of sugarcane plantations in Honouliuli including the Oahu Sugar Company. Extensive *mauka* lands in northern Honouliuli, including ridges and deep gulches, were unsuitable for commercial sugar cultivation and remained pasture land for grazing livestock. The Donn 1906 map suggests the present project area was at the *mauka* edge of sugarcane cultivation at that time (see Figure 15). By 1920, however, commercial sugarcane cultivation had expanded into the uplands including the present project area (Frierson 1972:18).

The project area is situated between Pu‘u Kapua‘i which is located 0.5 km to the northwest and Pu‘u Makakilo located 1.2 km to the southwest. These are understood as “very late cones [of the Wai‘anae volcano] […] composed of a varied mixture of cinder, spatter and lava flows” (Macdonald et al. 1983:429). Pukui et al. (1974:199) translate “Pu‘u Kapua‘i” as “footprint hill,” however, the association with that name is unknown. “Pu‘u Makakilo” is translated as “observing eyes” (Pukui et al. 1974:201). The association of this name is also unknown.

The project area is also located between two deeply dissected gulches, Kalo‘i Gulch which is located 300 m to the southwest and Honouliuli Gulch located 700 m to the northeast. These gulches are at a comparable elevation and are believed to rarely run with water. The name “Ka-lo‘i”

translates to “the taro patch” (Pukui et al. 1974:77). Sterling and Summers (1978:35) associates Kalo‘i Gulch with a number of vignettes regarding the “Waihuna” or “Punahuna” hidden spring. It was also noted that the hidden spring “had been one of the principal sources of water for all that country, which was quite heavily populated before the smallpox epidemic of 1840” (Ida E.K. von Holt in Sterling and Summers 1978:35).

8.4.1 A Summary of Cultural, Historical, or Natural Resources in the Project Area

8.4.1.1 Archaeological Resources

An AIS conducted for the University of Hawai‘i West O‘ahu Campus which encompassed the entirety of the project area (Dega et al. 1998) identified no surface Hawaiian features. Dega et al. (1998:i) noted several plantation-era “flumes, aqueducts, ditches, pumps, and other irrigation features occurring within the heavily modified landscape of the project area.” The features represented an irrigation complex (SIHP # 50-80-08-5593) which was used for sugarcane cultivation from the 1920s through more recent times. A portion of the Waiahole Ditch System (SIHP # 50-80-09-2268) was also documented crossing through the northwest section of the project area and continuing southwest through the lower agricultural fields.

A companion *Archaeological Inventory Survey Report for the AES West O‘ahu Solar Project* (Welser et al. 2019 draft) only identified the same two twentieth century historic properties associated with commercial sugarcane cultivation as were identified in the Dega et al. (1998) study. The historic properties previously identified in the general vicinity are virtually all post-Contact (Welser et al. 2019:42–44). Two basalt cobble and boulder mounds identified 800 m to the west of the project area (CSH2 described in Tulchin and Hammatt 2007) were thought to be possible trail markers but their age is unclear. The reader is referred to that archaeological study for further details of the archaeological resources in the vicinity.

8.4.1.2 Burials

The “Ewa Karst,” which consists of limestone caves formed in the uplifted coral, was undoubtedly more extensive during traditional Hawaiian times than present exposures suggest. Where not covered by alluvium or stockpiled material, this Pleistocene limestone outcrop has characteristic dissolution “pit caves” (Mylroie and Carew 1995) which were sometimes also used as burial caves. Burials have been encountered frequently in coastal areas of Honouliuli Ahupua‘a, however, previous archaeological studies (Dega et al. 1998) within the project area have not documented any burials within the project area nor within the vicinity of the project area. No *iwi kūpuna* have been identified within the project area or within a kilometer of the project area (Welser et al. 2019:42–44). No burials are believed to be present.

8.4.1.3 Faunal Resources

In written testimony provided to CSH via email on 19 August 2019, Mr. Tom Berg, former City Councilman, expressed concern for two *‘aumākua* and celebrated species (*pueo* and *‘ōpe‘ape‘a*). Mr. Berg stated the project has been “proposed on a pueo (owl) foraging and breeding ecosystem.” The *pueo*, which are found on all of the main Hawaiian islands, are listed by the State of Hawai‘i as endangered on the island of O‘ahu (DLNR 2005). The DLNR states that *pueo* are most commonly found in “open habitats such as grasslands, shrublands, and montane parklands, including urban areas and those actively managed for conservation” (DLNR 2005).

Mr. Berg also noted records indicate that per earliest colonial contact, the *pueo* is most abundant on the slopes from Pu‘u Kapua‘i to West Loch, adding that “Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood.” He also noted *pueo* are not forest dwellers, preferring “scrub, open fields/dirt landscapes with some grass.” He stated that the proposed project will “encroach on prime pueo habitat-considered to be graded A+—“a ten (10)”—when it comes to the degree of pueo habitat in use on this project site.”

Mr. Berg also stated that the project site is “inhabited by the ōpe‘ape‘a at various times of the seasons.” The *‘ōpe‘ape‘a* or Hawaiian hoary bat was listed as an endangered species under the Endangered Species Conservation Act of 1969. Mr. Berg noted that in 1910, the State of Hawai‘i documented *‘ōpe‘ape‘a* within a half-mile of the project area. *‘Ōpe‘ape‘a* is “the only land mammal native to the Hawaiian archipelago” and is found on all of the main Hawaiian islands except for Ni‘ihau (DLNR 2005:3-13).

Mr. Berg stated his concern that the “property in question will not receive the proper protocol to conclude no endangered species inhabit the area.” He recommended that “a thorough and complete protocol is adopted to repeat the inventory exercise for pueo and ‘ōpe‘ape‘a over the course of a calendar year would be in order so the project does not inadvertently contribute to more endangered species habitat loss.” He also recommended consulting with Dr. Melissa Price and Dr. Javier Cotin of the Project Pueo Biologist Team and DOFAW Biologist Afsheen Siddiqi regarding *pueo* protocol.

Mr. Berg also expressed his concern for the possible negative aspects of lighting operations at an adjacent parcel which may reflect off of a solar panel into “the flight patterns of migrating birds and the *‘ōpe‘ape‘a* and *pueo* in particular need to be addressed.”

The cultural impact assessment acknowledges the role of *pueo* as one of the most important *‘aumākua* gods and ancestral deities of the family (Valeri 1985:19, 21). While *‘ōpe‘ape‘a* are rarely documented as *‘aumakua,* they fit the intersection of classes of animals (mammal and bird) and intersection of two domains (air and land) that would make them an appropriate manifestation of the *‘aumakua*. (Valeri 1985:23). Without question both *pueo and ‘ōpe‘ape‘a* are greatly celebrated in the *mo‘olelo* of Hawai’i’s past.

No accounts of hunting have been identified in association with this project area.

8.4.1.4 Earth Resources

No traditional use of the stones (or soft sediments) within the project area has been documented.

8.4.1.5 Plant Resources

Vegetation composition within the project area has been significantly impacted by human activities with the result that the overwhelming majority of the vegetation is exotic. Today the project area is largely covered with *haole koa* (*Leucaena leucocephala*) and exotic grasses. *Wiliwili* (*Erythrina sandwicensis*), sweet acacia or *klu* (*Acacia farnesiana*), and *kiawe* (*Prosopis pallida*) were also observed within the project area. No evidence of traditional gathering practices in the project area or vicinity was encountered.

Ms. Paglinawan stated that as a result of the development of the *moku* of ‘Ewa including the *ahupua‘a* of Honouliuli, “we destroyed the habitat of the *ao kuewa* which is the *wiliwili* trees.”

She recommended planting “a wall of trees” surrounding the proposed project area which would provide a home for the displaced spirits. She also discussed the types of plants that were previously found in the area which include *noni* plants, coconut trees, *lauhala* trees, and *‘ulu* trees. She noted that these plants were “very plentiful but sparse not like a big grove where it’s like a park of trees, it was interspersed throughout.”

8.4.1.6 Trails

In traditional times, trails were well used for travel within the *ahupua‘a* between *mauka* and *makai* and laterally between *ahupua‘a*. A historical trail system existed on O‘ahu extending from Honolulu to Wai‘anae. A cross-*ahupua‘a* (east-west) trail passed through Honouliuli north of Pu‘uokapolei, and continued along the coast to Wai‘anae following the route of the modern Farrington Highway. Early historic maps depict a trail that branches off the cross-*ahupua‘a* trail into the uplands in the Pālehua area. The 1825 Malden map (see Figure 7) shows a trail extending into the Pālehua area a couple hundred meters to the southwest of the project area. A 1919 map (see Figure 16) shows an unimproved road alignment just south of the project area, understood as the Pālehua Road, approximating a traditional Hawaiian footpath into the uplands, on the north slope of Pu‘u Makakilo and a less formal trail into the uplands skirting the west side of Pu‘u Kapua‘i to the west of the project area. However, a 1922 map (see Figure 17 and Figure 18 showing annotations), shows the Pālehua trail as arcing through the western portion of the project area before arcing north of Pu‘u Makakilo. This trail may have always been somewhat braided. The trail appears to only be depicted on the 1922 map (see Figure 17 and Figure 18) and appears to have been largely under Sugar Cane Field 30 in the 1925 map (Figure 19). This trail was not identified on the ground in either of the AIS studies of this area (Dega et al. 1998 and Welser et al. 2019). Access into the southeastern Wai‘anae Range today is facilitated by Makakilo Drive. Development of the present project area is suggested to have no adverse impact to traditional Hawaiian trails or access to upland resources.

Interviewee Lynette Paglinawan stated that “this area where the University [of Hawai‘i West O‘ahu] is located has a lot of trails that go from *mauka-makai*, come from Honolulu going towards Nānākuli.” She noted that “spirits travel on ancient trails” which they use to “go from *mauka* going down to *makai*.” She added that these “ancient trails are still in use,” noting that people who live in homes that have been built on or near these ancient pathways have experienced “strange happenings” which she believes are due to the *‘uhane* that still use these ancient trails to travel from *mauka* to *makai*.

8.4.1.7 Wahi Pana

While Pu‘u Kapua‘i (located 0.5 km to the northwest) and Pu‘u Makakilo (located 1.2 km to the southwest) are certainly prominent, they are not particularly “storied” places. They are some distance away.

Kalo‘i Gulch is arguably a more renowned *wahi pana* with a number of vignettes regarding a “Waihuna” or “Punahuna” hidden spring. It was also noted that the hidden spring “had been one of the principal sources of water for all that country, which was quite heavily populated […]” Historic maps indicate a spring located approximately 2.2 km to the north. It is believed that a significant spring may have been identified during an inventory survey for a neighboring Pālehua East B project (Tulchin and Hammatt 2005). The project area per se would not appear to merit consideration as a *wahi pana*.

8.4.2 The Extent to which Traditional and Customary Native Hawaiian Resources will be Affected by the Proposed Action

While acknowledging Mr. Berg's concern for *‘ōpe‘ape‘a* and *pueo* as a cultural concern, in addition to a concern for endangered species, the impact of the project on these natural populations, if any, is suggested as appropriately a matter for zoological analysis.

8.4.3 Feasible Action, if any, to be Taken by the LUC to Reasonably Protect Native Hawaiian Rights

In order to evaluate any possible adverse impact to cultural resources it is recommended that consideration of review of the biological study pertaining to populations of *‘ōpe‘ape‘a* and *pueo* be undertaken. With that possible exception, no adverse impact on cultural resources or practices is anticipated. No other customary resource has come to light in the historic background research or in the consultation outreach to 70+ individuals and NHOs and Mr. Berg was the only party to express concern for the *‘ōpe‘ape‘a* and *pueo.*

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Appendix A Written Testimony from Tom Berg

August 19, 2019

TO: Mr. Kellen Tanaka
Cultural Researcher
Cultural Surveys Hawaii, Inc.
41-1537 Kalanianaole Hwy., Suite 204
Waimanalo, Hawaii 96795

FROM: Tom Berg
91-203 Hanapouli Circle
Ewa Beach, Hawaii 96706
Phone: 808-685-1932
Email: tomberg00@yahoo.com

RE: CULTURAL IMPACT ASSESSMENT (CIA) FOR THE AES WEST O'AHU SOLAR PLUS STORAGE PROJECT, APPROXIMATELY 80-ACRES

AREA: TAX MAP KEY (TMK) 9-2-002:007, OWNED BY THE UNIVERSITY OF HAWAI'I (UH)

Aloha Mr. Kellen Tanaka,

My name is Tom Berg, and I am aware that a solar farm has been proposed on a pueo foraging and breeding ecosystem and how that solar farm may have potential impacts to cultural resources, cultural practices, and beliefs as a result of the proposed project (AES West O'ahu Solar Plus Storage). This project site is also inhabited by the Ōpe'ape'a at various times of the seasons.

I have two areas of concern that I would appreciate you taking into consideration for the Cultural Impact Assessment (CIA)- they are:

The State of Hawaii Department of Land and Natural Resources (DLNR) and the United States Department of Fish and Wildlife Service (USFWS) have developed a protocol to conduct biological surveys to inventory for endangered species that are considered sacred- of great spiritual value, and these relations are known as ʻaumakua- and of them, are the pueo (Hawaiian owl) and the 'Ōpe'ape'a (Hoary bat) that are being systematically extirpated due to poor, inadequate, faulty, Environmental Assessments (EA) and or Environmental Impact Statements (EIS) that lack proper protocol.

A protocol is defined as the methodology an observer undertakes when performing the biological survey for the property to be developed. This protocol is to be deployed on the site to ensure that prior to development, it can be concluded the property did not serve endangered species- or if found, mitigated as the law requires.

My concern is this property in question will not receive the proper protocol to conclude no endangered species inhabit the area- when they are indeed there- 'you just have to know when and where to look.' For instance, what protocol will be deployed to determine if the population of both the pueo and 'Ōpe'ape'a are served by habitat on the property? Five points to address are:

1. Who will look for the pueo and 'Ōpe'ape'a on the land? What is their expertise and qualifications as observers?
2. Did the observation to inventory for the species transpire before sunrise and after the sunset periods when the 'Ōpe'ape'a and pueo are most active and can be recorded?

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3. Did the observer conduct the biological survey whereby the inventory for the species was repeated year-round over the wet and dry seasons?

4. What tools were used- visual aids in the field – techniques to identify the species while observing/conducting the inventory?

5. Was the inventory to assess and survey for pueo and 'Ōpe'ape'a done completely on foot- or was a vehicle used?

The State of Hawaii has documented 'Ōpe'ape'a (1910) sighted within a half-mile of the project (State Office of Planning) which begs the question: When was the last population survey for 'Ōpe'ape'a in the proposed project area done?

Records illustrate the pueo being most abundant on the very slopes where this project is slated (Pu'ukapuai to West Loch) per earliest colonial contact. Hunehune Gulch, Kaloi Gulch, and Honouliuli Gulch are migratory routes used by the pueo to go from mountain to sea to court, mate, forage, and raise their brood. This solar project- is slated in the heart, direct line of the pueo and use of these gulches.

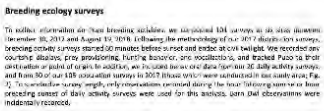
Pueo love scrub, open fields/dirt landscapes with some grass- and as such, they are not forest dwellers. This project site is to encroach upon prime pueo habitat-considered to be graded A+ - "a ten (10)" - when it comes to the degree of pueo habitat in use on this project site.

The pueo has a direct connection to Native Hawaiian family lineage in Ewa Beach-- with the Michael Lee family - and the pueo is their 'aumakua and these accounts with the pueo are documented at the State Archives Building in Honolulu going back over seven generations for the Lee family. https://www.youtube.com/watch?v=sfW8FGt1Xil

To elaborate on my first concern, the DLNR and USFWS developed a protocol to properly account for 'Ōpe'ape'a and pueo and stated that a survey to inventory for them should be executed over the changing seasons year-round. This practice, to deploy the protocol, year-round, is not being done in either the EA and or EIS review processes. Furthermore, the inventory exercise conducted by the observer is to be undertaken after sunset and before the sunrise periods, otherwise:

> "The observer is more apt to miss the species since the pueo and 'Ōpe'ape'a are migratory- transient in nature and rotate plots with the changing seasons." (Wildlife Biologist Jenny Hoskins, USFWS; August 18, 2016, UHWO Town Hall Meeting on Pueo.). https://www.youtube.com/watch?v=i1Tm98qpmcQ

A population distribution survey for pueo was completed recently for the island of Oahu that included the area of UHWO (University of Hawaii West Oahu Mauka Segment) where I and Mike Lee have relations with the pueo. The observer began their inventory exercise December 31, 2017, and terminated it early August of 2018. The pueo that inhabited UHWO per my experience came to the property throughout the months of late August through September, October, November, and vacate late December. However, the survey didn't include those months for observation.
https://docs.wixstatic.com/ugd/35ff1d_864845984aec47e58618e97ca46e578f.pdf


Breeding ecology surveys

To collect observation on owl breeding activities, we conducted 104 surveys in six study locations (December 18, 2017 and August 12, 2018, following the methodology of our 2017 distribution surveys, breeding activity surveys started 60 minutes before sunset and ended at civil twilight. We recorded any courting displays, prey provisioning, hunting behavior, pre-roosting, and tracked Pueo via their distribution or point of origin. In addition, we included review and data from the 20 daily activity surveys, and from 30 of our 109 crepuscular surveys in 2017 (those which were conducted in the study area; Fig. 7). To standardize survey length, only observations recorded during the hour following sunrise or from preceding sunset of daily activity surveys were used for this analysis. Dawn owl observations were incidentally recorded.

Therefore, the survey mistakenly concluded no pueo or its habitat existed on the property at UHWO- *because the observer simply avoided conducting the inventory exercise on the property during the months when the pueo were historically and traditionally known to be most prevalent.*

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I have stipulated, that had the survey exercise at UHWO been conducted year-round as recommended as the proper protocol to inventory for pueo, the results of the survey would have reported a pueo ecosystem thriving on the property and many Native Hawaiians' 'aumakua would be protected rather than purged from the property.

Your assurances a thorough and complete protocol is adopted to repeal the inventory exercise for pueo and 'Ōpe'ape'a over the course of a calendar year would be in order so the project does not inadvertently contribute to more endangered species habitat loss.

Here is a video of Mike Lee performing a chant to the pueo on January 1, 2018 at UHWO- note:

> UHWO / UH Board of Regents / DLNR / Attorney General, have stated that the pueo you see in the video- all taken at UHWO- "DID NOT and HAVE NOT EVER EXISTED THERE"- meaning, that I and Mike Lee fabricated the pueo recordings. https://www.youtube.com/watch?v=d9yoxIGeNCA
>
> This claim by government entities, that pueo never used the property at UHWO and no habitat ever existed there to serve pueo, is not only an affront to our State, its people, but also a violation of the law- HRS Ch. 343 that protects endangered species and their habitat.

Again, this claim by Hawaii's governor- the Ige Administration, that absolutely no pueo used UHWO property, is not only patently false- but a deliberate act of Administrative Bias, Institutional Prejudice- and a willful act of Malice- to cause direct harm to an endangered specie- a 100% violation of Article XII, Section VII of Hawaii's State Constitution that protects Native Hawaiian Religious and Cultural Practices and their 'aumakua ---- https://www.youtube.com/watch?v=d9yoxIGeNCA --

This is significant, in that UH to this day, denies the pueo had any habitat on the UHWO Mauka Segment property when the evidence depicts otherwise. Will you too- be orchestrating another fake EIS or EA for this solar farm project that falsifies true characteristics of the property and misrepresents it's significance to sustain endangered species?

My other concern has to do with the illumination of property owned nearby by Monsanto that the AES West Oahu Solar Project may interface with. The lights when activated by Monsanto on its fields may have a negative effect on many avian species. How a solar panel may be reflecting Monsanto's lighting operations into the flight patterns of migrating birds and the 'Ōpe'ape'a and pueo in particular needs to be addressed.

Please reference the lights in operation next to your proposed solar farm operations: https://www.youtube.com/watch?v=S8Ba0zpSBI0

Your favorable review of my concerns in the CIA and any answers to my inquiries that you can provide are greatly appreciated.

Mahalo Nui,

Tom Berg

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Appendix H
Glare Analysis Report

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Glare Analysis Report for the West O‘ahu Solar Plus Storage Project

‘Ewa District, O‘ahu, Hawai‘i

Prepared for:

AES Distributed Energy

Prepared by:

Tetra Tech, Inc.

February 2020

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Executive Summary

At the request of AES Distributed Energy (AES), Tetra Tech, Inc. (Tetra Tech) conducted a glint and glare analysis of the proposed West Oahu Solar Plus Storage Project (Project). The analysis was conducted using the Solar Glare Hazard Analysis Tool (SGHAT) software through an online tool (GlareGauge) developed by Sandia National Laboratories and hosted by ForgeSolar. A total of three glare analyses were conducted for the Project. The first two analyses included three observation points from the surrounding community (to the west, south and east) and three segmented traffic routes (H-1 Freeway, Farrington Highway, and Kualakai Parkway). Analysis 1 represents the point of view from an average first floor residential/commercial structure and typical commuter car, while Analysis 2 represents the point of view from an average second floor residential/ commercial structure and typical semi-tractor-trailer truck. The third analysis included 14 final approach flight paths and two air traffic control towers (ATCTs) associated with Kalaeloa Airport, Daniel K. Inouye International Airport and Wheeler Army Airfield.

The results of the analysis indicate that none of the residential/commercial observation points would experience glare as a result of the Project. Analysis 1 and 2 predicted that a limited amount of green glare (the least severe type of glare) would occur at two segments along Farrington Highway and at two segments along H-1 Freeway southeast of the Project area. In addition, a very limited amount of yellow glare was predicted along one segment of H-1 Freeway. The predicted occurrences of glare along these roadway segments would occur intermittently in the evening hours during certain months of the year, for a period of less than 15 minutes per day. The results of Analysis 3 indicate that no glare would be experienced at Kalaeloa Airport or Wheeler Army Airfield. A limited amount of green glare was predicted for three of the final approach paths and the ATCT for Daniel K. Inouye International Airport, located approximately 8 miles from the Project area. The predicted occurrences of glare from these locations would occur intermittently in the evening hours during certain months of the year, for a period of less than 10 minutes per day. As recommended by the Federal Aviation Administration (FAA) Notice Criteria Tool (NCT), the Project will be formally filed with the FAA Obstruction Evaluation Group (OEG).

It is important to note that the GlareGauge model does not account for varying ambient conditions (i.e., cloudy days, precipitation), atmospheric attenuation, screening due to existing topography not located within the defined array layouts, or existing vegetation or structures (including fences or walls); nor does the tool allow proposed landscaping to be included. In this instance, an existing berm and vegetation are located along portions of the northern side of H1 Freeway and would be expected to screen views of the Project from vehicular traffic along the modeled segments of H1 Freeway; views of portions of the Project from vehicular traffic along the modeled segments of Farrington Highway may also be intermittently screened by vegetation and other existing features. Therefore, the model results are conservative and may predict glare at locations where glare will not actually be experienced.

1.0 Introduction

The Project involves construction and operation of a solar photovoltaic and battery energy storage system on land owned by University of Hawaiʻi (UH), approximately 3 miles northeast of Kapolei on the southwest side of Oʻahu. The Project area encompasses approximately 95.5 acres in an area commonly referred to as the UH West Oʻahu Mauka Lands property and is within tax map key (TMK) 9-2-002:007. The topography of the site ranges from relatively flat to moderately sloping. The elevation along the southeastern boundary of the Project area is approximately 280 feet above mean sea level (amsl) and rises to approximately 675 feet amsl in the northwestern portion.

The UH West Oʻahu Mauka Lands property is bordered on its southeastern edge by the H1 Freeway, beyond which is the UH West Oʻahu campus and the city of Kapolei. The southern and western portions of the property are bordered by vacant land, with Makakilo Quarry and the residential community of Makakilo located just beyond. The area north of the Project area generally comprises open space associated with the Waianae Mountains. The former Honouliuli Internment Camp site, which the National Park Service (NPS) is currently working to incorporate as a National Monument, is located to the northeast. The eastern portion of the property is bordered by Honouliuli Gulch and a variety of agricultural operations; further east is Kunia Road and the Village Park community.

As an industry standard, the term "glint and glare" analysis is typically used to describe an analysis of potential ocular impacts to defined receptors. As a point of clarification, ForgeSolar defines glint and glare in the following statement:

> *Glint is typically defined as a momentary flash of bright light, often caused by a reflection off a moving source. A typical example of glint is a momentary solar reflection from a moving car. Glare is defined as a continuous source of bright light. Glare is generally associated with stationary objects, which, due to the slow relative movement of the sun, reflect sunlight for a longer duration.*

Based on the ForgeSolar definitions of glint and glare and the stationary nature of the Project solar photovoltaic modules (fixed tilt), the potential reflectance from the Project modeled throughout this report is referred to as glare.

Tetra Tech completed a glare analysis using the SGHAT software, developed by Sandia Laboratories, now hosted by ForgeSolar (as discussed further below). The SGHAT software is considered an industry best practice and conservative model that effectively models the potential for glare at defined receptors from defined solar energy generating facilities. As discussed further below, the model is conservative in that it does not account for potential screening such as existing or proposed vegetation, topography outside of the defined areas, buildings, walls, or fences.

This report summarizes the glare analysis conducted based on the preliminary Project layout provided by AES dated December 4, 2019. Included as attachments are the Preliminary Site Plan that formed the basis of the analysis (Attachment A); Figure 1: PV Array Areas, Figure 2: Receptors and Figure 3: Airport Receptors (Attachment B); and the glare analysis reports generated by the ForgeSolar tool (Attachment C).

2.0 FAA Notice Criteria Consultation

The FAA developed Technical Guidance for Evaluating Selected Solar Technologies on Airports in 2010, in addition to FAA regulatory guidance under 78 FR 63276 Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports (collectively referred to as FAA Guidance). The FAA Guidance recommends that glare analyses should be performed on a site-specific basis using the Sandia Laboratories SGHAT. This guidance applies to solar facilities located on federally-obligated airport property; it is not mandatory for a proposed solar installation that is not on an airport (and for which a Form 7460-1 is filed with FAA pursuant to CFR Title 14 Part 77.9, as discussed below), but is considered to be an industry best practice for solar facilities in general. The SGHAT is the standard for measuring potential ocular impact as a result of solar facilities (78 FR 63276).

According to 78 FR 63276, the FAA has determined that "glint and glare from solar energy systems could result in an ocular impact to pilots and/or air traffic control (ATC) facilities and compromise the safety of the air transportation system." The FAA has developed the following criteria for analysis of solar energy projects located on jurisdictional airports:

- No potential for glint or glare in the existing or planned ATCT cab; and
- No potential for glare or "low potential for after-image" along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two miles from 50 feet above the landing threshold using a standard three-degree glidepath.

The online FAA NCT reports whether a proposed structure is in proximity to a jurisdictional air navigation facility and if formal submission to the FAA OEG under CFR Title 14 Part 77.9 (Safe, Efficient Use, and Preservation of the Navigable Airspace) is recommended. The NCT also identifies final approach flight paths that may be considered vulnerable to a proposed structure's impact on navigation signal reception. The NCT was utilized to determine if the proposed Project is located within an FAA-identified impact area based on the Project boundaries and height above ground surface. The FAA NCT Report stated that a formal filing with the FAA OEG is recommended, and referenced Kalaeloa Airport (John Rodgers Field, JRF) to the south, Daniel K. Inouye International Airport (Honolulu International, HNL) to the east, and Wheeler Army Airfield (HHI) to the northeast. Based on this information, these three airport facilities were included in the SGHAT analysis, as further discussed below.

3.0 Glare Analysis Methods

The SGHAT is considered to be an industry best practice for analysis of glare related to solar energy generating facilities. Tetra Tech utilized the SGHAT technology as part of an online tool (GlareGauge) developed by Sandia National Laboratories and hosted by ForgeSolar. GlareGauge provides a quantitative assessment of the following:

- When and where glare has the potential to occur throughout the year for a defined solar array polygon; and
- Potential effects on the human eye at locations where glare is predicted.

The following statement was issued by Sandia Laboratories regarding the SGHAT technology:

> *Sandia developed SGHAT v. 3.0, a web-based tool and methodology to evaluate potential glint/glare associated with solar energy installations. The validated tool provides a quantified assessment of when and where glare will occur, as well as information about potential ocular impacts. The calculations and methods are based on analyses, test data, a database of different photovoltaic module surfaces (e.g. anti-reflective coating, texturing), and models developed over several years at Sandia. The results are presented in a simple easy-to-interpret plot that specifies when glare will occur throughout the year, with color indicating the potential ocular hazard (Sandia Laboratories, 2016).*

Note, however, that technology changes continue to occur to address issues such as reflectivity. The model, therefore, presents a conservative assessment based upon simplifying assumptions inherent in the model, as well as industry improvements since the most recent update of such assumptions.

Based on the predicted retinal irradiance (intensity) and subtended angle (size/distance) of the glare source to receptor, the GlareGauge categorizes potential glare where it is predicted by the model to occur in accordance with three tiers of severity (ocular hazards) that are shown by different colors in the model output:

- Red glare: glare predicted with a potential for permanent eye damage (retinal burn)
- Yellow glare: glare predicted with a potential for temporary after-image
- Green glare: glare predicted with a low potential for temporary after-image

These categories of glare are calculated using a typical observer's blink response time, ocular transmission coefficient (the amount of radiation absorbed in the eye prior to reaching the retina), pupil diameter, and eye focal length (the distance between where rays intersect in the eye and the retina). As a point of comparison, direct viewing of the sun without a filter is considered to be on the border between yellow glare and red glare, while typical camera flashes are considered to be lower tier yellow glare. Upon exposure to yellow glare, the observer may experience a temporary spot in their vision temporarily lasting after the exposure. Upon exposure to green glare, the observer may experience a bright reflection but typically no spot lasting after exposure.

4.0 Glare Analysis Inputs

The modules to be used for the proposed Project are smooth glass surface material with an anti-reflection coating (ARC), which are parameters selected in the glare analyses. Values associated with panel reflectivity and reflective scatter were not altered from the GlareGauge standard input averaged from various module reflectance profiles produced from module research concluded in 2016; therefore, as previously noted, the model does not incorporate further advances in anti-reflective coatings since that time.

Tetra Tech performed three separate glare analyses: the first two analyses included three proximal segmented vehicular traffic routes and three observation points (OPs; two taken from the Tetra Tech visual simulation viewpoints and one taken near residential and commercial receptors to the east). Analysis 1 and 2 differ in the heights assumed for the OP and vehicular routes; Analysis 1 represents the point of view from an average first floor residential/commercial structure and typical commuter car, while Analysis 2 represents the point of view from an average second floor residential/commercial structure and typical semi-tractor-trailer truck. Analysis 3 is focused on modeling the airport receptors referenced in the NCT results; it includes 14 two-mile final approach flight paths and two ATCTs associated with Kalaeloa Airport (John Rodgers Field, JRF), Daniel K. Inouye International Airport (Honolulu International, HNL), and Wheeler Army Airfield (HHI). In Analysis 3, a typical 30-degree maximum downward viewing angle and 50-degree maximum azimuthal viewing angle from the aircraft cockpit were included among other parameters presented in Table 2. For all three analyses, the Project Area consisted of nine separate "PV Array Areas", which are segmented polygons generally representative of the proposed Project layout dated December 4, 2019 (Attachment A). Segmentation of the Project layout allows GlareGauge to more accurately represent potential ocular impacts as a result of the Project. The additional input features used in the analyses are summarized in Table 1 and Table 2.

Table 1. Glare Analyses Input Features

Analysis No.[1]	Racking Type	Module Orientation	Tilt[2] (degrees)	Module Height[3] (feet)	OP Height[4] (feet)	Route Height[5] (feet)	ATCT	Flight Paths
1	Fixed	South-facing	15	7.6	6	5	-	-
2	Fixed	South-facing	15	7.6	16	9	-	-
3	Fixed	South-facing	15	7.6	-	-	2	14

1.Noted on page 1 of each analysis in Attachment C.

2. Module tilt for fixed arrays.

3. Average module centroid height above ground surface.

4. Height of observation point receptor: 6 feet represents an average first floor residential/commercial point of view and 16 feet represents an average second floor residential/commercial point of view.

5. Height of vehicular route receptor: 5 feet represents typical commuter car height and 9 feet represents typical semi-tractor-trailer truck views.

Table 2. Analysis 3 Input Features

Flight Path/ATCT Name	Associated Airport	True Direction (degrees)	Threshold Crossing Height (feet)	Glide Path[1] (degrees)	Height Above Ground (feet)
HHI RWY 24	Wheeler Army Airfield	248[2]	50[3]	3[3]	-
HHI RWY 6	Wheeler Army Airfield	68[2]	50[3]	3[3]	-
HNL RWY 04L	Daniel K. Inouye International Airport	53	50	3	-
HNL RWY 04R	Daniel K. Inouye International Airport	53	71	3	-
HNL RWY 08R	Daniel K. Inouye International Airport	90	96	3.25	-
HNL RWY 22L	Daniel K. Inouye International Airport	233	80	3.44	-
HNL RWY 22R	Daniel K. Inouye International Airport	233	50[3]	3[3]	-
HNL RWY 26L	Daniel K. Inouye International Airport	270	75	3	-
JRF RWY 04L	Kalaeloa Airport	55	35	3	-
JRF RWY 04R	Kalaeloa Airport	55	55	3	-
JRF RWY 11	Kalaeloa Airport	118	48	3	-
JRF RWY 22L	Kalaeloa Airport	235	32	3	-
JRF RWY 22R	Kalaeloa Airport	235	33	3	-
JRF RWY 29	Kalaeloa Airport	298	52	3	-
1-ATCT	Kalaeloa Airport	-	-	-	50[4]
2-ATCT	Daniel K. Inouye International Airport	-	-	-	50[4]

1. Angle of descent along final approach flight path.

2.Unable to be confirmed based on public information. Estimated based on runway direction on aerial photography.

3. Unable to be confirmed based on public information. Default parameters in the SGHAT software which references the FAA criteria found in Section 2.0 were used.

4. Unable to be confirmed based on public information. A conservative height of 50 feet was used based on aerial photography and Google street views.

5.0 Glare Analysis Assumptions

The GlareGauge model is bound by conservative limitations. The following assumptions provide a level of conservatism to the GlareGauge model:

- The GlareGauge model simulates PV arrays as infinitesimally small modules within planar convex polygons exemplifying the tilt and orientation characteristics defined by the user. Gaps between modules, variable heights of the PV array within the polygons, and supporting structures are not considered in the analysis. Since the actual module rows will be separated by open space, this model assumption could result in indication of glare in locations where panels will not be located. In addition, the supporting structures are considered to have reflectivity values that are negligible relative to the module surfaces included in the model.
- The GlareGauge model does not consider obstacles (either man-made or natural) between the defined PV arrays and the receptors such as vegetative screening (existing or planted), buildings, topography, etc. Where such features exist, they would screen views of the Project and, thus, minimize or eliminate glare from those locations.
- The GlareGauge model does not consider the potential effect of shading from existing topography between the sun and the Project outside of the defined areas. In this instance, the lower slopes of the Waianae Mountains are located to the northwest of the Project. This ridgeline may shade the Project from the sun's position at certain times of the year in the evening hours. The GlareGauge model does not account for this potential shading effect.
- The direct normal irradiance (DNI) is defined as variable using a typical clear day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum of 1,000 Watts per square meter (W/m^2) at solar noon. The irradiance profile uses the coordinates from Google Maps and a sun position algorithm to scale the DNI throughout the year. The actual daily DNI would be affected by precipitation, cloud cover, atmospheric attenuation (radiation intensity affected by gaseous constituents), and other environmental factors not considered in the GlareGauge model. This may result in modeled predicted glare occurrences when in fact the glare is not actually occurring due to cloud cover, rain, or other atmospheric conditions.

Note that hazard zone boundaries shown in the Glare Hazard plots are an approximation; actual ocular impacts encompass a continuous, not discrete, spectrum.

6.0 Glare Analysis Results

Tetra Tech performed three separate glare analyses to provide a quantitative assessment of the potential for glare from the Project based on different receptor characteristics. The GlareGauge model's predicted results for the Project are summarized in the following sections partitioned according to the receptor parameters.

6.1 Analysis 1: First Story and Commuter Car View Results

Analysis 1 included three OPs at six feet above ground surface (typical first story receptor height) and three segmented vehicular traffic routes at five feet above ground surface (typical commuter vehicle receptor height). The southern (OP 1) and western (OP 2) residential OPs were selected in the glare analysis to match representative residential viewpoints selected in the visual simulation analysis. The eastern OP (OP 3) was selected in order to capture a representative viewpoint of the residential and commercial receptors in Village Park. The route segment extents were based on the results of a preliminary viewshed analysis dated November 2019.

Table 3 represents the glare summary in annual minutes of glare for Analysis 1. In general, green glare is predicted in limited amounts on Farrington Highway and H1 Freeway and a very limited amount of yellow glare is predicted on H1 Freeway. No red glare is predicted at the defined receptors.

Table 3. Analysis 1 Annual Minutes of Glare Summary

Receptor	Green Glare	Yellow Glare	Red Glare
OP 1	0	0	0
OP 2	0	0	0
OP 3	0	0	0
Farrington-1[1]	1,578	0	0
Farrington-2	4,785	0	0
H1 Freeway-1[2]	0	0	0
H1 Freeway-2	104	0	0
H1 Freeway-3	2,498	35	0
H1 Freeway-4	0	0	0
Kualakai-1[3]	0	0	0
Kualakai-2	0	0	0
Kualakai-3	0	0	0
Kualakai-4	0	0	0
Kualakai-5	0	0	0

1. Segments of Farrington Highway to the south of the Project. Segment 1 is to the east of Segment 2 as depicted in Figure 2.
2. Segments of H1 Freeway (Queen Liliuokalani Freeway) to the south of the Project. Segment 1 to Segment 4 is from east to west.
3. Segments of Kualakai Parkway to the south of the Project. Segment 1 to Segment 5 is from north to south.

Table 4 represents the detailed glare summary for both Analysis 1 and Analysis 2. The predicted green glare at the receptors is between the hours of 6:00 PM and 7:00 PM and ranges from April through mid-September. Less than 15 minutes of green glare per day is predicted within the one-hour period. The limited amount of yellow glare on H1 Freeway-3 is predicted between 6:00 PM and 7:00 PM from mid-May to mid-July. Less than 5 minutes of yellow glare per day is predicted within the one-hour period. Glare was not predicted at the defined residential/commercial OPs or along Kualakai Parkway.

Table 4. Analysis 1 and Analysis 2 Detailed Glare Summary

Receptor	Green Glare Time of Day Range	Green Glare Time of Year Range	Yellow Glare Time of Day Range	Yellow Glare Time of Year Range
Farrington-1	6:00 - 7:00 PM	April to May; mid-July to mid-September	N/A	N/A
Farrington-2	6:00 - 7:00 PM	April to mid-September	N/A	N/A
H1 Freeway-2	6:00 - 7:00 PM	April to mid-May; August to mid-September	N/A	N/A
H1 Freeway-3	6:00 - 7:00 PM	April to May; July to mid-September	6:00 - 7:00 PM	mid-May to mid-July

6.2 Analysis 2: Second Story and Tractor-Trailer View Results

Analysis 2 included the same OP locations at 16 feet above ground surface (typical second story receptor height) and the same segmented vehicular traffic routes at nine feet above ground surface (typical tractor-trailer receptor height).

Table 5 represents the glare summary in annual minutes of glare for Analysis 2. Similar to Analysis 1, green glare is predicted at limited amounts on Farrington Highway and H1 Freeway and a very limited amount of yellow glare is predicted on H1 Freeway. No red glare is predicted at the defined receptors.

Table 5. Analysis 2 Annual Minutes of Glare Summary

Receptor	Green Glare	Yellow Glare	Red Glare
OP 1	0	0	0
OP 2	0	0	0
OP 3	0	0	0
Farrington-1[1]	1,608	0	0
Farrington-2	4,840	0	0
H1 Freeway-1[2]	0	0	0
H1 Freeway-2	118	0	0
H1 Freeway-3	2,624	50	0
H1 Freeway-4	0	0	0
Kualakai-1[3]	0	0	0

Receptor	Green Glare	Yellow Glare	Red Glare
Kualakai-2	0	0	0
Kualakai-3	0	0	0
Kualakai-4	0	0	0
Kualakai-5	0	0	0

As seen in Table 5, the second story and tractor-trailer view results show a minimal increase in annual glare minutes from each receptor exhibiting glare. For example, green glare at H1 Freeway-3 increased by 126 annual minutes, which is a 5% increase in annual green glare minutes from the commuter car height at the H1 Freeway-3 route segment (as shown in Table 3). No significant changes were noted from the time of day and/or the time of year for predicted glare in Analysis 2 (see Table 4 for detailed glare summary).

6.3 Analysis 3: Flight Path and ATCT Results

Analysis 3 included 14 proximal two-mile final approach flight paths and two ATCTs (as outlined in Table 2). The final approach flight paths that were modeled are located at the airports that were referenced in the NCT results: Kalaeloa Airport (John Rodgers Field, JRF), Daniel K. Inouye International Airport (Honolulu International, HNL), and Wheeler Army Airfield (HHI). Table 5 represents the glare summary in annual minutes of glare for Analysis 3.

Table 6. Analysis 3 Annual Minutes of Glare Summary

Receptor	Green Glare	Yellow Glare	Red Glare
HHI RWY 24	0	0	0
HHI RWY 6	0	0	0
HNL RWY 04L	0	0	0
HNL RWY 04R	0	0	0
HNL RWY 08R	0	0	0
HNL RWY 22L	847	0	0
HNL RWY 22R	866	0	0
HNL RWY 26L	2,149	0	0
JRF RWY 04L	0	0	0
JRF RWY 04R	0	0	0
JRF RWY 11	0	0	0
JRF RWY 22L	0	0	0
JRF RWY 22R	0	0	0
JRF RWY 29	0	0	0
1-ATCT	0	0	0
2-ATCT	749	0	0

As noted in Section 2.0, the FAA has developed the following criteria (78 FR 63276) for analysis of solar energy projects located on jurisdictional airports:

- No potential for glint or glare in the existing or planned ATCT cab; and
- No potential for glare or "low potential for after-image" along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved ALP.

The green glare noted in the SGHAT and summarized in this report is considered the "low potential for after-image" described in the applicable FAA criteria. As seen in Table 6, a low potential for after-image (green glare) is predicted in limited amounts along three two-mile final approach paths and the ATCT at Daniel K. Inouye International Airport. The potential green glare is predicted at the flight paths facing the southwest (HNL RWY 22L and HNL RWY 22R) and west (HNL RWY 26L). As summarized in Table 7, the green glare along the flight paths is sporadically limited to April to September between 6:00PM and 7:00PM, not exceeding 10 minutes per day. The green glare at the ATCT (2-ATCT) is sporadically limited to May to August, also between 6:00PM and 7:00PM and not exceeding 10 minutes per day. No yellow glare or red glare was predicted in Analysis 3. As previously noted, in addition to the other conservative values built into the model, visual screening by existing or proposed vegetation or other visual barriers cannot be accounted for in the GlareGauge model. In addition, the model assumes constant ideal (sunny) conditions; however, this area has an average of 78 days of precipitation per year (WRCC 2012). These atmospheric conditions would further reduce the actual occurrence of glare from the Project, such that actual glare conditions are expected to be less than predicted.

Table 7. Analysis 3 Detailed Glare Summary

Receptor	Green Glare Time of Day Range	Green Glare Time of Year Range	Yellow Glare Time of Day Range	Yellow Glare Time of Year Range
HNL RWY 22L	6:00 - 7:00 PM	Mid-April to May; mid-August to September	N/A	N/A
HNL RWY 22R	6:00 - 7:00 PM	Mid-April to May; mid-August to September	N/A	N/A
HNL RWY 26L	6:00 - 7:00 PM	Mid-May to August	N/A	N/A
2-ATCT	6:00 - 7:00 PM	Mid-May to August	N/A	N/A

7.0 Summary

The preliminary Project layout was modeled using GlareGauge to evaluate the potential extent of glare the Project may cause to receptors at three observation points to the east, south and west; receptors along segments of Farrington Highway, H1 Freeway, and Kualakai Parkway; and 14 proximal two-mile final approach flight paths and two ATCTs associated with Kalaeloa Airport (John Rodgers Field, JRF), Daniel K. Inouye International Airport (Honolulu International, HNL), and Wheeler Army Airfield (HHI). In order to better analyze the potential for glare as a result of sunlight reflectance from the Project and accommodate GlareGauge conservatisms noted in Section 4.0, nine array segments (PV Arrays) were modeled within the Project Area. Three separate glare analyses (Analysis 1, Analysis 2 and Analysis 3) were performed to provide a quantitative assessment of the potential for glare as a result of the Project, based on views from first- and second-story structures, commuter vehicles and semi-tractor-trailer trucks, and proximal two-mile final approach flight paths and ATCTs at airports referenced in the FAA NCT results. A summary of total glare predicted based on the analyses is presented in Table 8.

Table 8. Project Glare Summary

Analysis No.	OP Height (feet)	Route Height (feet)	Total Green Glare Predicted (annual minutes)[1]	Total Yellow Glare Predicted (annual minutes)	Total Red Glare Predicted (annual minutes)	Total Glare Predicted (annual minutes)	Total Potential Glare Percentage of Annual Daylight Hours[2]
1	6	5	8,965	35	0	9,000	3.4
2	16	9	9,190	50	0	9,240	3.5
3	50 (ATCTs)	Variable (flight paths)	4,611	0	0	4,611	1.8

1. Total annual daylight minutes equal approximately 262,800.
2. Total annual daylight hours equal approximately 4,380.

None of the residential/commercial OPs to the east (OP 3), south (OP 1) and/or west (OP 2) of the Project were predicted to experience glare as a result of the Project. Green glare (the least severe type of glare) was predicted in Analysis 1 and Analysis 2 at two segments along Farrington Highway (Farrington-1 and Farrington-2) and at two segments along H1 Freeway (H1 Freeway-2 and H1 Freeway-3) to the south of the Project. In addition, a very limited amount of yellow glare (85 combined annual minutes) was predicted at segment H1 Freeway-3. As previously noted, the GlareGauge model does not account for varying ambient conditions (i.e., cloudy days, precipitation); atmospheric attenuation; screening due to existing topography not located within the defined array layouts; or existing vegetation or structures (including fences or walls); nor does the tool allow proposed landscaping to be included. In this instance, an existing berm and vegetation are located along portions of the northern side of H1 Freeway and would be expected to screen views of the Project from vehicular traffic along the modeled segments of H1 Freeway; views of portions of the

Project from vehicular traffic along the modeled segments of Farrington Highway may also be intermittently screened by vegetation and other existing features. Therefore, the model results are conservative and may predict glare at locations where glare will not actually be experienced.

Based on Analysis 3, a total of 4,611 annual minutes (approximately 1.8% of annual daylight hours) of green glare was predicted at three two-mile final approach flight paths (RWY 22L, RWY 22R, and RWY 26L) and the ATCT at the Daniel K. Inouye International Airport, located approximately eight miles east of the Project. As recommended by the NCT, the Project will be formally filed with the FAA OEG to more comprehensively study the impacts of the Project to proximal navigable airspace. In addition, it is recommended that the State of Hawaiʻi Department of Transportation (DOT) Airports Division be consulted regarding these results.

8.0 References

FAA, 2010a. Federal Aviation Administration. CFR Title 14 Part 77.9 Notice of Proposed Construction or Alteration Requiring Notice. 2010.

FAA, 2010b. Federal Aviation Administration. Technical Guidance for Evaluating Selected Solar Technologies on Airports. 2010.

Ho et al. Sandia National Laboratories, Solar Glare Hazard Analysis Tool (SGHAT) Technical Reference Manual. March 2015.

Sandia Solar Glare Hazard Analysis Tool, GlareGauge hosted by ForgeSolar. Accessed online https://www.forgesolar.com/.

Sandia, 2016. Sandia National Laboratories, Solar Glare Hazard Analysis Tool (SGHAT) User's Manual v. 3.0. December 6, 2016.

WRCC (Western Regional Climate Center), 2012. Period of Record General Climate Summary – Precipitation. Ewa Plantation 741, Hawaii. Available online at: https://wrcc.dri.edu/cgi-bin/cliGCStP.pl?hi0507

Attachment A. Preliminary Site Plan

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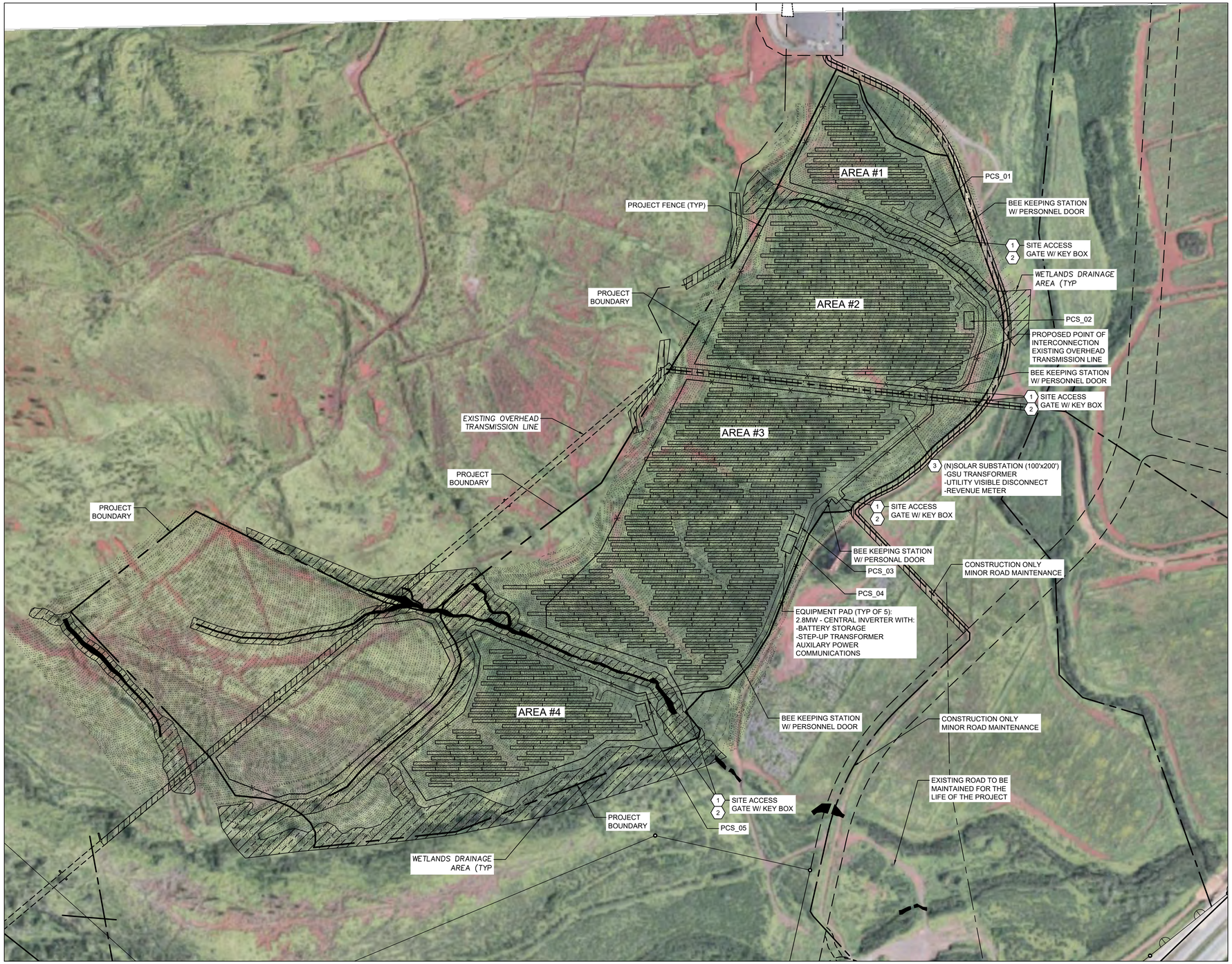


LEGEND

PCS	PCS POWER CONVERSION STATION
	PCS BOUNDARY

GENERAL NOTES

1. REFER TO CIVIL DRAWINGS FOR PERIMETER FENCE, ROADS AND GATES.
2. REFER TO SOLTEC DRAWINGS FOR TRACKER PILE LOCATIONS.
3. PV SITE WILL NOT HAVE SITE LIGHTING OR SECURITY CAMERAS.

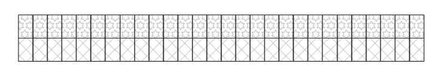
KEYED NOTES

1. CONTRACTOR TO FURNISH AND INSTALL KNOX BOX ACCESS ENCLOSURE AT ENTRANCE TO EVERY ROAD.
2. INSTALL FENCE GROUNDING. SEE E511 FOR DETAILS.
3. SUBSTATION LOCATION IS PENDING, AND SUBJECT TO CHANGE.

DESIGN SPECIFICATIONS

DC SYSTEM VOLTAGE		1500V
ARRAY CAPACITY		17.407MW DC
		12.5MW AC POI
DC/AC RATIO		1.39
MODULE		JINKO - EAGLE BIFACIAL 4C-72M
MODULE WATTAGE		405Wp
MODULE QUANTITY	AREA #1	3,192
	AREA #2	12,656
	AREA #3	20,776
	AREA #4	6,384
	AREA #5	-
	TOTAL	43,008
STRINGS		1,536 STRINGS OF 28 MODULES
INVERTERS (QTY)		(5) 2.8MW CENTRAL INVERTERS WITH INTEGRAL BESS DC/DC CONVERSION
BATTERY STORAGE		(10) 1,300kW BATTERY CONTAINERS
RACKING SYSTEM		FIXED TILT 15°
AZIMUTH		0°
PANEL TILT ANGLE		15°
ROW TO ROW SPACING		21' - 7"
GROUND COVER RATIO		0.62 (TBC)
FENCED IN AREA	AREA #1	APPROX. 4.6 ACRES
	AREA #2	APPROX. 13.26 ACRES
	AREA #3	APPROX. 22.04 ACRES
	AREA #4	APPROX. 8.18 ACRES
	AREA #5	APPROX. 7.79 ACRES
	TOTAL	APPROX. 56.23 ACRES

1. MODULES ARE POSITIONED TWO DEEP IN PORTRAIT ORIENTATION.



NOTE: EACH TRACKER CONTAINS (2) STRINGS OF (28) PV MODULES.

2 / - TRACKER STRING DETAIL
SCALE: NONE

N
W E
S

SCALE: 1" = 200'
0 200' 400' FT

AES
Distributed Energy

AES Distributed Energy
282 Century Pl. Suite 2000
Louisville, CO 80027 USA

HDR
3J CONSULTING
CIVIL ENGINEERING
WATER RESOURCES
COMMUNITY PLANNING
9600 SW NIMBUS AVE, SUITE 100; BEAVERTON, OR 97008

SYSTEM DESCRIPTION

REVISIONS			
REV	BY	DATE	DESCRIPTION

PE STAMP

OVERALL SITE PLAN
WEST OAHU SOLAR
AES DE
OAHU, HI

PROJECT NUMBER
19537
PHASE
ISSUED FOR REVIEW
MILESTONE
30% DESIGN

ELECTRICAL DESIGNER

STRUCTURAL DESIGNER

DATE 12-04-2019
SCALE 1"=200'

TITLE

DRAWING
C200

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Attachment B. Figures

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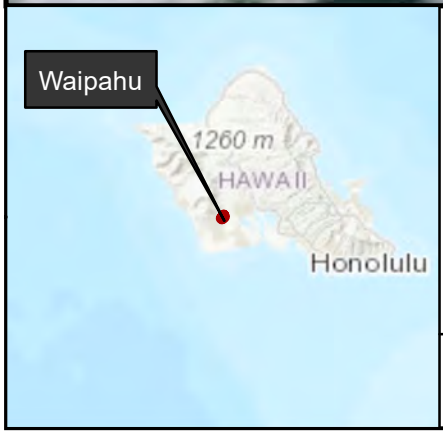


Legend

Project Layout (PV Array Areas)

*Locations are approximate

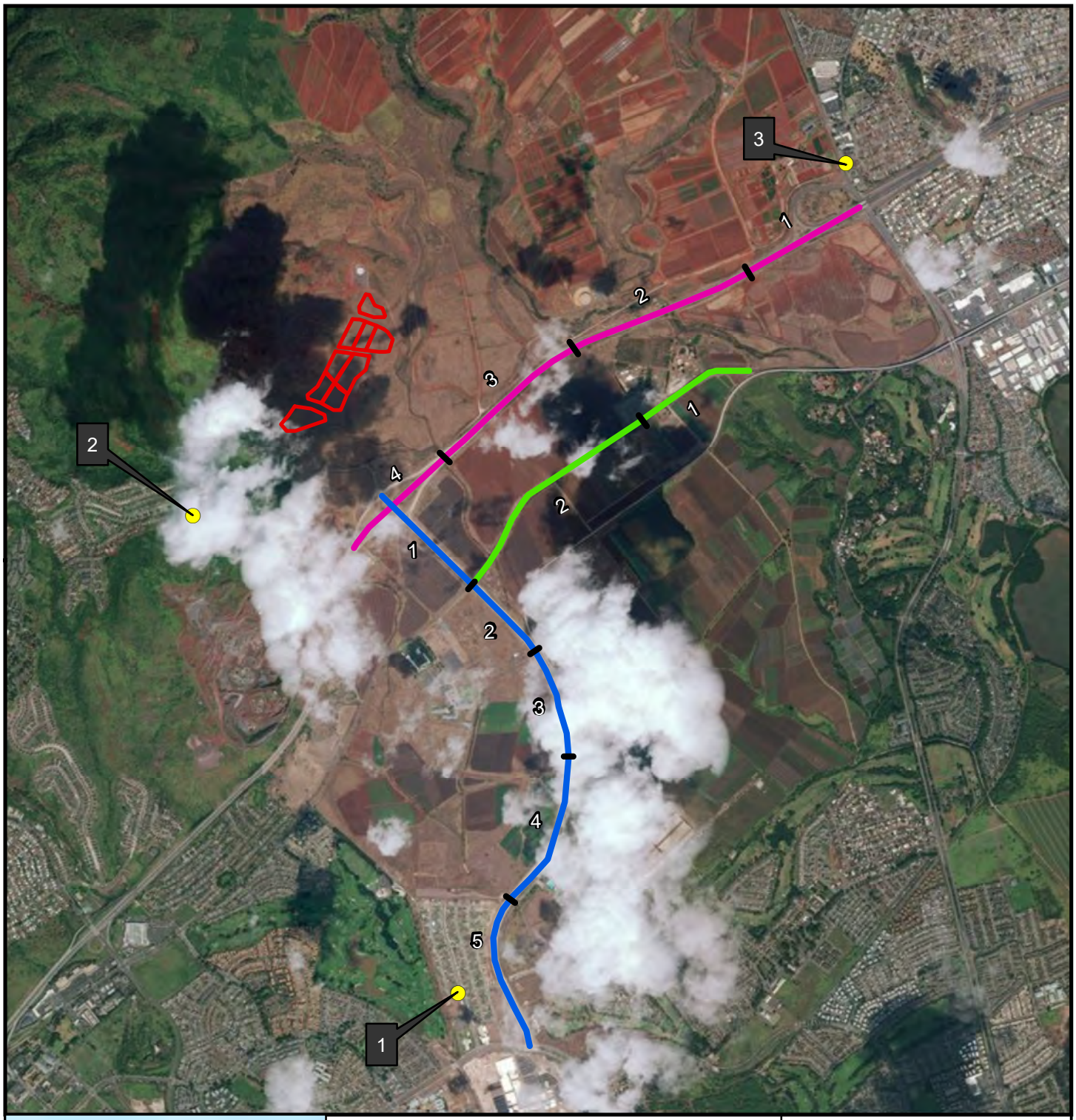
0 375 750 1,500 Feet

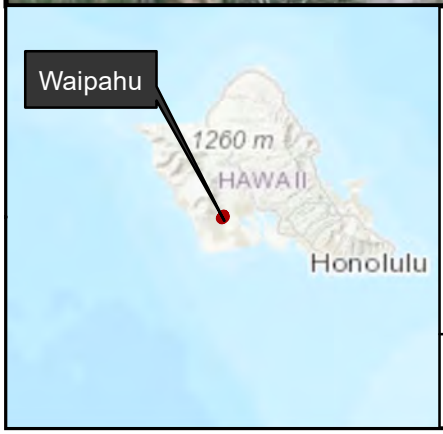
TETRA TECH

Figure 1
PV Array Areas

West Oahu Solar
Oahu, Hawaii

Sources: ESRI Digital Globe 2018 (Basemap)





Legend

- Project Layout (PV Array Areas)
- OPs
- Farrington
- Highway 1 (H1)
- Kualakai

*Locations are approximate

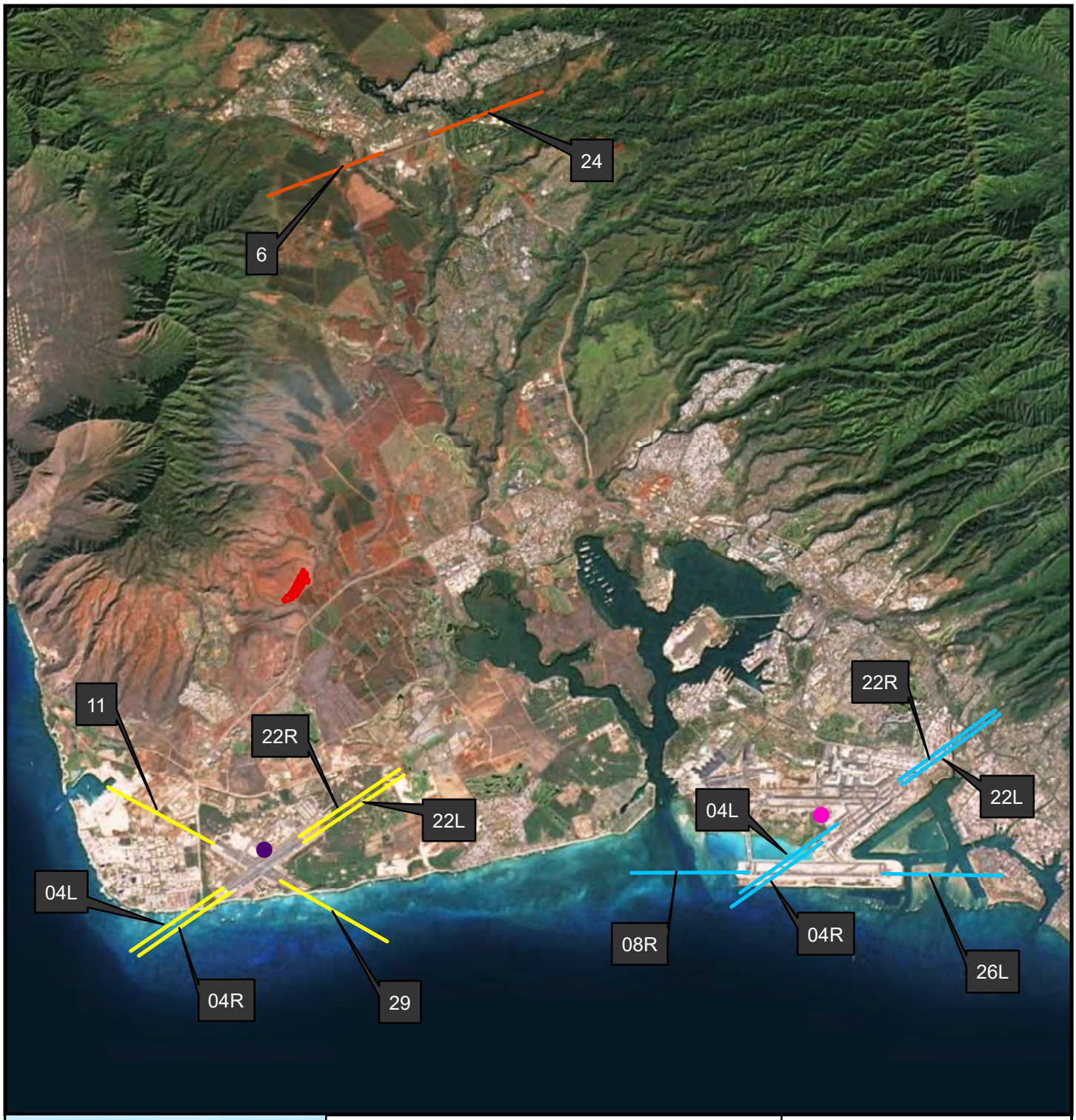
0 1,625 3,250 6,500 Feet

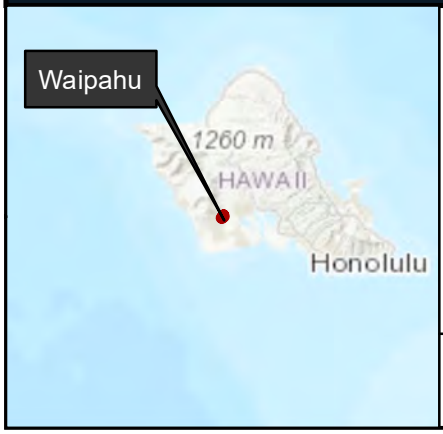
TETRA TECH

Figure 2
Receptors

West Oahu Solar
Oahu, Hawaii

Sources: ESRI Digital Globe 2018 (Basemap)





Legend

- Project Layout (PV Array Areas)
- HNL Final Approach
- HNL ATCT
- JRF Final Approach
- JRF ATCT
- HHI Final Approach

*Locations are approximate

0 1.25 2.5 5 Miles

TETRA TECH

Figure 3
Airport Receptors

West Oahu Solar
Oahu, Hawaii

Sources: ESRI Digital Globe 2018 (Basemap)

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Attachment C. ForgeSolar Glare Analysis Reports

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FORGESOLAR GLARE ANALYSIS

Project: **AES - Hawaii**
Site configuration: **West Oahu Solar**
Analysis conducted by Josh Burdett (joshua.burdett@tetratech.com) at 20:36 on 12 Dec, 2019.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 34061.6258

PV Array(s)

Name: PV Area 1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.378202	-158.062098	414.48	7.60	422.08
2	21.377800	-158.062280	419.04	7.60	426.64
3	21.377602	-158.062377	415.86	7.60	423.46
4	21.377450	-158.062465	411.42	7.60	419.02
5	21.377213	-158.062374	398.76	7.60	406.36
6	21.376973	-158.061441	350.35	7.60	357.96
7	21.377008	-158.060918	333.62	7.60	341.22
8	21.377120	-158.060923	338.28	7.60	345.88
9	21.377490	-158.061106	356.91	7.60	364.51
10	21.377622	-158.061476	374.30	7.60	381.90
11	21.378147	-158.061891	404.33	7.60	411.93

Name: PV Area 2-1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376881	-158.062833	410.48	7.60	418.08
2	21.376459	-158.063010	418.17	7.60	425.77
3	21.375907	-158.063270	403.44	7.60	411.04
4	21.375544	-158.063457	390.88	7.60	398.48
5	21.375315	-158.063565	394.11	7.60	401.71
6	21.375277	-158.063152	370.95	7.60	378.55
7	21.375227	-158.062736	356.59	7.60	364.19
8	21.375574	-158.062618	369.95	7.60	377.55
9	21.376031	-158.062454	383.79	7.60	391.39
10	21.376511	-158.062293	385.02	7.60	392.62
11	21.376713	-158.062218	382.76	7.60	390.36
12	21.376833	-158.062401	392.49	7.60	400.09

Name: PV Area 2-2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376711	-158.062205	381.82	7.60	389.42
2	21.376361	-158.062326	386.07	7.60	393.67
3	21.375894	-158.062492	380.15	7.60	387.75
4	21.375450	-158.062645	364.88	7.60	372.48
5	21.375217	-158.062728	355.93	7.60	363.53
6	21.375152	-158.062331	344.64	7.60	352.24
7	21.375065	-158.061803	333.62	7.60	341.22
8	21.375484	-158.061666	342.96	7.60	350.56
9	21.375989	-158.061513	354.20	7.60	361.80
10	21.376499	-158.061365	347.02	7.60	354.62
11	21.376598	-158.061776	365.54	7.60	373.14

Name: PV Area 2-3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376496	-158.061349	345.68	7.60	353.28
2	21.376129	-158.061451	353.34	7.60	360.94
3	21.375649	-158.061591	344.73	7.60	352.33
4	21.375267	-158.061711	337.77	7.60	345.37
5	21.375055	-158.061786	333.19	7.60	340.80
6	21.375025	-158.061175	318.48	7.60	326.08
7	21.375050	-158.060813	303.34	7.60	310.94
8	21.375095	-158.060542	290.44	7.60	298.04
9	21.375475	-158.060413	294.34	7.60	301.94
10	21.375724	-158.060362	297.35	7.60	304.95
11	21.376002	-158.060582	314.55	7.60	322.15
12	21.376299	-158.060797	321.82	7.60	329.42

Name: PV Area 3-1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.374960	-158.063771	403.94	7.60	411.54
2	21.374550	-158.064018	409.08	7.60	416.68
3	21.374006	-158.064372	405.79	7.60	413.39
4	21.373486	-158.063921	358.12	7.60	365.72
5	21.374071	-158.063321	356.56	7.60	364.16
6	21.374800	-158.062698	341.18	7.60	348.79
7	21.375030	-158.063702	401.45	7.60	409.05

Name: PV Area 3-2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373471	-158.063900	356.53	7.60	364.13
2	21.373052	-158.063605	329.89	7.60	337.49
3	21.372872	-158.063063	308.33	7.60	315.93
4	21.373132	-158.062811	306.55	7.60	314.15
5	21.373511	-158.062468	302.42	7.60	310.02
6	21.373911	-158.062012	300.71	7.60	308.31
7	21.374650	-158.061711	322.58	7.60	330.18
8	21.374790	-158.062634	337.82	7.60	345.42
9	21.374361	-158.063010	346.18	7.60	353.78
10	21.373771	-158.063557	360.52	7.60	368.12
11	21.373431	-158.063927	356.09	7.60	363.69

Name: PV Area 3-3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373971	-158.064423	405.46	7.60	413.06
2	21.373346	-158.064702	408.59	7.60	416.19
3	21.372987	-158.064917	407.08	7.60	414.68
4	21.372597	-158.065507	390.32	7.60	397.92
5	21.372397	-158.065474	370.08	7.60	377.68
6	21.372093	-158.064670	325.30	7.60	332.90
7	21.372627	-158.064343	352.86	7.60	360.46
8	21.373376	-158.063887	352.43	7.60	360.03

Name: PV Area 3-4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373311	-158.063844	348.21	7.60	355.81
2	21.372912	-158.064117	354.61	7.60	362.22
3	21.372332	-158.064477	337.76	7.60	345.36
4	21.372073	-158.064616	321.88	7.60	329.48
5	21.371838	-158.064101	301.52	7.60	309.12
6	21.371713	-158.063763	289.80	7.60	297.40
7	21.371698	-158.063415	280.75	7.60	288.35
8	21.372113	-158.063200	288.24	7.60	295.85
9	21.372807	-158.063007	305.71	7.60	313.31
10	21.372967	-158.063495	325.17	7.60	332.77
11	21.373032	-158.063661	332.00	7.60	339.60
12	21.373232	-158.063774	341.54	7.60	349.14

Name: PV Area 4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.371341	-158.066427	397.82	7.60	405.42
2	21.371151	-158.066598	400.08	7.60	407.68
3	21.370776	-158.066875	379.77	7.60	387.37
4	21.370671	-158.066832	364.94	7.60	372.54
5	21.370531	-158.066590	351.04	7.60	358.64
6	21.370651	-158.065957	338.58	7.60	346.18
7	21.370836	-158.065356	317.01	7.60	324.61
8	21.371091	-158.064434	293.63	7.60	301.23
9	21.371416	-158.064423	295.80	7.60	303.40
10	21.371675	-158.065072	321.71	7.60	329.31
11	21.371765	-158.065963	374.69	7.60	382.29

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	21.338918	-158.055780	62.34	6.00
OP 2	2	21.365603	-158.072233	580.70	5.00
OP 3	3	21.386054	-158.033239	227.55	5.00

Route Receptor(s)

Name: Farrington -1
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.374314	-158.038678	145.95	5.00	150.95
2	21.374270	-158.040953	161.53	5.00	166.53
3	21.374074	-158.041468	165.25	5.00	170.25
4	21.371476	-158.045244	172.88	5.00	177.88

Name: Farrington - 2
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.371337	-158.045416	172.99	5.00	177.99
2	21.368939	-158.049107	172.07	5.00	177.07
3	21.366881	-158.052196	167.23	5.00	172.23
4	21.366321	-158.052604	164.96	5.00	169.96
5	21.362824	-158.054514	154.31	5.00	159.31
6	21.362164	-158.055179	155.55	5.00	160.55

Name: H 1 - 1
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.383670	-158.032421	174.50	5.00	179.50
2	21.383101	-158.033311	183.18	5.00	188.18
3	21.382202	-158.034942	180.15	5.00	185.15
4	21.381033	-158.037012	192.95	5.00	197.95
5	21.379864	-158.039115	181.51	5.00	186.51

Name: H 1 - 2
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.379784	-158.039212	180.23	5.00	185.23
2	21.378825	-158.040950	184.82	5.00	189.83
3	21.378086	-158.042849	176.17	5.00	181.17
4	21.377196	-158.045166	170.51	5.00	175.51
5	21.376093	-158.047863	197.59	5.00	202.59
6	21.375454	-158.049472	200.45	5.00	205.45

Name: H 1 - 3
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.375384	-158.049558	200.81	5.00	205.81
2	21.374635	-158.050770	224.53	5.00	229.53
3	21.373785	-158.051961	218.02	5.00	223.02
4	21.372457	-158.053453	212.66	5.00	217.66
5	21.370868	-158.055212	204.08	5.00	209.08
6	21.369140	-158.057100	199.86	5.00	204.86

Name: H 1 - 4
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.369060	-158.057143	198.86	5.00	203.86
2	21.366202	-158.060383	213.91	5.00	218.92
3	21.365253	-158.061435	206.63	5.00	211.63
4	21.364254	-158.062325	213.41	5.00	218.41

Name: Kualakai - 1
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.366859	-158.060799	229.85	5.00	234.85
2	21.366040	-158.059962	204.96	5.00	209.96
3	21.365001	-158.058804	185.96	5.00	190.96
4	21.363982	-158.057624	172.93	5.00	177.93
5	21.362703	-158.056143	160.77	5.00	165.77
6	21.362083	-158.055499	157.30	5.00	162.30

Name: Kualakai - 2
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.361924	-158.055349	155.26	5.00	160.26
2	21.361124	-158.054319	148.95	5.00	153.95
3	21.360365	-158.053525	138.32	5.00	143.32
4	21.359526	-158.052602	140.78	5.00	145.78
5	21.358646	-158.051766	140.91	5.00	145.91

Name: Kualakai - 3
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.358466	-158.051594	139.44	5.00	144.44
2	21.357647	-158.051122	134.59	5.00	139.59
3	21.356528	-158.050478	125.14	5.00	130.14
4	21.355149	-158.049899	119.06	5.00	124.06
5	21.353670	-158.049491	111.60	5.00	116.60
6	21.352431	-158.049362	102.67	5.00	107.67

Name: Kualakai - 4
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.352347	-158.049384	102.24	5.00	107.24
2	21.351248	-158.049384	95.16	5.00	100.16
3	21.349290	-158.049706	84.68	5.00	89.68
4	21.347391	-158.050199	78.74	5.00	83.74
5	21.345253	-158.051744	77.85	5.00	82.85
6	21.344313	-158.052667	75.37	5.00	80.37

Name: Kualakai - 5
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.344193	-158.052796	74.68	5.00	79.68
2	21.343174	-158.053439	70.98	5.00	75.98
3	21.342295	-158.053697	68.90	5.00	73.90
4	21.341075	-158.053718	68.79	5.00	73.79
5	21.339097	-158.052860	59.09	5.00	64.09
6	21.336099	-158.051379	55.78	5.00	60.78

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt	Orient	"Green" Glare	"Yellow" Glare	Energy
	(°)	(°)	min	min	kWh
PV Area 1	15.0	180.0	1,237	0	-
PV Area 2-1	15.0	180.0	0	0	-
PV Area 2-2	15.0	180.0	840	0	-
PV Area 2-3	15.0	180.0	1,173	0	-
PV Area 3-1	15.0	180.0	1,216	0	-
PV Area 3-2	15.0	180.0	1,028	35	-
PV Area 3-3	15.0	180.0	472	0	-
PV Area 3-4	15.0	180.0	1,253	0	-
PV Area 4	15.0	180.0	1,746	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	1578	0
Farrington - 2	4785	0
H 1 - 1	0	0
H 1 - 2	104	0
H 1 - 3	2498	35
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Results for: PV Area 1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	538	0
Farrington - 2	0	0
H 1 - 1	0	0
H 1 - 2	104	0
H 1 - 3	595	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

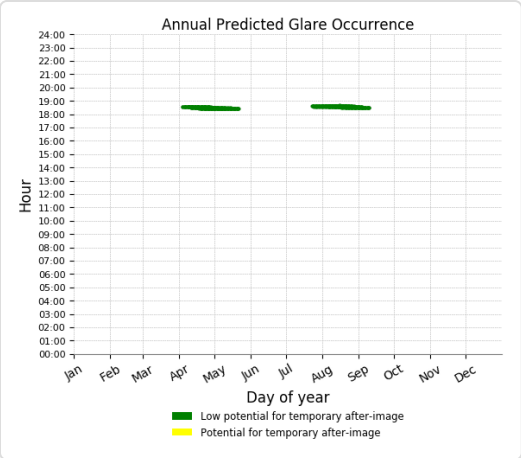
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
538 minutes of green glare



Route: Farrington - 2

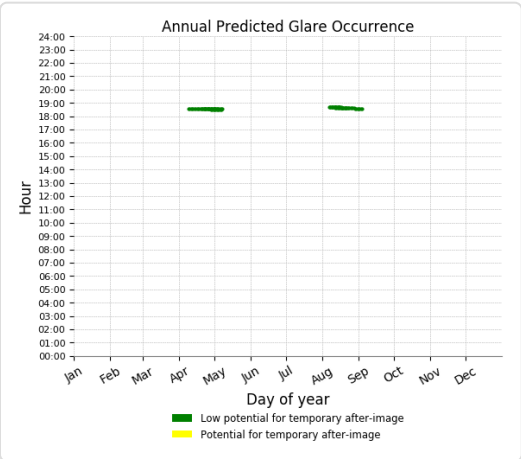
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 1

0 minutes of yellow glare
0 minutes of green glare

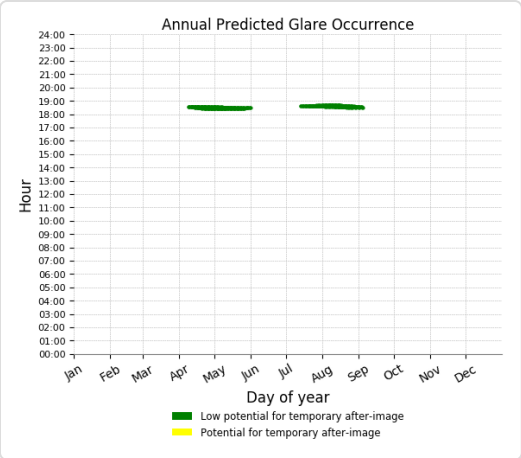
Route: H 1 - 2

0 minutes of yellow glare
104 minutes of green glare



Route: H 1 - 3

0 minutes of yellow glare
595 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	0	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	0	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 1

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-2

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	312	0
Farrington - 2	305	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	223	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

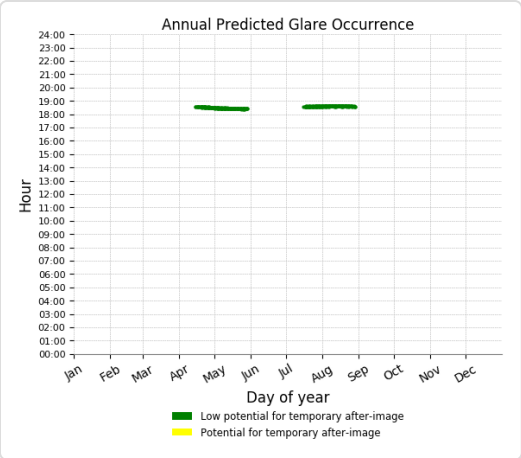
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

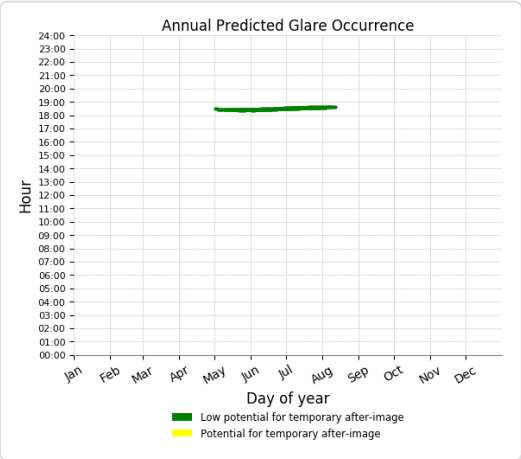
Route: Farrington -1

0 minutes of yellow glare
312 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
305 minutes of green glare



Route: H 1 - 1

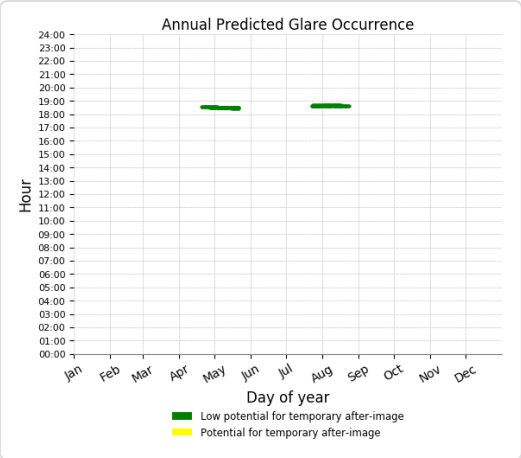
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
223 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-3

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	412	0
Farrington - 2	404	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	357	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

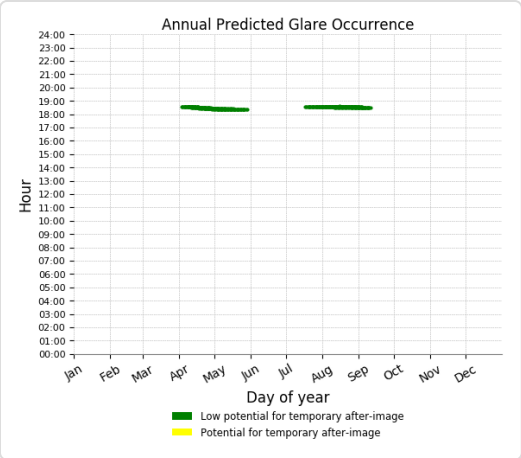
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

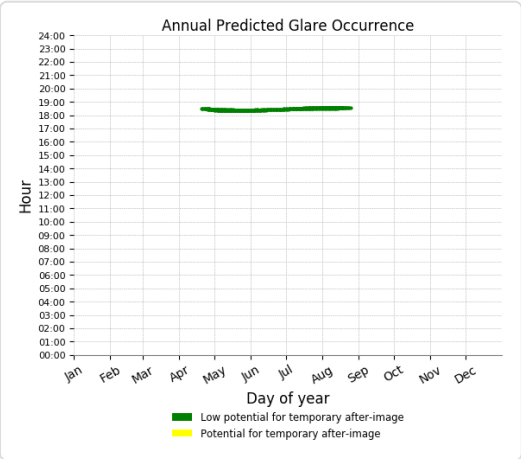
Route: Farrington -1

0 minutes of yellow glare
412 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
404 minutes of green glare



Route: H 1 - 1

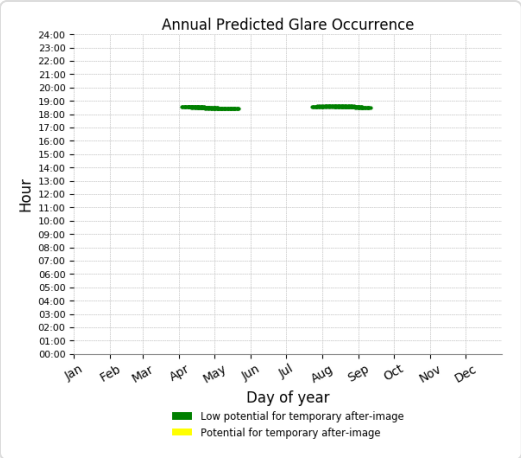
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
357 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	191	0
Farrington - 2	751	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	274	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

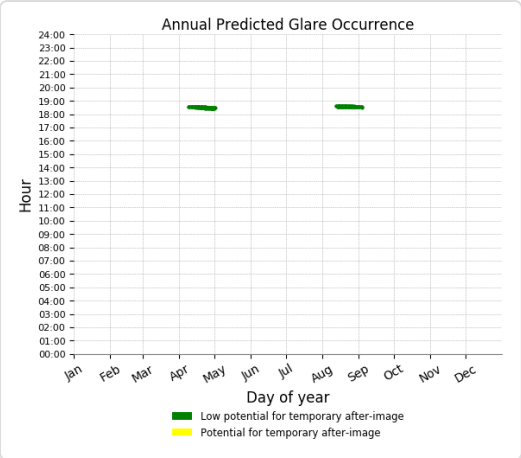
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

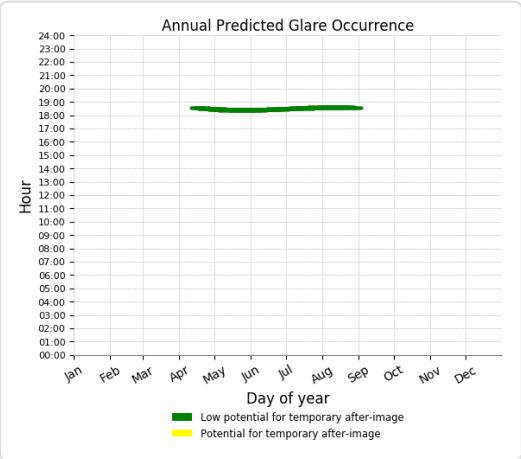
Route: Farrington -1

0 minutes of yellow glare
191 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
751 minutes of green glare



Route: H 1 - 1

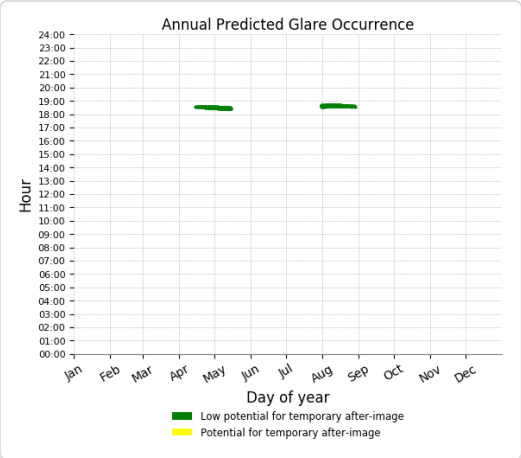
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
274 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-2

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	123	0
Farrington - 2	614	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	291	35
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

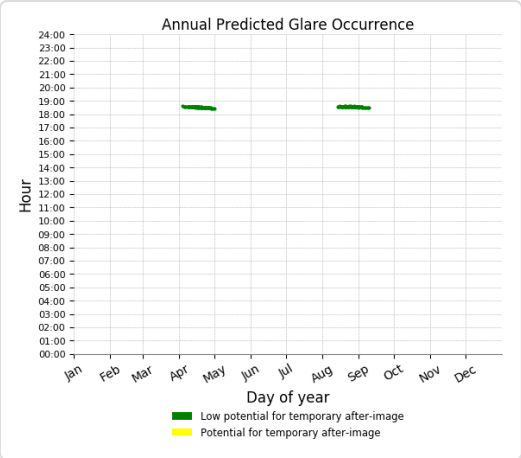
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

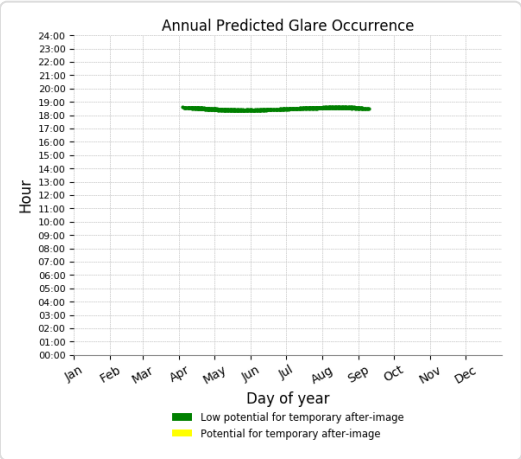
Route: Farrington -1

0 minutes of yellow glare
123 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
614 minutes of green glare



Route: H 1 - 1

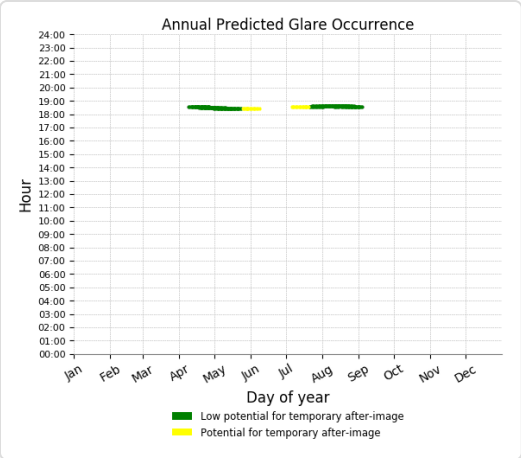
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

35 minutes of yellow glare
291 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-3

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	444	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	28	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

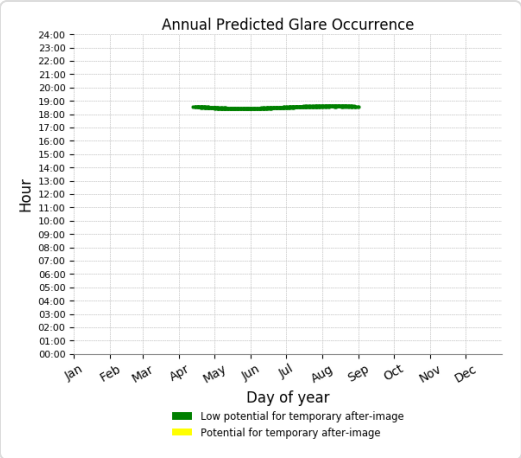
0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare
444 minutes of green glare



Route: H 1 - 1

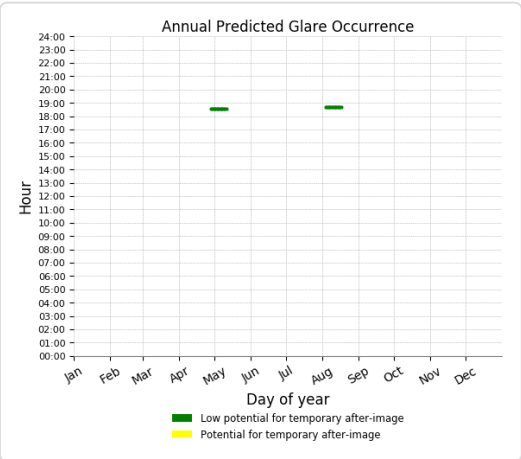
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
28 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-4

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	2	0
Farrington - 2	883	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	368	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

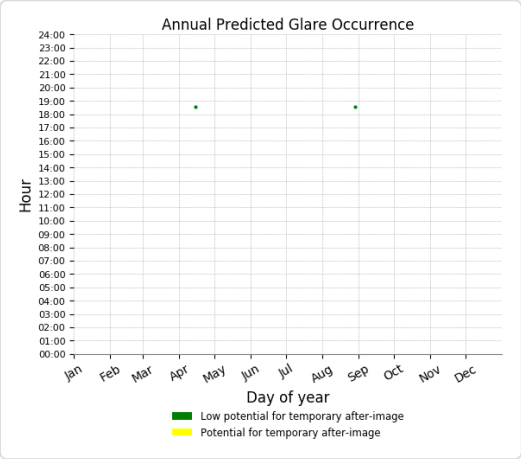
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

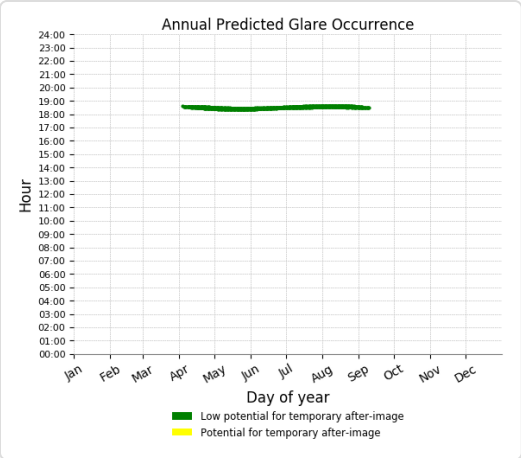
Route: Farrington -1

0 minutes of yellow glare
2 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
883 minutes of green glare



Route: H 1 - 1

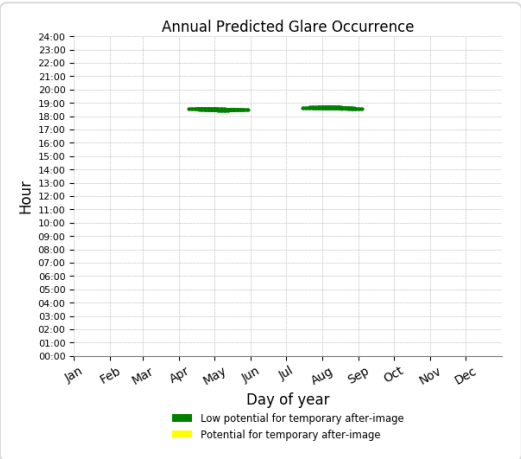
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
368 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 4

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	1384	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	362	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

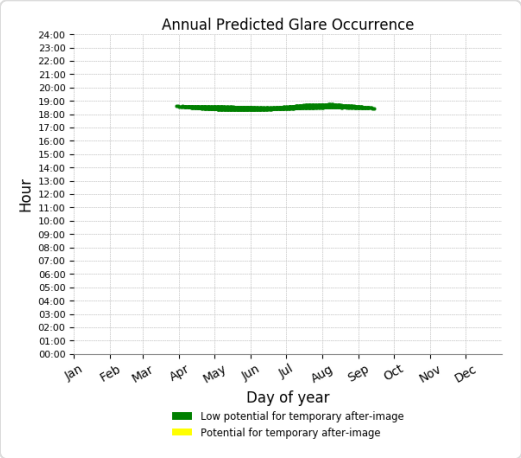
0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare
1384 minutes of green glare



Route: H 1 - 1

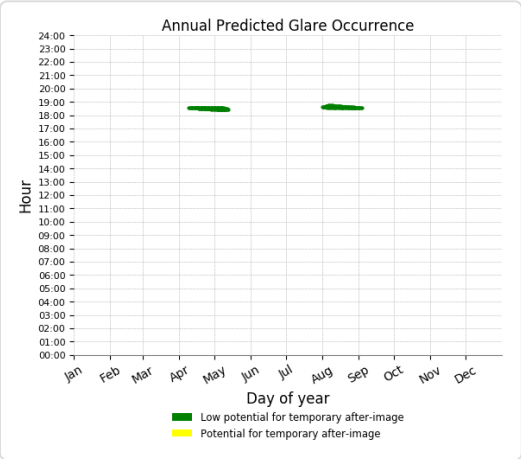
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
362 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

FORGESOLAR GLARE ANALYSIS

Project: **AES - Hawaii**
Site configuration: **West Oahu Solar - upper**
Analysis conducted by Josh Burdett (joshua.burdett@tetratech.com) at 19:59 on 16 Dec, 2019.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 34346.6258

PV Array(s)

Name: PV Area 1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.378202	-158.062098	414.48	7.60	422.08
2	21.377800	-158.062280	419.04	7.60	426.64
3	21.377602	-158.062377	415.86	7.60	423.46
4	21.377450	-158.062465	411.42	7.60	419.02
5	21.377213	-158.062374	398.76	7.60	406.36
6	21.376973	-158.061441	350.35	7.60	357.96
7	21.377008	-158.060918	333.62	7.60	341.22
8	21.377120	-158.060923	338.28	7.60	345.88
9	21.377490	-158.061106	356.91	7.60	364.51
10	21.377622	-158.061476	374.30	7.60	381.90
11	21.378147	-158.061891	404.33	7.60	411.93

Name: PV Area 2-1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376881	-158.062833	410.48	7.60	418.08
2	21.376459	-158.063010	418.17	7.60	425.77
3	21.375907	-158.063270	403.44	7.60	411.04
4	21.375544	-158.063457	390.88	7.60	398.48
5	21.375315	-158.063565	394.11	7.60	401.71
6	21.375277	-158.063152	370.95	7.60	378.55
7	21.375227	-158.062736	356.59	7.60	364.19
8	21.375574	-158.062618	369.95	7.60	377.55
9	21.376031	-158.062454	383.79	7.60	391.39
10	21.376511	-158.062293	385.02	7.60	392.62
11	21.376713	-158.062218	382.76	7.60	390.36
12	21.376833	-158.062401	392.49	7.60	400.09

Name: PV Area 2-2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376711	-158.062205	381.82	7.60	389.42
2	21.376361	-158.062326	386.07	7.60	393.67
3	21.375894	-158.062492	380.15	7.60	387.75
4	21.375450	-158.062645	364.88	7.60	372.48
5	21.375217	-158.062728	355.93	7.60	363.53
6	21.375152	-158.062331	344.64	7.60	352.24
7	21.375065	-158.061803	333.62	7.60	341.22
8	21.375484	-158.061666	342.96	7.60	350.56
9	21.375989	-158.061513	354.20	7.60	361.80
10	21.376499	-158.061365	347.02	7.60	354.62
11	21.376598	-158.061776	365.54	7.60	373.14

Name: PV Area 2-3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376496	-158.061349	345.68	7.60	353.28
2	21.376129	-158.061451	353.34	7.60	360.94
3	21.375649	-158.061591	344.73	7.60	352.33
4	21.375267	-158.061711	337.77	7.60	345.37
5	21.375055	-158.061786	333.19	7.60	340.80
6	21.375025	-158.061175	318.48	7.60	326.08
7	21.375050	-158.060813	303.34	7.60	310.94
8	21.375095	-158.060542	290.44	7.60	298.04
9	21.375475	-158.060413	294.34	7.60	301.94
10	21.375724	-158.060362	297.35	7.60	304.95
11	21.376002	-158.060582	314.55	7.60	322.15
12	21.376299	-158.060797	321.82	7.60	329.42

Name: PV Area 3-1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.374960	-158.063771	403.94	7.60	411.54
2	21.374550	-158.064018	409.08	7.60	416.68
3	21.374006	-158.064372	405.79	7.60	413.39
4	21.373486	-158.063921	358.12	7.60	365.72
5	21.374071	-158.063321	356.56	7.60	364.16
6	21.374800	-158.062698	341.18	7.60	348.79
7	21.375030	-158.063702	401.45	7.60	409.05

Name: PV Area 3-2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373471	-158.063900	356.53	7.60	364.13
2	21.373052	-158.063605	329.89	7.60	337.49
3	21.372872	-158.063063	308.33	7.60	315.93
4	21.373132	-158.062811	306.55	7.60	314.15
5	21.373511	-158.062468	302.42	7.60	310.02
6	21.373911	-158.062012	300.71	7.60	308.31
7	21.374650	-158.061711	322.58	7.60	330.18
8	21.374790	-158.062634	337.82	7.60	345.42
9	21.374361	-158.063010	346.18	7.60	353.78
10	21.373771	-158.063557	360.52	7.60	368.12
11	21.373431	-158.063927	356.09	7.60	363.69

Name: PV Area 3-3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373971	-158.064423	405.46	7.60	413.06
2	21.373346	-158.064702	408.59	7.60	416.19
3	21.372987	-158.064917	407.08	7.60	414.68
4	21.372597	-158.065507	390.32	7.60	397.92
5	21.372397	-158.065474	370.08	7.60	377.68
6	21.372093	-158.064670	325.30	7.60	332.90
7	21.372627	-158.064343	352.86	7.60	360.46
8	21.373376	-158.063887	352.43	7.60	360.03

Name: PV Area 3-4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373311	-158.063844	348.21	7.60	355.81
2	21.372912	-158.064117	354.61	7.60	362.22
3	21.372332	-158.064477	337.76	7.60	345.36
4	21.372073	-158.064616	321.88	7.60	329.48
5	21.371838	-158.064101	301.52	7.60	309.12
6	21.371713	-158.063763	289.80	7.60	297.40
7	21.371698	-158.063415	280.75	7.60	288.35
8	21.372113	-158.063200	288.24	7.60	295.85
9	21.372807	-158.063007	305.71	7.60	313.31
10	21.372967	-158.063495	325.17	7.60	332.77
11	21.373032	-158.063661	332.00	7.60	339.60
12	21.373232	-158.063774	341.54	7.60	349.14

Name: PV Area 4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.371341	-158.066427	397.82	7.60	405.42
2	21.371151	-158.066598	400.08	7.60	407.68
3	21.370776	-158.066875	379.77	7.60	387.37
4	21.370671	-158.066832	364.94	7.60	372.54
5	21.370531	-158.066590	351.04	7.60	358.64
6	21.370651	-158.065957	338.58	7.60	346.18
7	21.370836	-158.065356	317.01	7.60	324.61
8	21.371091	-158.064434	293.63	7.60	301.23
9	21.371416	-158.064423	295.80	7.60	303.40
10	21.371675	-158.065072	321.71	7.60	329.31
11	21.371765	-158.065963	374.69	7.60	382.29

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	21.338918	-158.055780	62.34	16.00
OP 2	2	21.365603	-158.072233	580.70	16.00
OP 3	3	21.386054	-158.033239	227.55	16.00

Route Receptor(s)

Name: Farrington -1
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.374314	-158.038678	145.95	9.00	154.95
2	21.374270	-158.040953	161.53	9.00	170.53
3	21.374074	-158.041468	165.25	9.00	174.25
4	21.371476	-158.045244	172.88	9.00	181.88

Name: Farrington - 2
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.371337	-158.045416	172.99	9.00	181.99
2	21.368939	-158.049107	172.07	9.00	181.07
3	21.366881	-158.052196	167.23	9.00	176.23
4	21.366321	-158.052604	164.96	9.00	173.96
5	21.362824	-158.054514	154.31	9.00	163.31
6	21.362164	-158.055179	155.55	9.00	164.55

Name: H 1 - 1
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.383670	-158.032421	174.50	9.00	183.50
2	21.383101	-158.033311	183.18	9.00	192.18
3	21.382202	-158.034942	180.15	9.00	189.15
4	21.381033	-158.037012	192.95	9.00	201.95
5	21.379864	-158.039115	181.51	9.00	190.51

Name: H 1 - 2
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.379784	-158.039212	180.23	9.00	189.23
2	21.378825	-158.040950	184.82	9.00	193.83
3	21.378086	-158.042849	176.17	9.00	185.17
4	21.377196	-158.045166	170.51	9.00	179.51
5	21.376093	-158.047863	197.59	9.00	206.59
6	21.375454	-158.049472	200.45	9.00	209.45

Name: H 1 - 3
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.375384	-158.049558	200.81	9.00	209.81
2	21.374635	-158.050770	224.53	9.00	233.53
3	21.373785	-158.051961	218.02	9.00	227.02
4	21.372457	-158.053453	212.66	9.00	221.66
5	21.370868	-158.055212	204.08	9.00	213.08
6	21.369140	-158.057100	199.86	9.00	208.86

Name: H 1 - 4
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.369060	-158.057143	198.86	9.00	207.86
2	21.366202	-158.060383	213.91	9.00	222.92
3	21.365253	-158.061435	206.63	9.00	215.63
4	21.364254	-158.062325	213.41	9.00	222.41

Name: Kualakai - 1
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.366859	-158.060799	229.85	9.00	238.85
2	21.366040	-158.059962	204.96	9.00	213.96
3	21.365001	-158.058804	185.96	9.00	194.96
4	21.363982	-158.057624	172.93	9.00	181.93
5	21.362703	-158.056143	160.77	9.00	169.77
6	21.362083	-158.055499	157.30	9.00	166.30

Name: Kualakai - 2
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.361924	-158.055349	155.26	9.00	164.27
2	21.361124	-158.054319	148.95	9.00	157.95
3	21.360365	-158.053525	138.32	9.00	147.32
4	21.359526	-158.052602	140.78	9.00	149.78
5	21.358646	-158.051766	140.91	9.00	149.91

Name: Kualakai - 3
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.358466	-158.051594	139.44	9.00	148.44
2	21.357647	-158.051122	134.59	9.00	143.59
3	21.356528	-158.050478	125.14	9.00	134.14
4	21.355149	-158.049899	119.06	9.00	128.06
5	21.353670	-158.049491	111.60	9.00	120.60
6	21.352431	-158.049362	102.67	9.00	111.67

Name: Kualakai - 4
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.352347	-158.049384	102.24	9.00	111.24
2	21.351248	-158.049384	95.16	9.00	104.16
3	21.349290	-158.049706	84.68	9.00	93.68
4	21.347391	-158.050199	78.74	9.00	87.74
5	21.345253	-158.051744	77.85	9.00	86.85
6	21.344313	-158.052667	75.37	9.00	84.37

Name: Kualakai - 5
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.344193	-158.052796	74.68	9.00	83.68
2	21.343174	-158.053439	70.98	9.00	79.98
3	21.342295	-158.053697	68.90	9.00	77.90
4	21.341075	-158.053718	68.79	9.00	77.79
5	21.339097	-158.052860	59.09	9.00	68.09
6	21.336099	-158.051379	55.78	9.00	64.78

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt	Orient	"Green" Glare	"Yellow" Glare	Energy
	(°)	(°)	min	min	kWh
PV Area 1	15.0	180.0	1,278	0	-
PV Area 2-1	15.0	180.0	0	0	-
PV Area 2-2	15.0	180.0	849	0	-
PV Area 2-3	15.0	180.0	1,215	0	-
PV Area 3-1	15.0	180.0	1,253	0	-
PV Area 3-2	15.0	180.0	1,042	50	-
PV Area 3-3	15.0	180.0	466	0	-
PV Area 3-4	15.0	180.0	1,289	0	-
PV Area 4	15.0	180.0	1,798	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	1608	0
Farrington - 2	4840	0
H 1 - 1	0	0
H 1 - 2	118	0
H 1 - 3	2624	50
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Results for: PV Area 1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	542	0
Farrington - 2	0	0
H 1 - 1	0	0
H 1 - 2	118	0
H 1 - 3	618	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

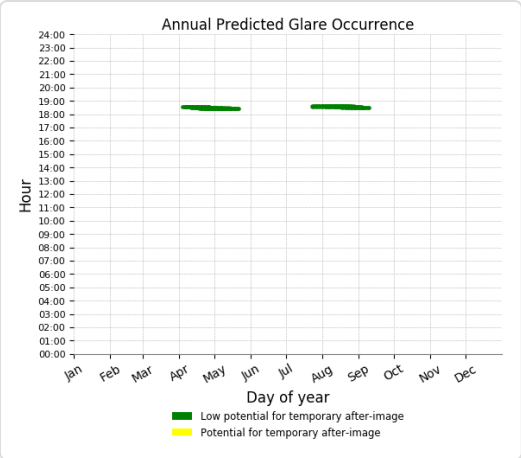
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
542 minutes of green glare



Route: Farrington - 2

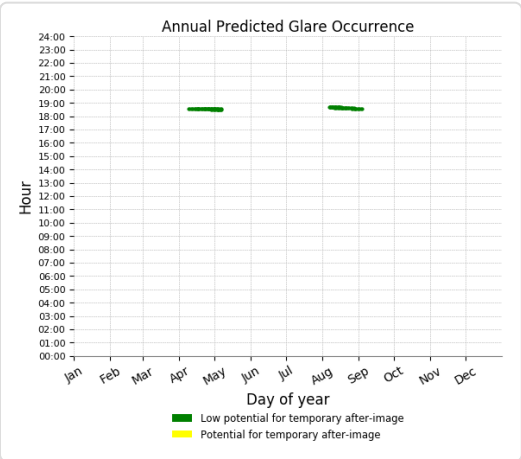
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 1

0 minutes of yellow glare
0 minutes of green glare

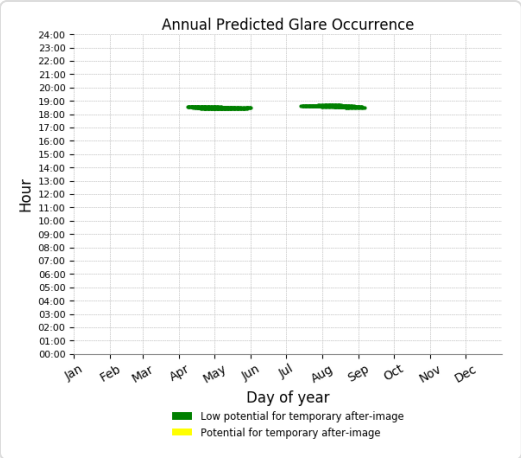
Route: H 1 - 2

0 minutes of yellow glare
118 minutes of green glare



Route: H 1 - 3

0 minutes of yellow glare
618 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	0	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	0	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 1

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-2

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	318	0
Farrington - 2	299	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	232	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

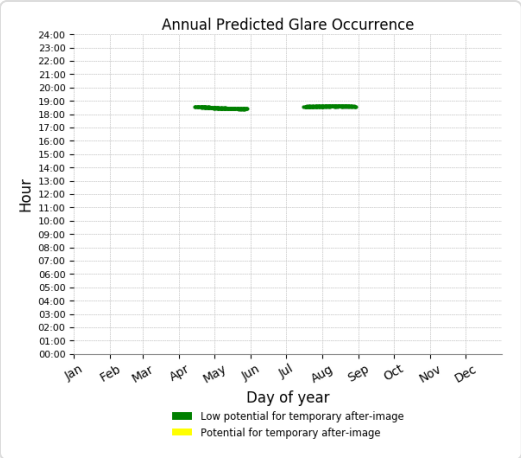
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

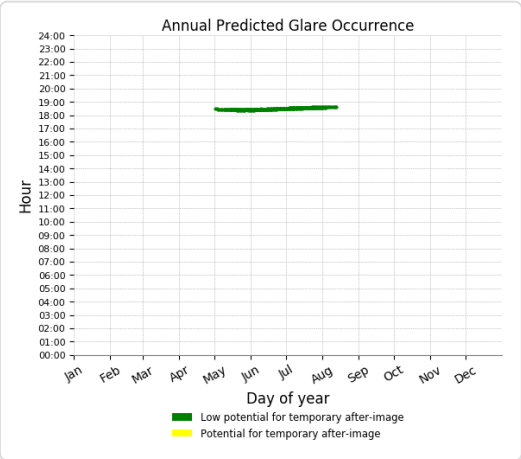
Route: Farrington -1

0 minutes of yellow glare
318 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
299 minutes of green glare



Route: H 1 - 1

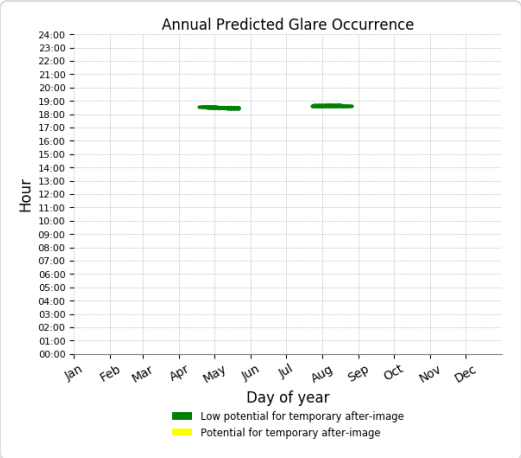
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
232 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-3

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	421	0
Farrington - 2	413	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	381	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

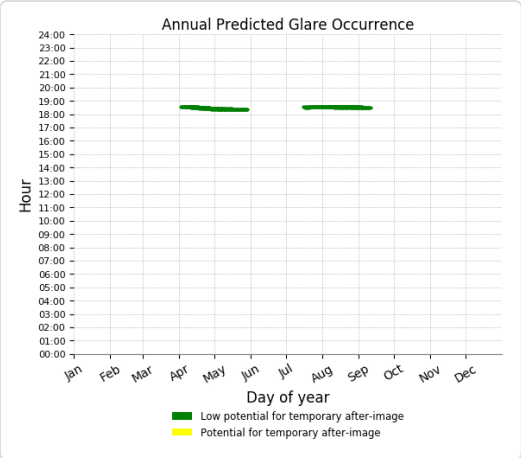
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

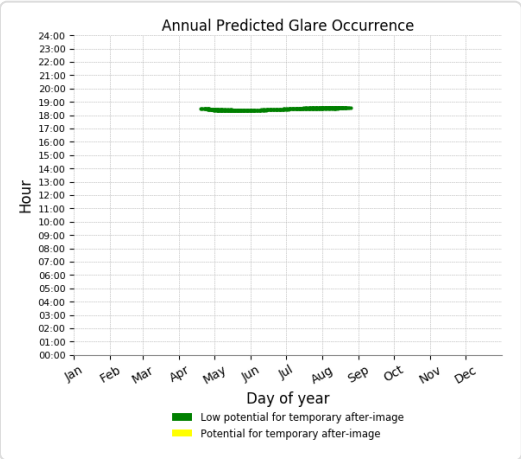
Route: Farrington -1

0 minutes of yellow glare
421 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
413 minutes of green glare



Route: H 1 - 1

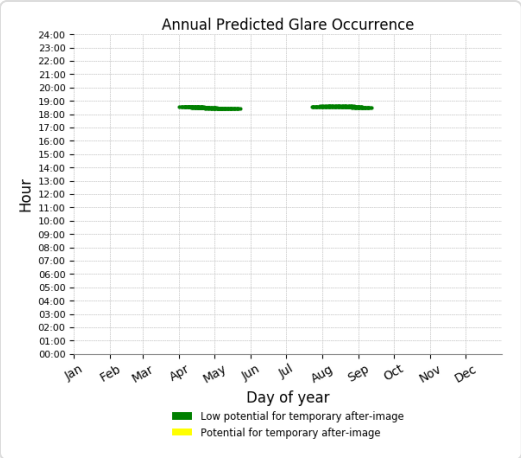
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
381 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	198	0
Farrington - 2	770	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	285	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

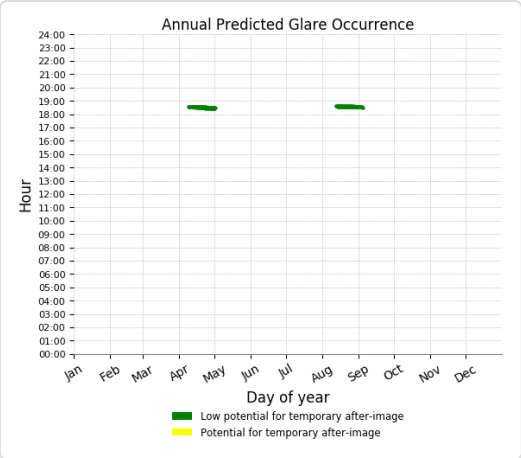
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

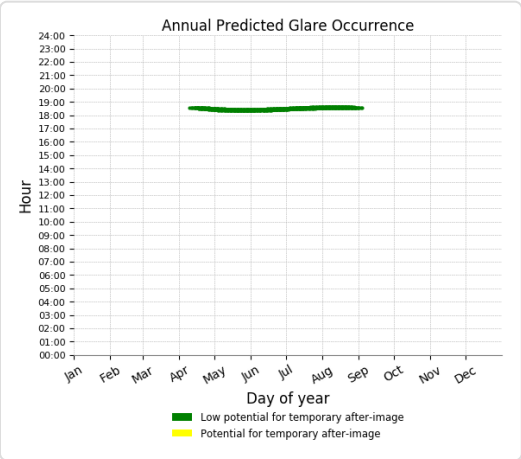
Route: Farrington -1

0 minutes of yellow glare
198 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
770 minutes of green glare



Route: H 1 - 1

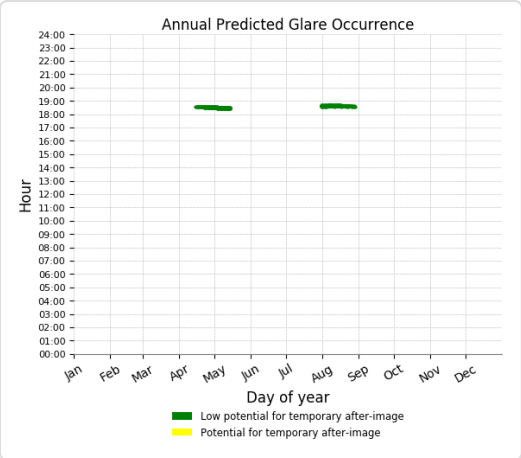
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
285 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-2

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	125	0
Farrington - 2	614	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	303	50
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

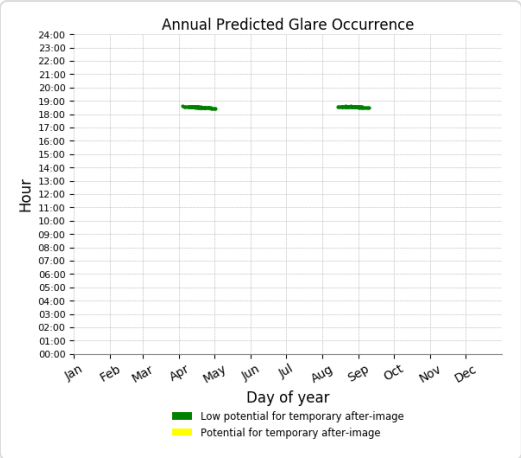
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

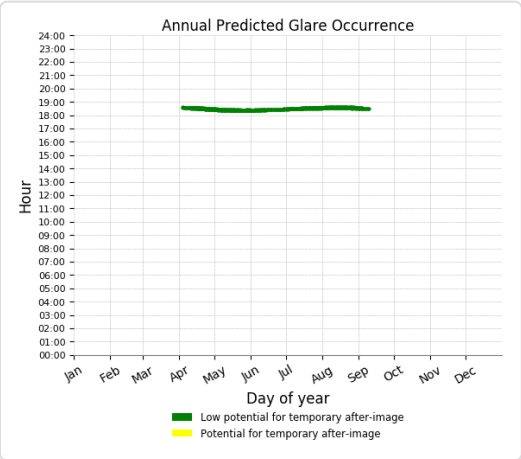
Route: Farrington -1

0 minutes of yellow glare
125 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
614 minutes of green glare



Route: H 1 - 1

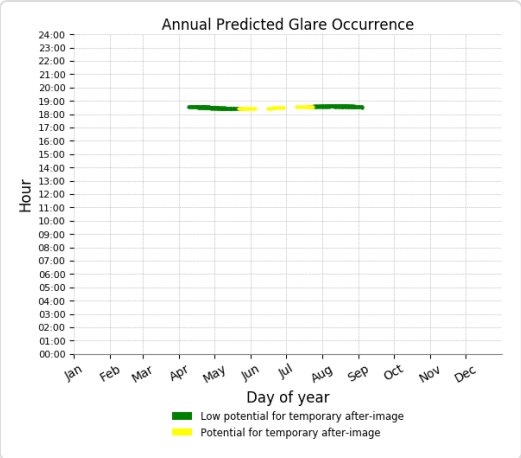
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

50 minutes of yellow glare
303 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-3

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	442	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	24	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

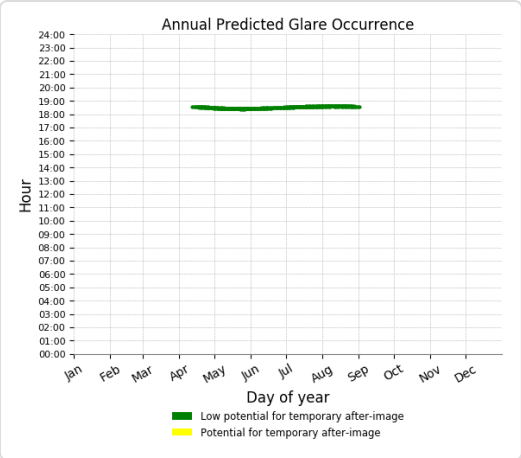
0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare
442 minutes of green glare



Route: H 1 - 1

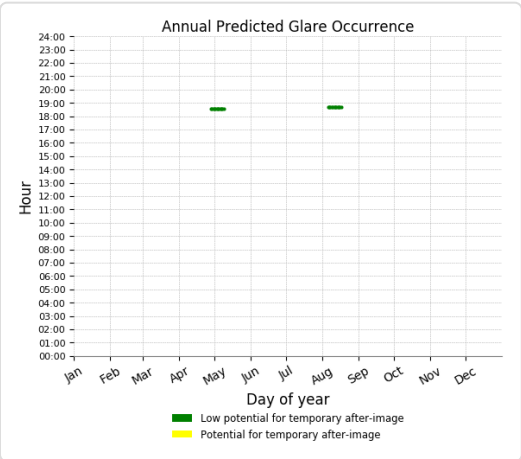
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
24 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-4

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	4	0
Farrington - 2	892	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	393	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

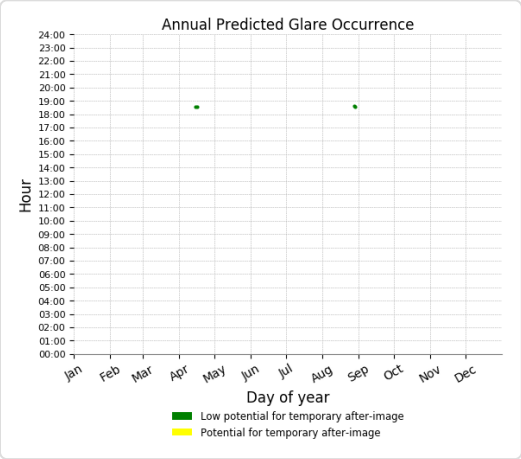
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

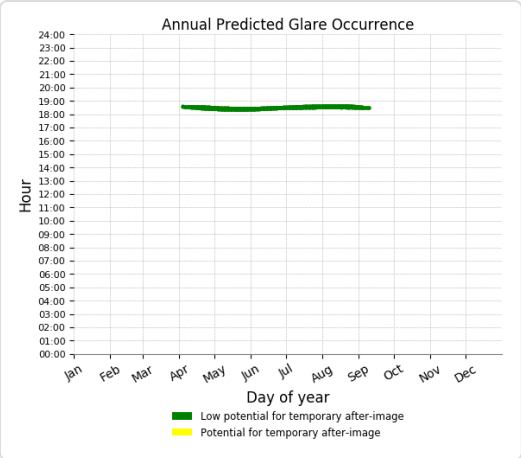
Route: Farrington -1

0 minutes of yellow glare
4 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
892 minutes of green glare



Route: H 1 - 1

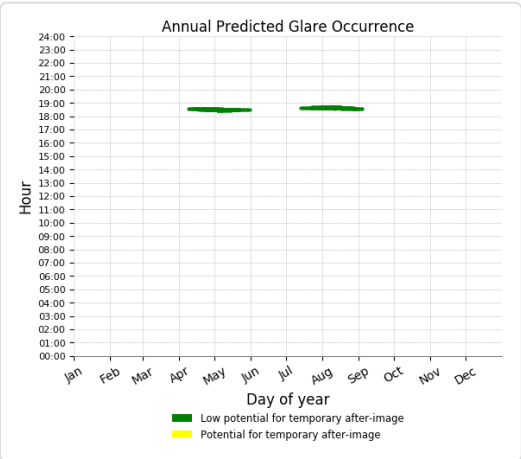
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
393 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 4

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	1410	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	388	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

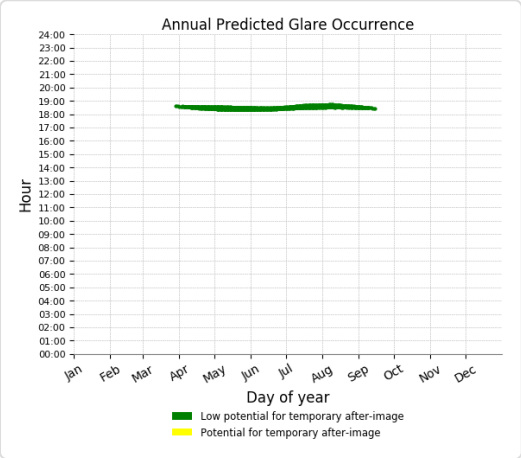
0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare
1410 minutes of green glare



Route: H 1 - 1

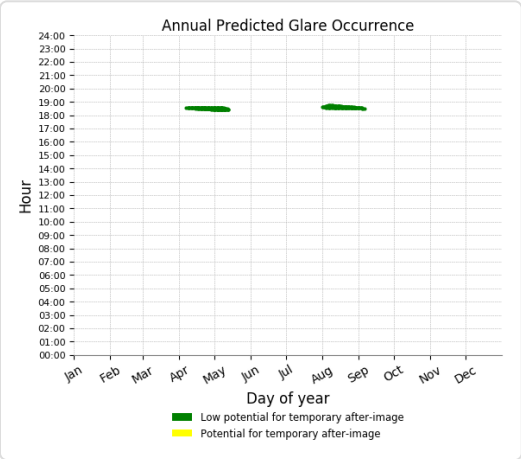
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
388 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

FORGESOLAR GLARE ANALYSIS

Project: **AES - Hawaii**
Site configuration: **West Oahu - FAA**
Analysis conducted by Josh Burdett (joshua.burdett@tetratech.com) at 16:43 on 21 Jan, 2020.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	FAIL	Receptor(s) marked as ATCT receive green and/or yellow glare

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 34872.6258

PV Array(s)

Name: PV Area 1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.378202	-158.062098	414.48	7.60	422.08
2	21.377800	-158.062280	419.04	7.60	426.64
3	21.377602	-158.062377	415.86	7.60	423.46
4	21.377450	-158.062465	411.42	7.60	419.02
5	21.377213	-158.062374	398.76	7.60	406.36
6	21.376973	-158.061441	350.35	7.60	357.96
7	21.377008	-158.060918	333.62	7.60	341.22
8	21.377120	-158.060923	338.28	7.60	345.88
9	21.377490	-158.061106	356.91	7.60	364.51
10	21.377622	-158.061476	374.30	7.60	381.90
11	21.378147	-158.061891	404.33	7.60	411.93

Name: PV Area 2-1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376881	-158.062833	410.48	7.60	418.08
2	21.376459	-158.063010	418.17	7.60	425.77
3	21.375907	-158.063270	403.44	7.60	411.04
4	21.375544	-158.063457	390.88	7.60	398.48
5	21.375315	-158.063565	394.11	7.60	401.71
6	21.375277	-158.063152	370.95	7.60	378.55
7	21.375227	-158.062736	356.59	7.60	364.19
8	21.375574	-158.062618	369.95	7.60	377.55
9	21.376031	-158.062454	383.79	7.60	391.39
10	21.376511	-158.062293	385.02	7.60	392.62
11	21.376713	-158.062218	382.76	7.60	390.36
12	21.376833	-158.062401	392.49	7.60	400.09

Name: PV Area 2-2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376711	-158.062205	381.82	7.60	389.42
2	21.376361	-158.062326	386.07	7.60	393.67
3	21.375894	-158.062492	380.15	7.60	387.75
4	21.375450	-158.062645	364.88	7.60	372.48
5	21.375217	-158.062728	355.93	7.60	363.53
6	21.375152	-158.062331	344.64	7.60	352.24
7	21.375065	-158.061803	333.62	7.60	341.22
8	21.375484	-158.061666	342.96	7.60	350.56
9	21.375989	-158.061513	354.20	7.60	361.80
10	21.376499	-158.061365	347.02	7.60	354.62
11	21.376598	-158.061776	365.54	7.60	373.14

Name: PV Area 2-3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376496	-158.061349	345.68	7.60	353.28
2	21.376129	-158.061451	353.34	7.60	360.94
3	21.375649	-158.061591	344.73	7.60	352.33
4	21.375267	-158.061711	337.77	7.60	345.37
5	21.375055	-158.061786	333.19	7.60	340.80
6	21.375025	-158.061175	318.48	7.60	326.08
7	21.375050	-158.060813	303.34	7.60	310.94
8	21.375095	-158.060542	290.44	7.60	298.04
9	21.375475	-158.060413	294.34	7.60	301.94
10	21.375724	-158.060362	297.35	7.60	304.95
11	21.376002	-158.060582	314.55	7.60	322.15
12	21.376299	-158.060797	321.82	7.60	329.42

Name: PV Area 3-1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.374960	-158.063771	403.94	7.60	411.54
2	21.374550	-158.064018	409.08	7.60	416.68
3	21.374006	-158.064372	405.79	7.60	413.39
4	21.373486	-158.063921	358.12	7.60	365.72
5	21.374071	-158.063321	356.56	7.60	364.16
6	21.374800	-158.062698	341.18	7.60	348.79
7	21.375030	-158.063702	401.45	7.60	409.05

Name: PV Area 3-2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373471	-158.063900	356.53	7.60	364.13
2	21.373052	-158.063605	329.89	7.60	337.49
3	21.372872	-158.063063	308.33	7.60	315.93
4	21.373132	-158.062811	306.55	7.60	314.15
5	21.373511	-158.062468	302.42	7.60	310.02
6	21.373911	-158.062012	300.71	7.60	308.31
7	21.374650	-158.061711	322.58	7.60	330.18
8	21.374790	-158.062634	337.82	7.60	345.42
9	21.374361	-158.063010	346.18	7.60	353.78
10	21.373771	-158.063557	360.52	7.60	368.12
11	21.373431	-158.063927	356.09	7.60	363.69

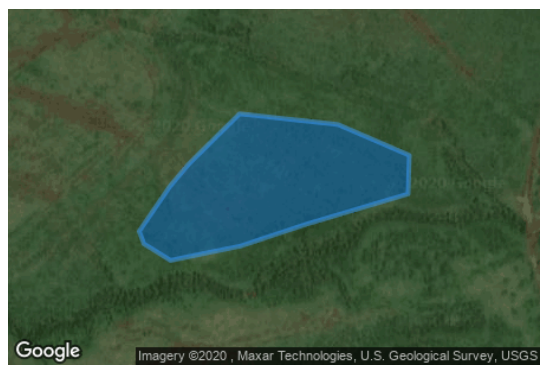
Name: PV Area 3-3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373971	-158.064423	405.46	7.60	413.06
2	21.373346	-158.064702	408.59	7.60	416.19
3	21.372987	-158.064917	407.08	7.60	414.68
4	21.372597	-158.065507	390.32	7.60	397.92
5	21.372397	-158.065474	370.08	7.60	377.68
6	21.372093	-158.064670	325.30	7.60	332.90
7	21.372627	-158.064343	352.86	7.60	360.46
8	21.373376	-158.063887	352.43	7.60	360.03

Name: PV Area 3-4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373311	-158.063844	348.21	7.60	355.81
2	21.372912	-158.064117	354.61	7.60	362.22
3	21.372332	-158.064477	337.76	7.60	345.36
4	21.372073	-158.064616	321.88	7.60	329.48
5	21.371838	-158.064101	301.52	7.60	309.12
6	21.371713	-158.063763	289.80	7.60	297.40
7	21.371698	-158.063415	280.75	7.60	288.35
8	21.372113	-158.063200	288.24	7.60	295.85
9	21.372807	-158.063007	305.71	7.60	313.31
10	21.372967	-158.063495	325.17	7.60	332.77
11	21.373032	-158.063661	332.00	7.60	339.60
12	21.373232	-158.063774	341.54	7.60	349.14

Name: PV Area 4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.371341	-158.066427	397.82	7.60	405.42
2	21.371151	-158.066598	400.08	7.60	407.68
3	21.370776	-158.066875	379.77	7.60	387.37
4	21.370671	-158.066832	364.94	7.60	372.54
5	21.370531	-158.066590	351.04	7.60	358.64
6	21.370651	-158.065957	338.58	7.60	346.18
7	21.370836	-158.065356	317.01	7.60	324.61
8	21.371091	-158.064434	293.63	7.60	301.23
9	21.371416	-158.064423	295.80	7.60	303.40
10	21.371675	-158.065072	321.71	7.60	329.31
11	21.371765	-158.065963	374.69	7.60	382.29

Flight Path Receptor(s)

Name: HHI RWY 24
Description:
Threshold height: 50 ft
Direction: 248.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.484137	-158.030623	836.65	50.00	886.65
Two-mile	21.494967	-158.001780	962.56	477.54	1440.10

Name: HHI RWY 6
Description:
Threshold height: 50 ft
Direction: 68.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.479376	-158.043476	816.49	50.00	866.49
Two-mile	21.468545	-158.072317	1132.87	287.08	1419.95

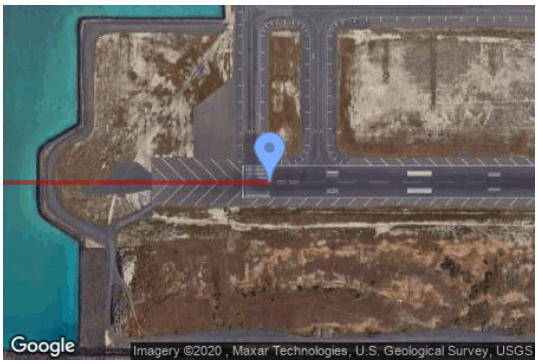
Name: HNL RWY 04L
Description:
Threshold height: 50 ft
Direction: 53.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.318627	-157.922958	6.56	50.00	56.56
Two-mile	21.301227	-157.947774	-24.77	634.79	610.02

Name: HNL RWY 04R
Description:
Threshold height: 71 ft
Direction: 53.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.314206	-157.926770	3.28	71.00	74.28
Two-mile	21.296806	-157.951585	-81.63	709.37	627.74

Name: HNL RWY 08R
Description:
Threshold height: 96 ft
Direction: 90.0°
Glide slope: 3.25°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.306817	-157.945391	3.15	96.00	99.15
Two-mile	21.306817	-157.976461	-12.57	711.39	698.82

Name: HNL RWY 22L
Description:
Threshold height: 80 ft
Direction: 233.0°
Glide slope: 3.44°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.328555	-157.906434	3.28	80.00	83.28
Two-mile	21.345955	-157.881617	98.61	619.49	718.10

Name: HNL RWY 22R
Description:
Threshold height: 50 ft
Direction: 233.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.329580	-157.907432	6.32	50.00	56.33
Two-mile	21.346980	-157.882614	113.79	495.99	609.78

Name: HNL RWY 26L
Description:
Threshold height: 75 ft
Direction: 270.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.306822	-157.911122	3.08	75.00	78.09
Two-mile	21.306827	-157.880052	8.34	623.20	631.54

Name: JRF RWY 04L
Description:
Threshold height: 35 ft
Direction: 55.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.301104	-158.080872	13.12	35.00	48.13
Two-mile	21.284521	-158.106322	-24.50	626.08	601.58

Name: JRF RWY 04R
Description:
Threshold height: 55 ft
Direction: 55.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.299691	-158.079822	13.11	55.00	68.11
Two-mile	21.283107	-158.105272	-28.50	650.06	621.56

Name: JRF RWY 11
Description:
Threshold height: 48 ft
Direction: 118.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.311555	-158.083631	35.84	48.00	83.84
Two-mile	21.325129	-158.111066	16.69	620.60	637.30

Name: JRF RWY 22L
Description:
Threshold height: 32 ft
Direction: 235.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.312291	-158.060624	26.25	32.00	58.25
Two-mile	21.328874	-158.035172	31.89	579.82	611.70

Name: JRF RWY 22R
Description:
Threshold height: 33 ft
Direction: 235.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.313722	-158.061641	29.53	33.00	62.53
Two-mile	21.330305	-158.036189	32.81	583.17	615.99

Name: JRF RWY 29
Description:
Threshold height: 52 ft
Direction: 298.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

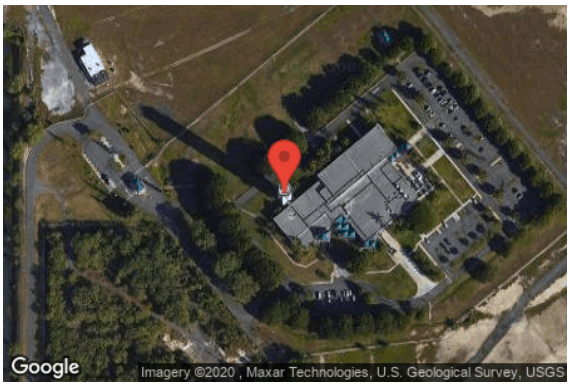
Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.302899	-158.066468	9.84	52.00	61.85
Two-mile	21.289326	-158.039035	-38.09	653.40	615.30

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
1-ATCT	1	21.310381	-158.070840	29.53	50.00
2-ATCT	2	21.320915	-157.927214	6.77	50.00

Map image of 1-ATCT

Map image of 2-ATCT



GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV Area 1	15.0	180.0	602	0	-
PV Area 2-1	15.0	180.0	266	0	-
PV Area 2-2	15.0	180.0	212	0	-
PV Area 2-3	15.0	180.0	417	0	-
PV Area 3-1	15.0	180.0	660	0	-
PV Area 3-2	15.0	180.0	451	0	-
PV Area 3-3	15.0	180.0	567	0	-
PV Area 3-4	15.0	180.0	623	0	-
PV Area 4	15.0	180.0	813	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	847	0
HNL RWY 22R	866	0
HNL RWY 26L	2149	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	749	0

Results for: PV Area 1

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	93	0
HNL RWY 22R	112	0
HNL RWY 26L	346	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	51	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

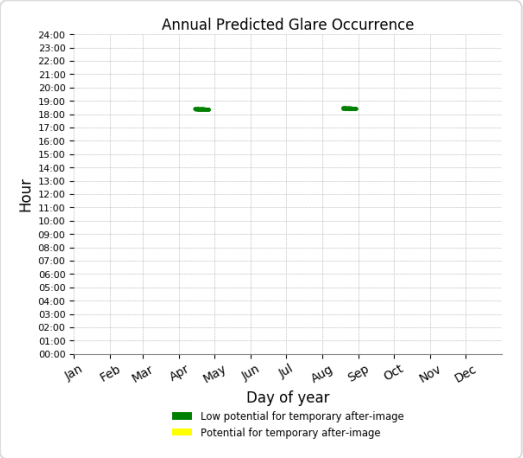
0 minutes of yellow glare
0 minutes of green glare

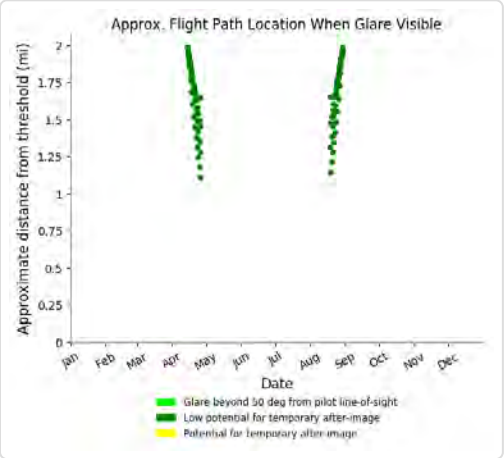
Flight Path: HNL RWY 08R

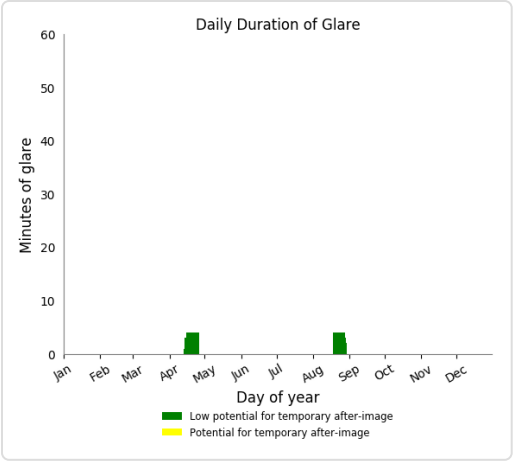
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
93 minutes of green glare



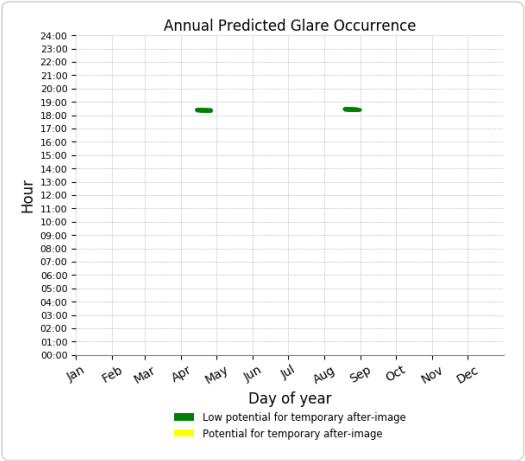


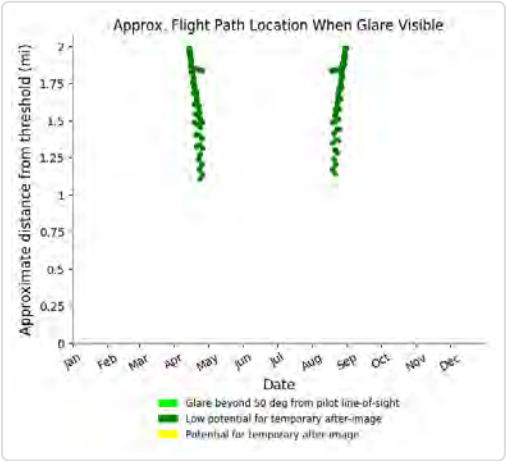


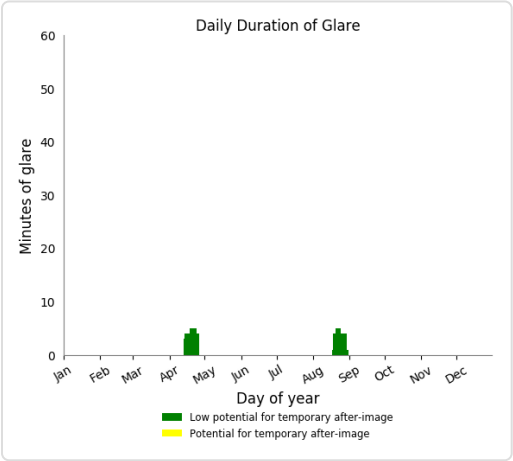
Flight Path: HNL RWY 22R

0 minutes of yellow glare

112 minutes of green glare



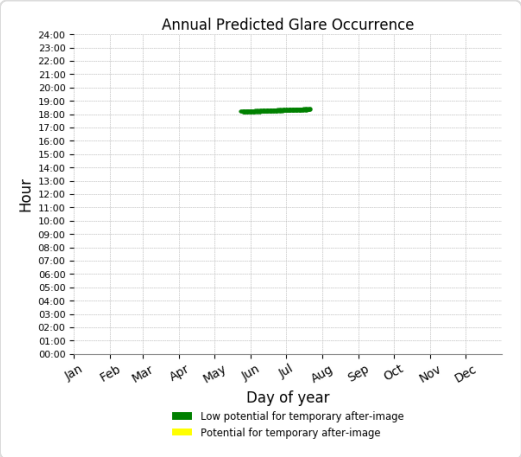


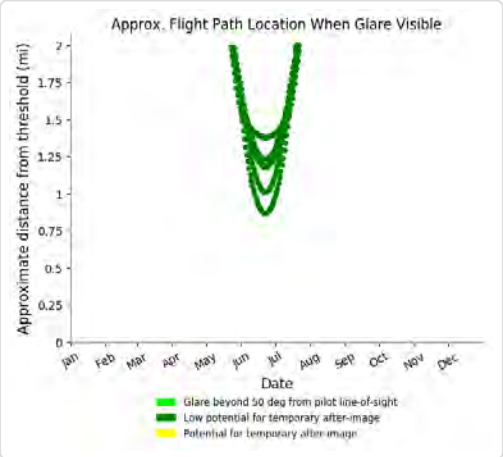


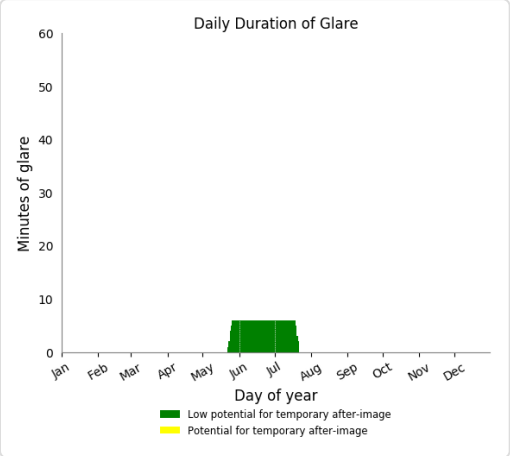
Flight Path: HNL RWY 26L

0 minutes of yellow glare

346 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

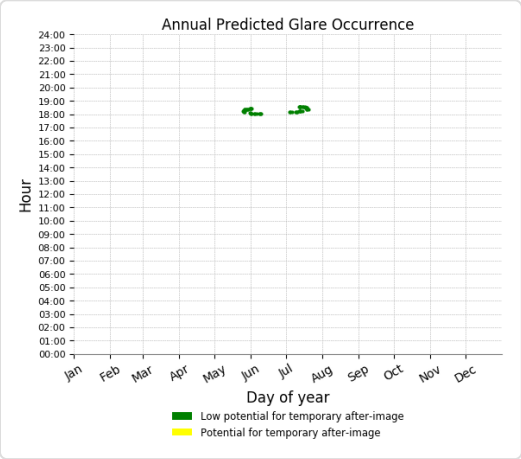
0 minutes of yellow glare
0 minutes of green glare

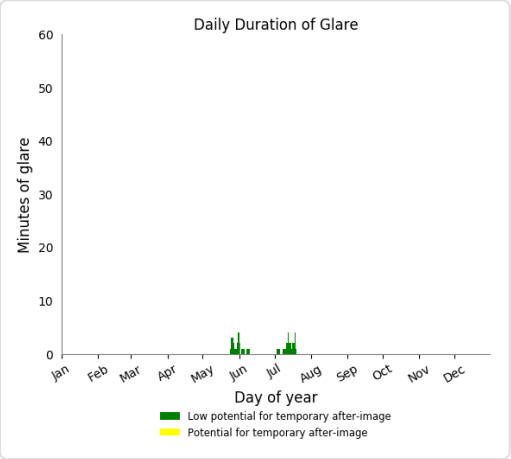
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
51 minutes of green glare





Results for: PV Area 2-1

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	31	0
HNL RWY 22R	29	0
HNL RWY 26L	151	0

Receptor	Green Glare (min)	Yellow Glare (min)
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	55	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

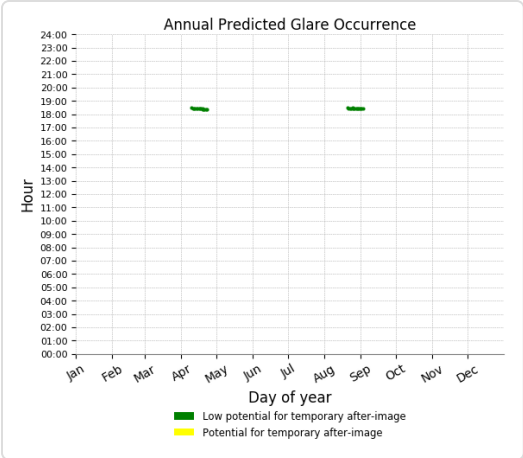
0 minutes of yellow glare
0 minutes of green glare

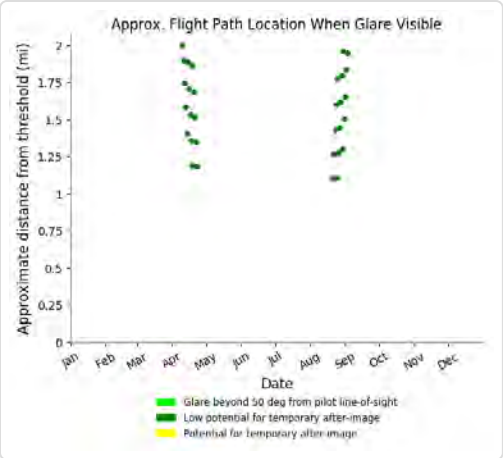
Flight Path: HNL RWY 08R

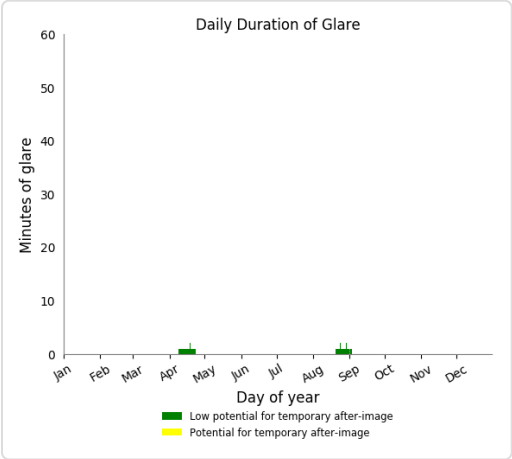
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
31 minutes of green glare



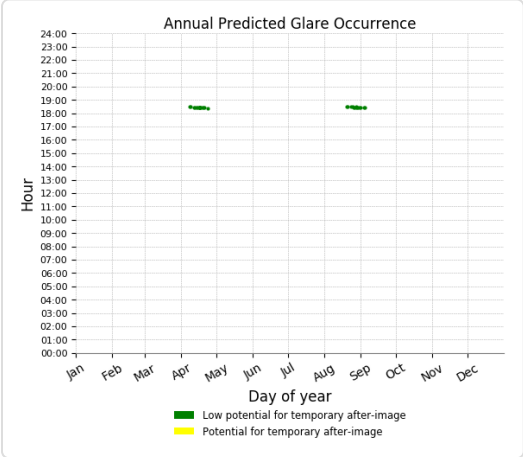


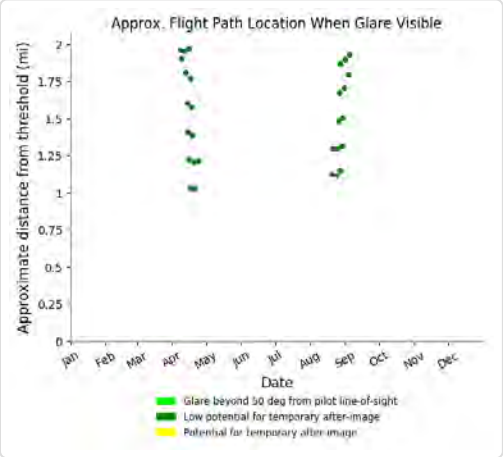


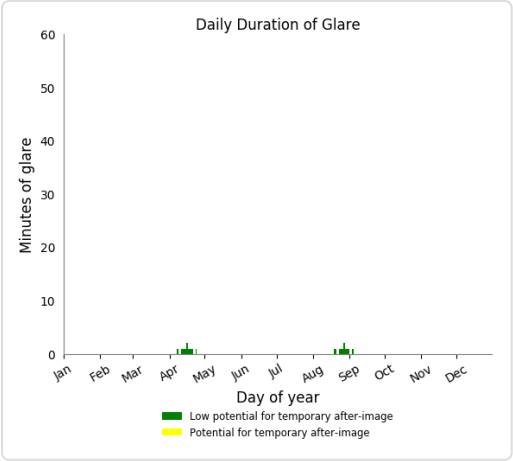
Flight Path: HNL RWY 22R

0 minutes of yellow glare

29 minutes of green glare



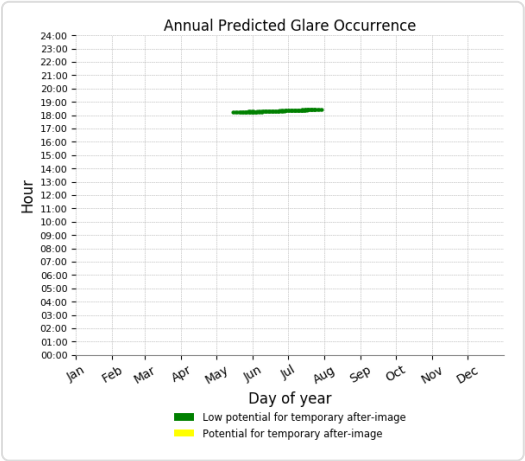


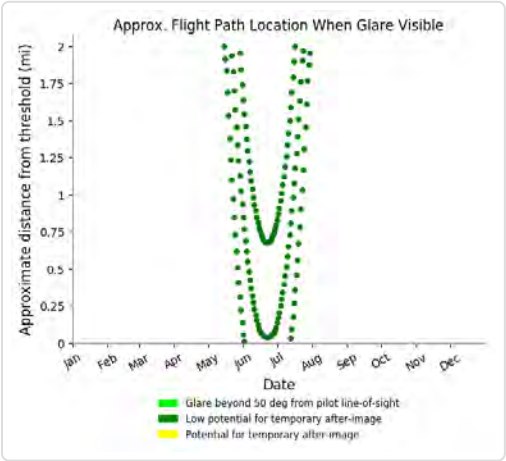


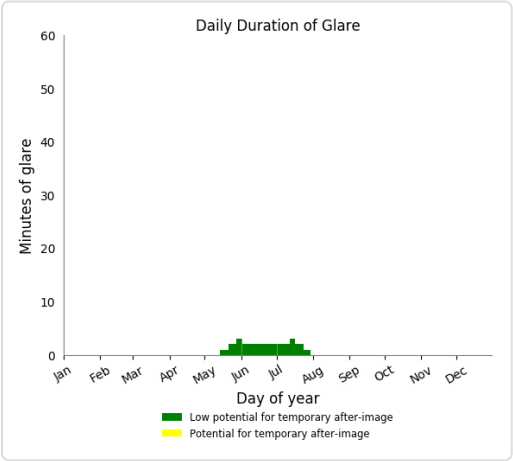
Flight Path: HNL RWY 26L

0 minutes of yellow glare

151 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

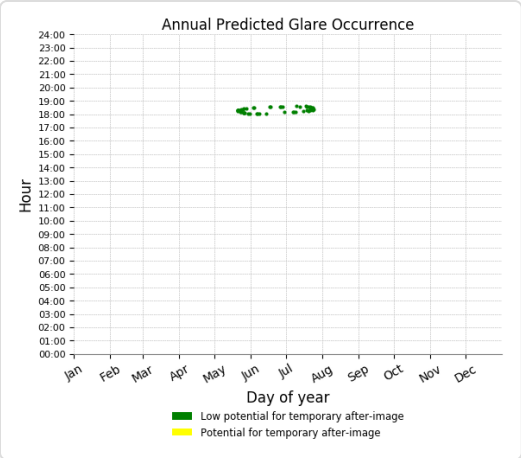
0 minutes of yellow glare
0 minutes of green glare

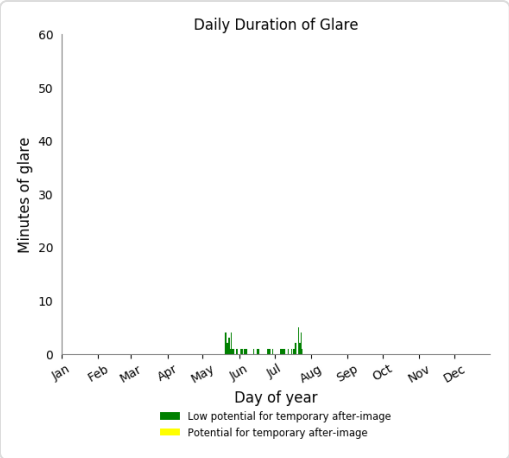
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
55 minutes of green glare





Results for: PV Area 2-2

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	33	0
HNL RWY 22R	32	0
HNL RWY 26L	82	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	65	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

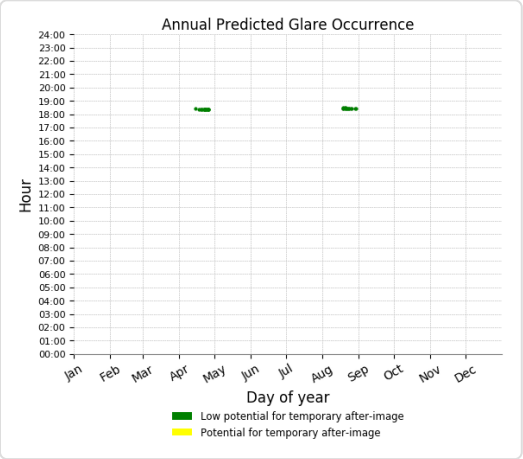
0 minutes of yellow glare
0 minutes of green glare

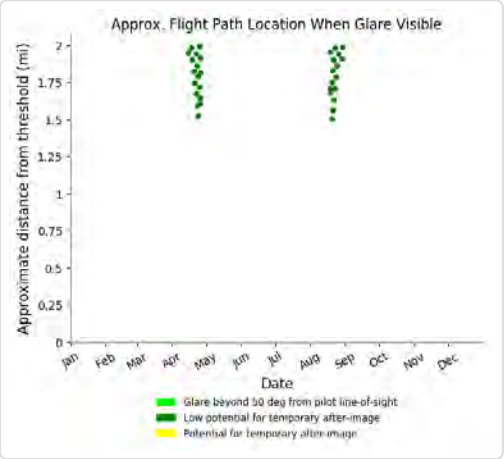
Flight Path: HNL RWY 08R

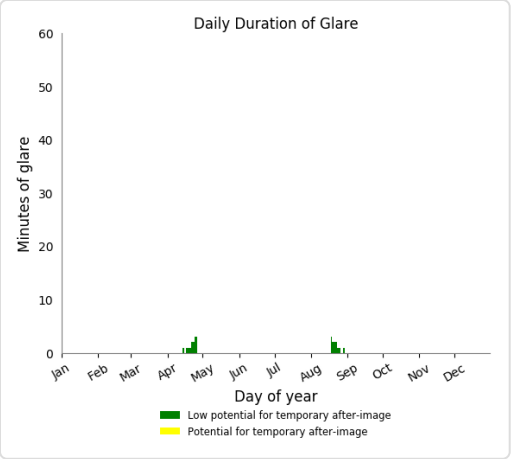
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
33 minutes of green glare



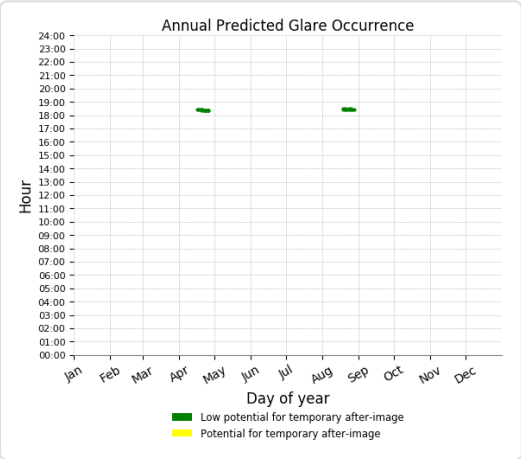


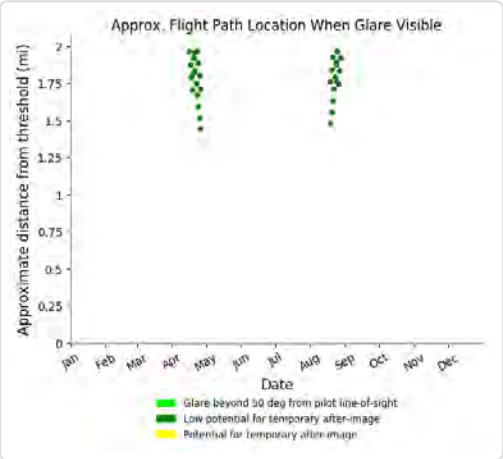


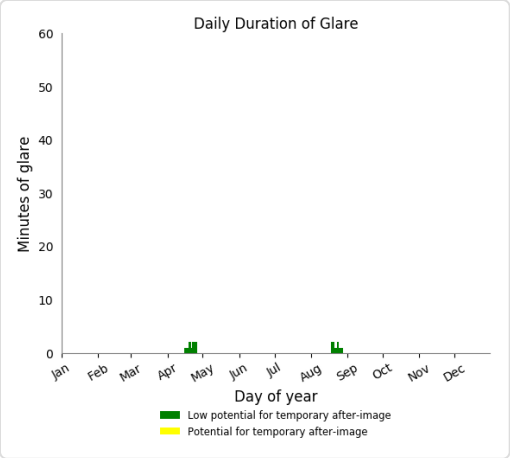
Flight Path: HNL RWY 22R

0 minutes of yellow glare

32 minutes of green glare



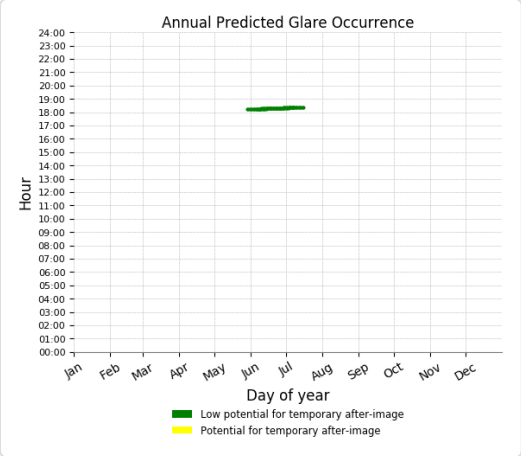


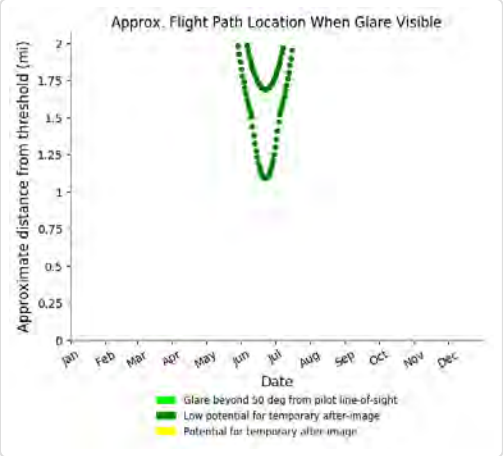


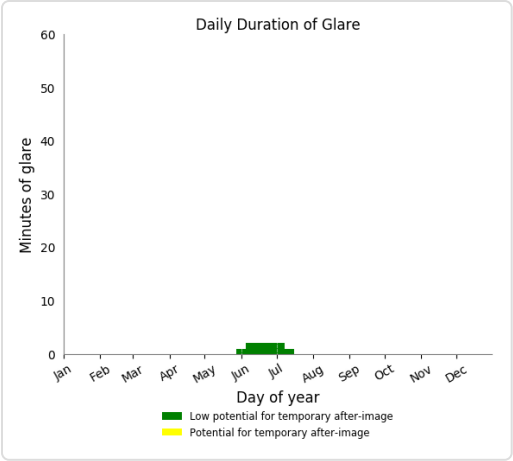
Flight Path: HNL RWY 26L

0 minutes of yellow glare

82 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

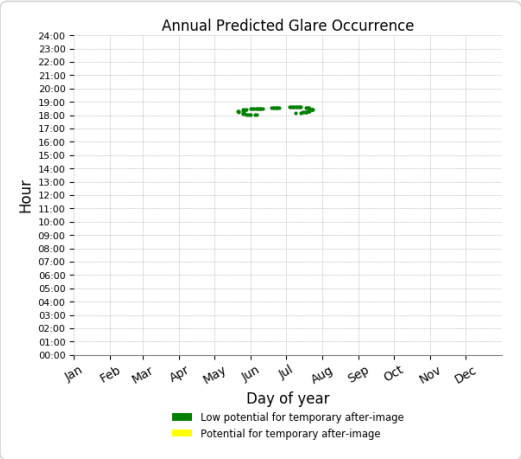
0 minutes of yellow glare
0 minutes of green glare

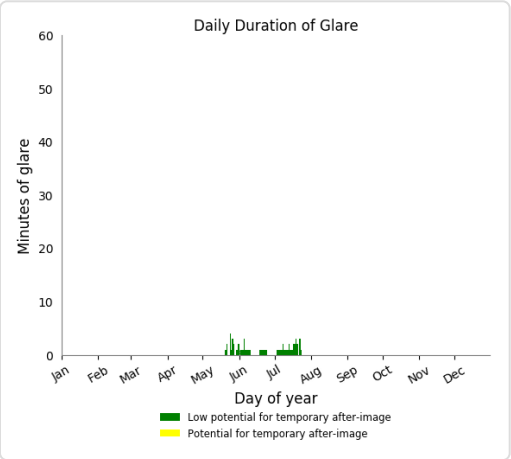
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
65 minutes of green glare





Results for: PV Area 2-3

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	72	0
HNL RWY 22R	75	0
HNL RWY 26L	224	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	46	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

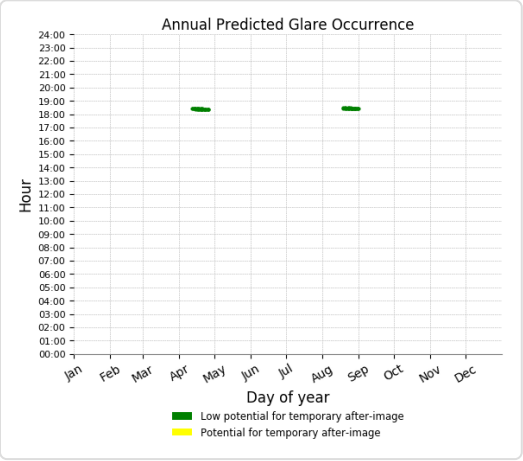
0 minutes of yellow glare
0 minutes of green glare

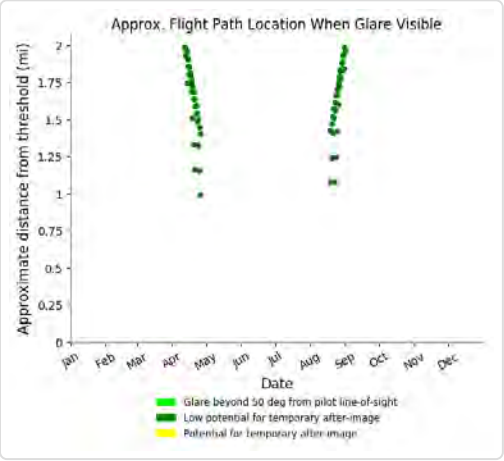
Flight Path: HNL RWY 08R

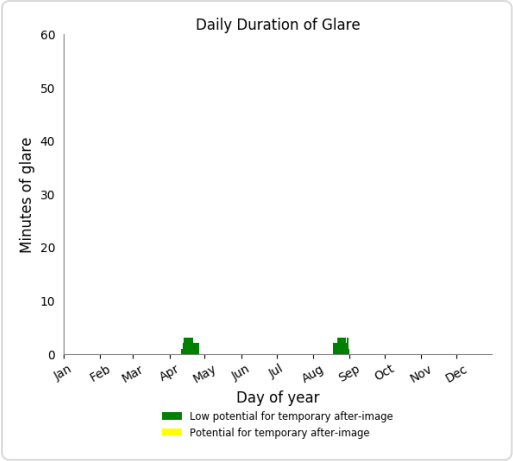
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
72 minutes of green glare



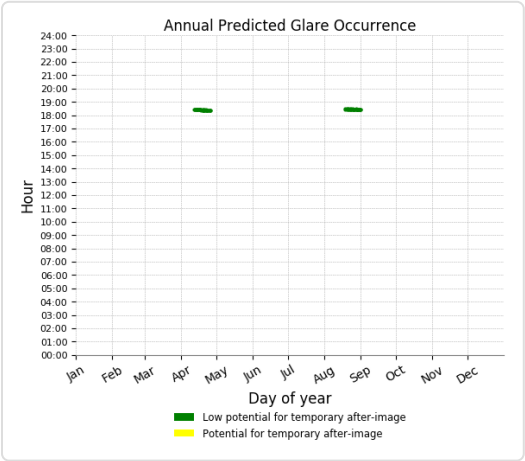


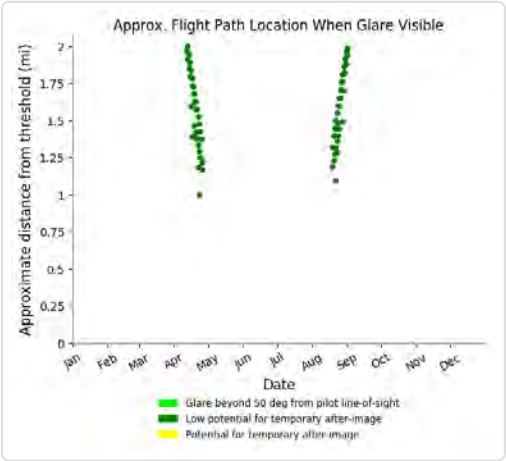


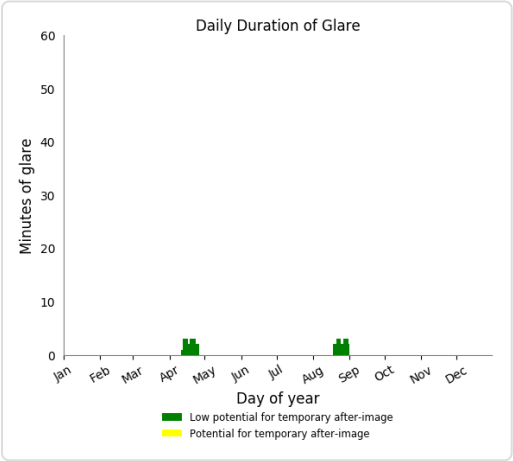
Flight Path: HNL RWY 22R

0 minutes of yellow glare

75 minutes of green glare



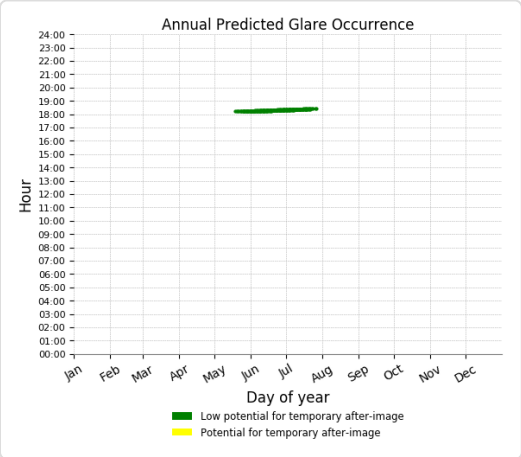


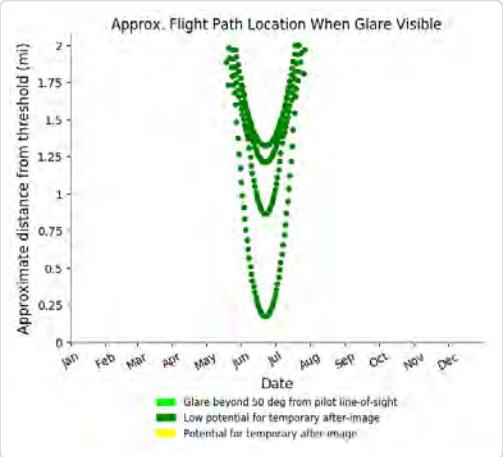


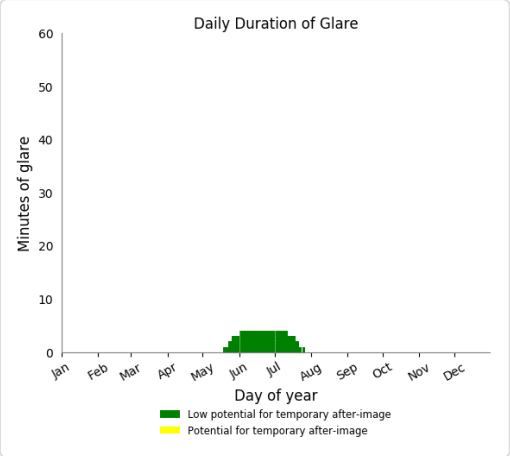
Flight Path: HNL RWY 26L

0 minutes of yellow glare

224 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

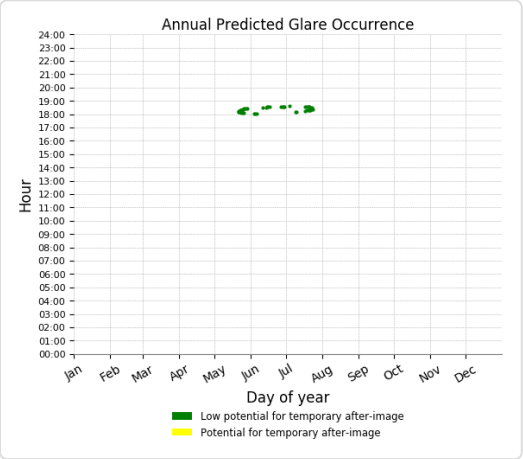
0 minutes of yellow glare
0 minutes of green glare

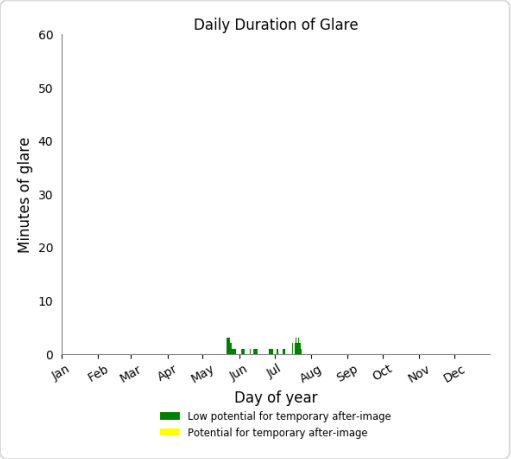
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
46 minutes of green glare





Results for: PV Area 3-1

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	132	0
HNL RWY 22R	133	0
HNL RWY 26L	292	0

Receptor	Green Glare (min)	Yellow Glare (min)
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	103	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

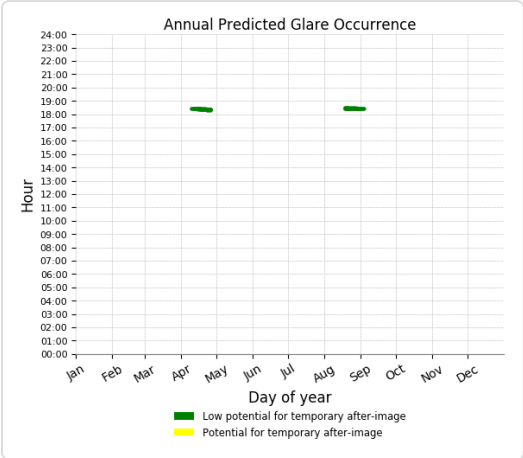
0 minutes of yellow glare
0 minutes of green glare

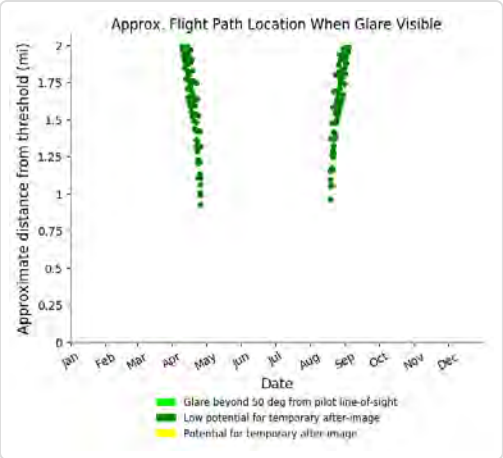
Flight Path: HNL RWY 08R

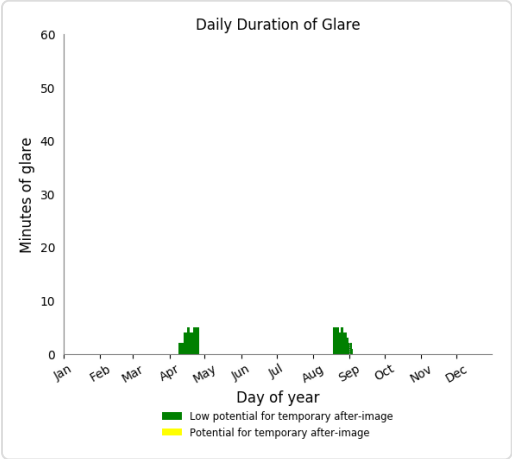
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
132 minutes of green glare



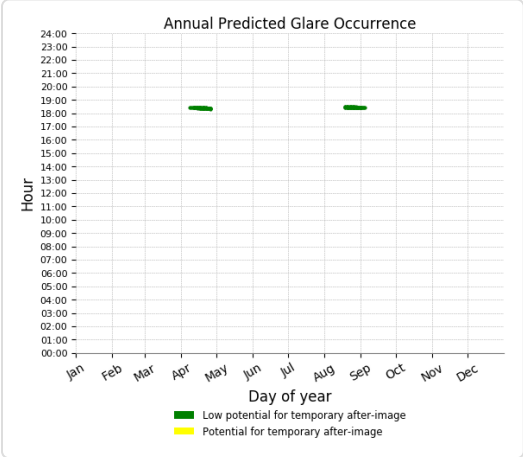


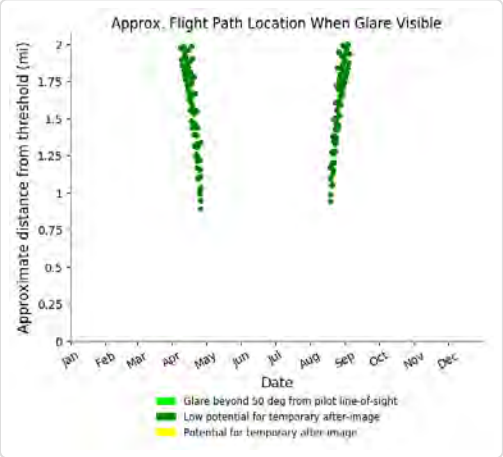


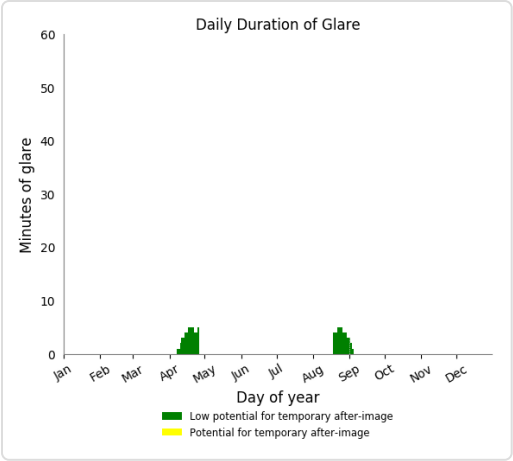
Flight Path: HNL RWY 22R

0 minutes of yellow glare

133 minutes of green glare



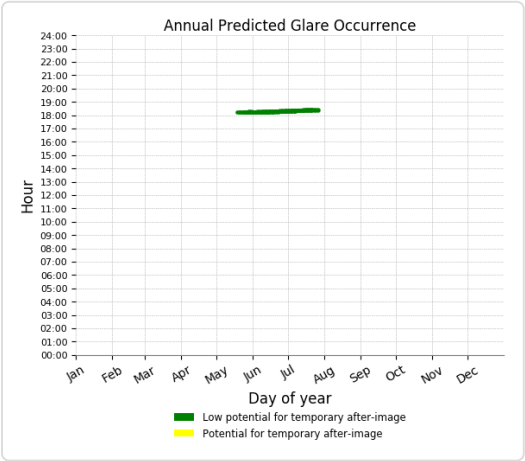


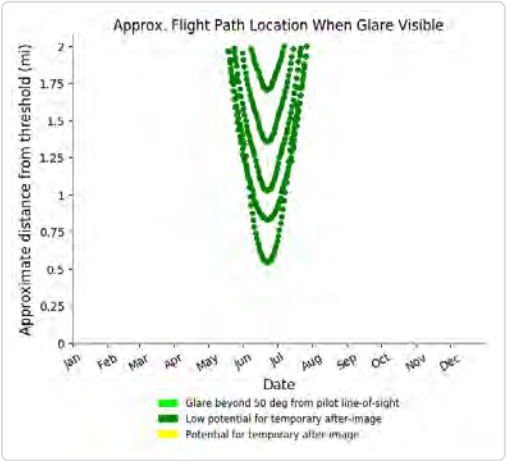


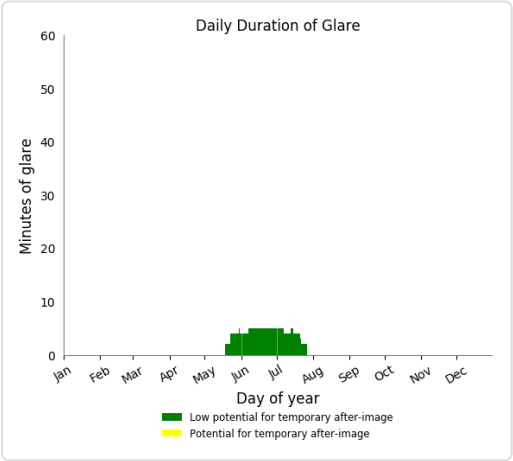
Flight Path: HNL RWY 26L

0 minutes of yellow glare

292 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

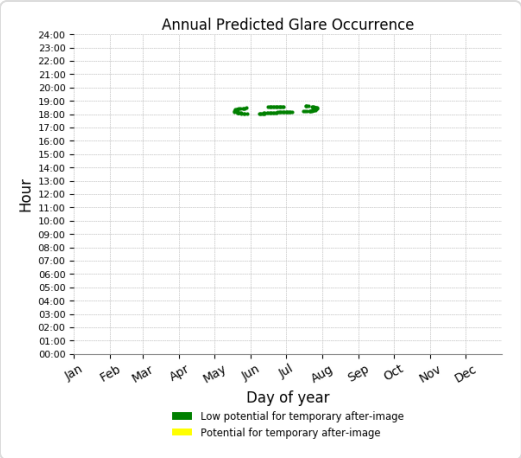
0 minutes of yellow glare
0 minutes of green glare

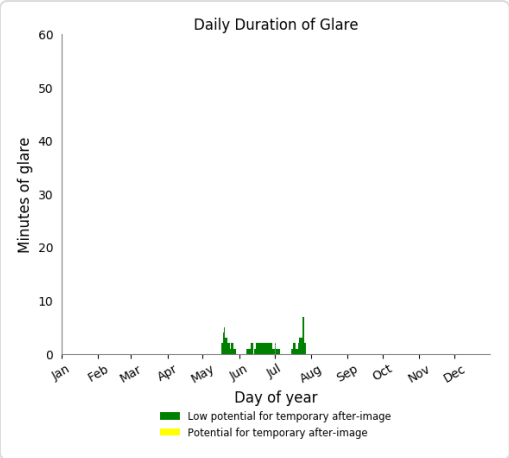
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
103 minutes of green glare





Results for: PV Area 3-2

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	80	0
HNL RWY 22R	81	0
HNL RWY 26L	193	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	97	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

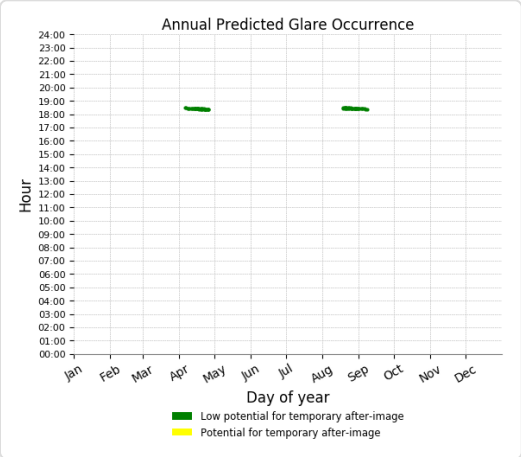
0 minutes of yellow glare
0 minutes of green glare

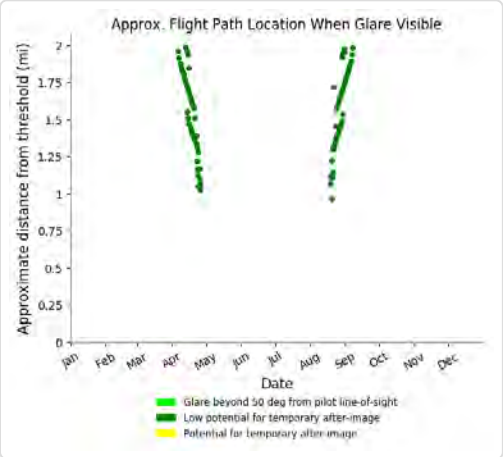
Flight Path: HNL RWY 08R

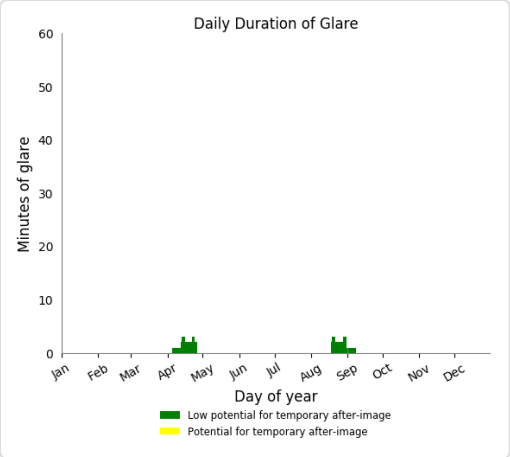
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
80 minutes of green glare



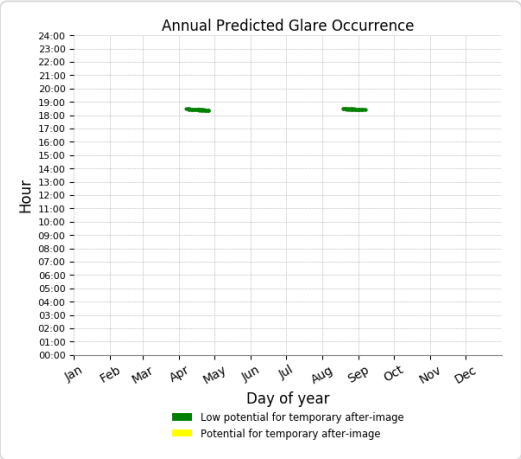


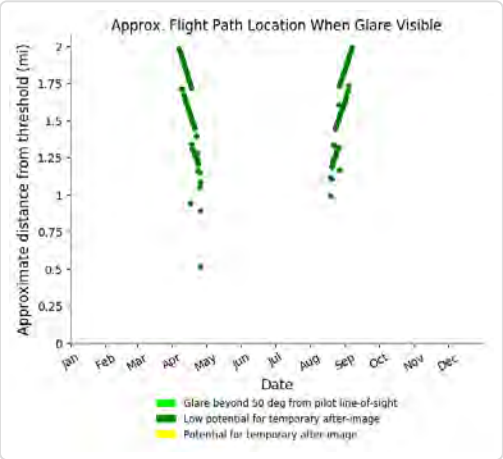


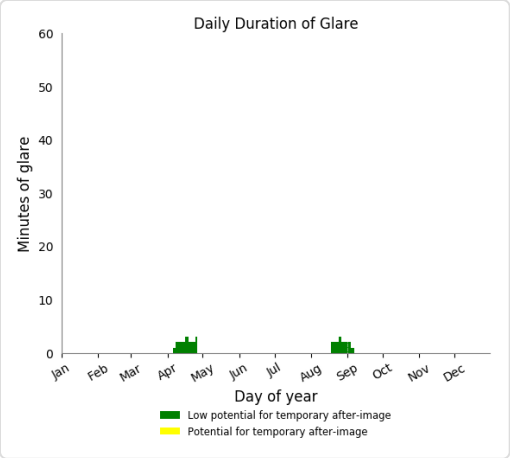
Flight Path: HNL RWY 22R

0 minutes of yellow glare

81 minutes of green glare



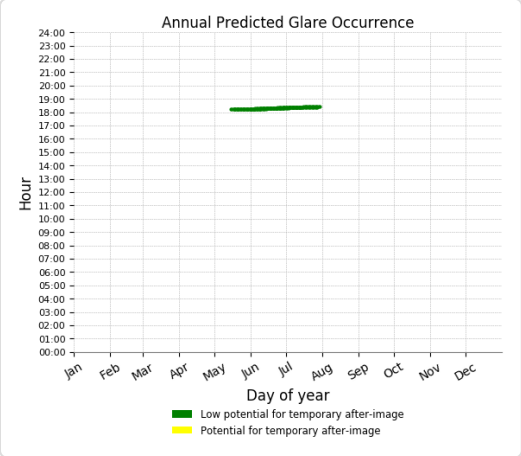


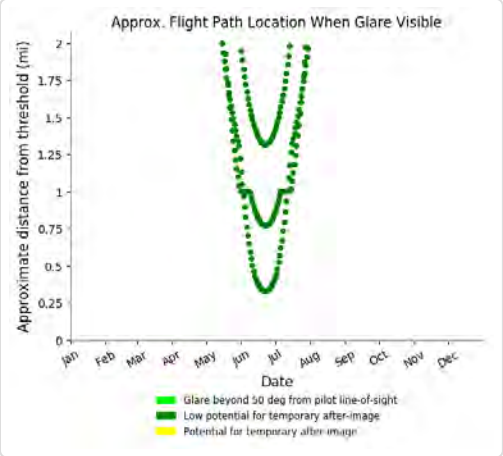


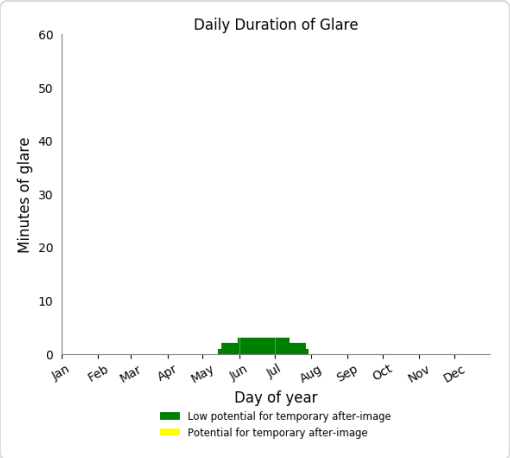
Flight Path: HNL RWY 26L

0 minutes of yellow glare

193 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

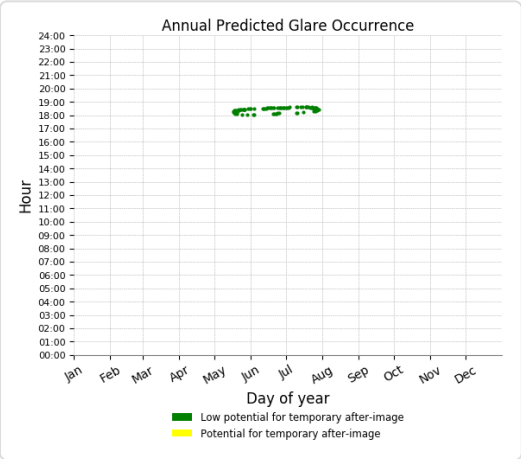
0 minutes of yellow glare
0 minutes of green glare

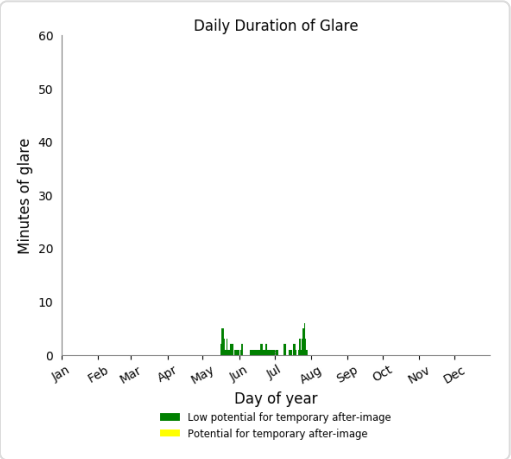
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
97 minutes of green glare





Results for: PV Area 3-3

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	108	0
HNL RWY 22R	110	0
HNL RWY 26L	284	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	65	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

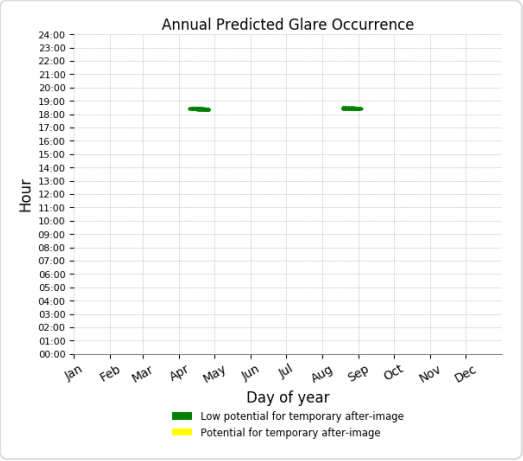
0 minutes of yellow glare
0 minutes of green glare

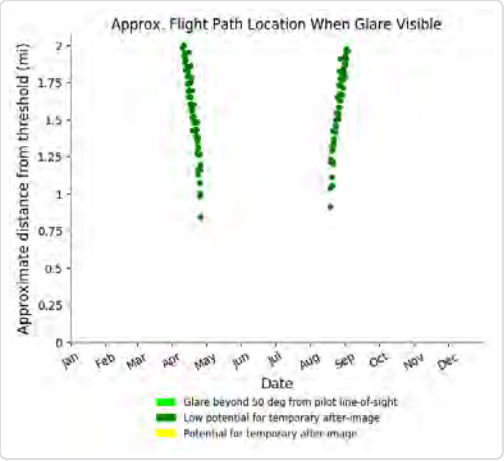
Flight Path: HNL RWY 08R

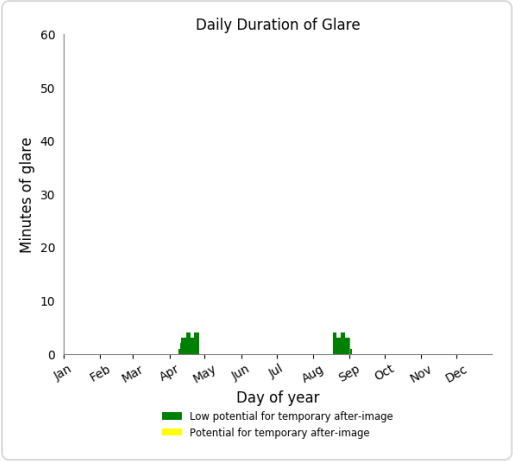
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
108 minutes of green glare



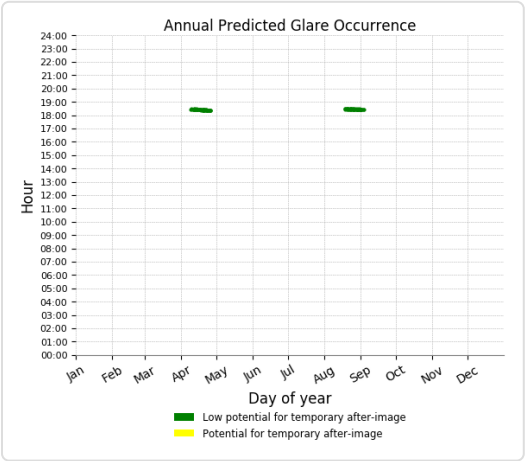


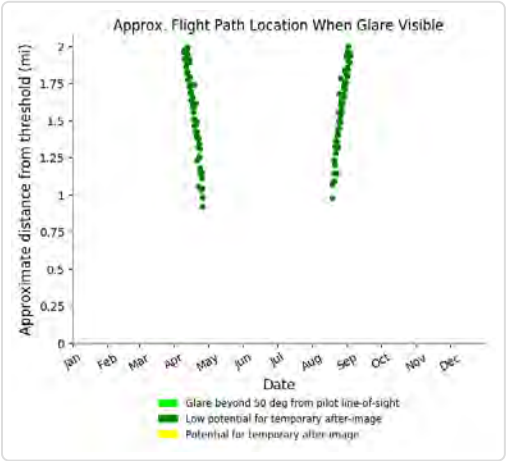


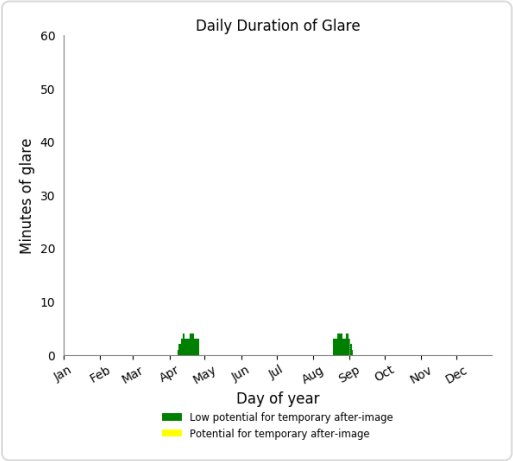
Flight Path: HNL RWY 22R

0 minutes of yellow glare

110 minutes of green glare



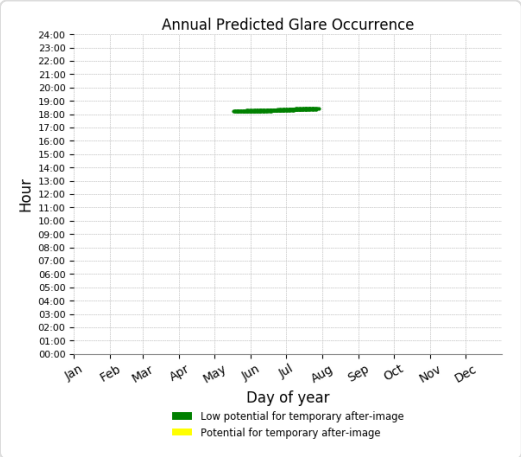


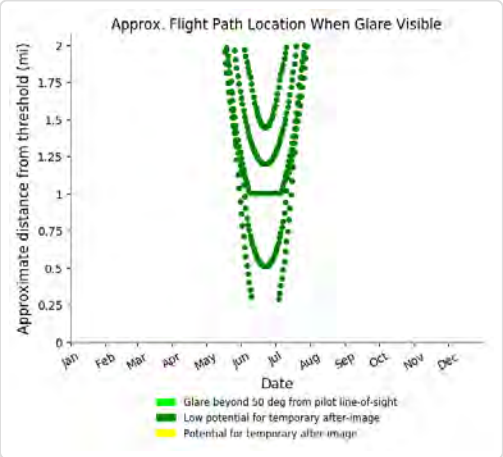


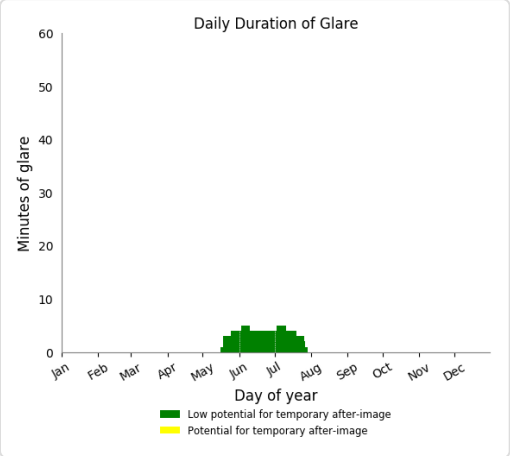
Flight Path: HNL RWY 26L

0 minutes of yellow glare

284 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

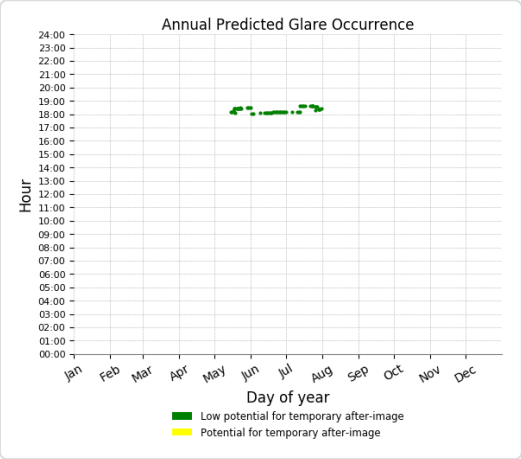
0 minutes of yellow glare
0 minutes of green glare

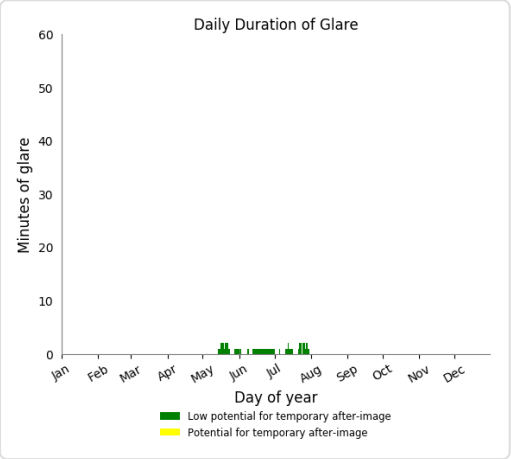
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
65 minutes of green glare





Results for: PV Area 3-4

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	142	0
HNL RWY 22R	135	0
HNL RWY 26L	266	0

Receptor	Green Glare (min)	Yellow Glare (min)
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	80	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

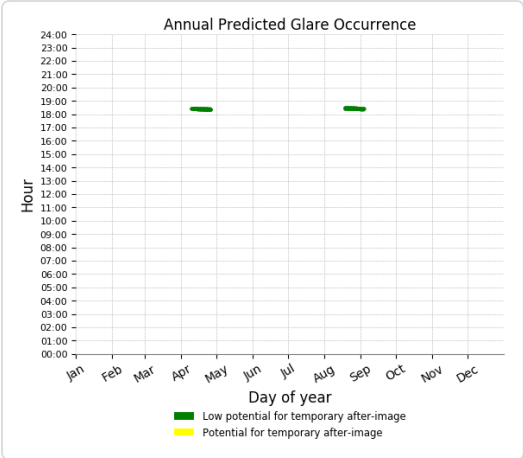
0 minutes of yellow glare
0 minutes of green glare

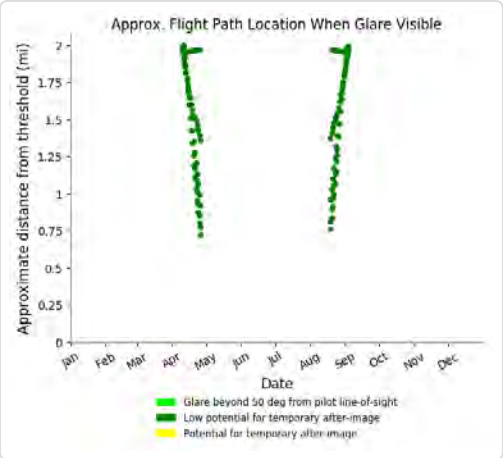
Flight Path: HNL RWY 08R

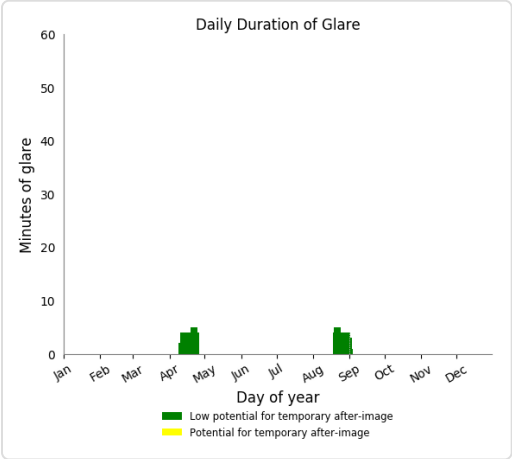
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
142 minutes of green glare



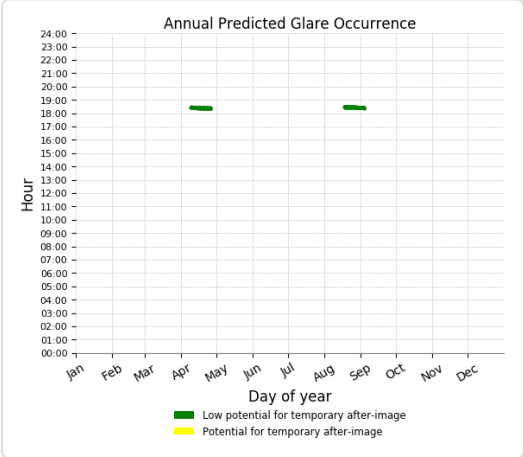


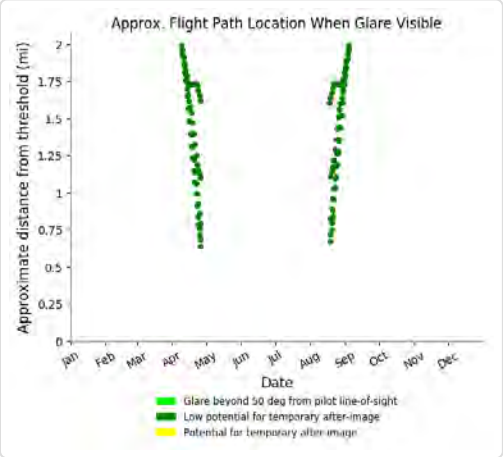


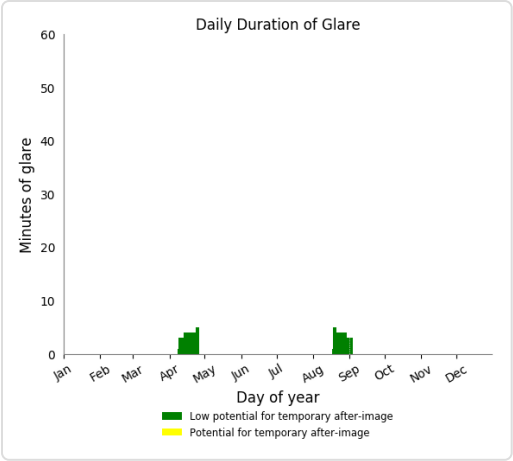
Flight Path: HNL RWY 22R

0 minutes of yellow glare

135 minutes of green glare



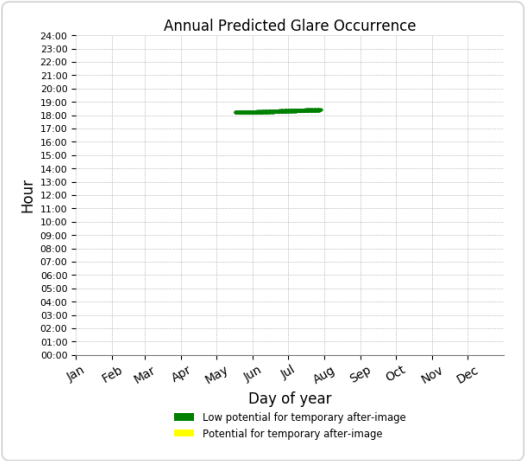


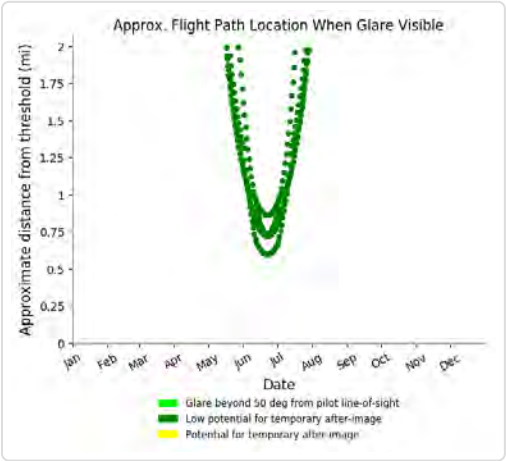


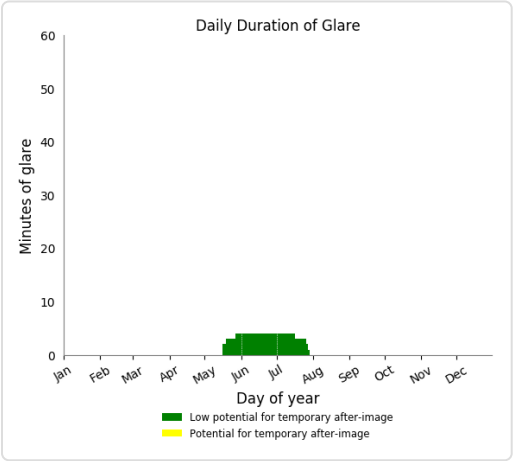
Flight Path: HNL RWY 26L

0 minutes of yellow glare

266 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

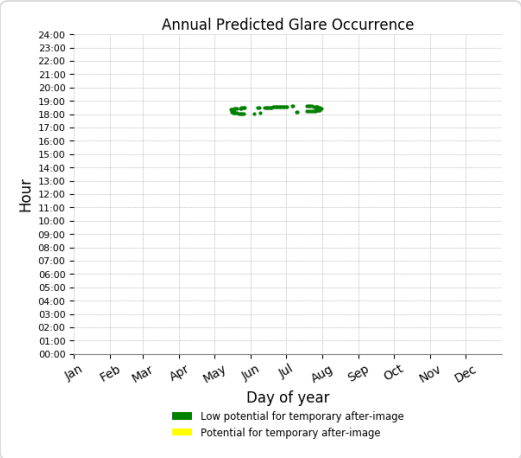
0 minutes of yellow glare
0 minutes of green glare

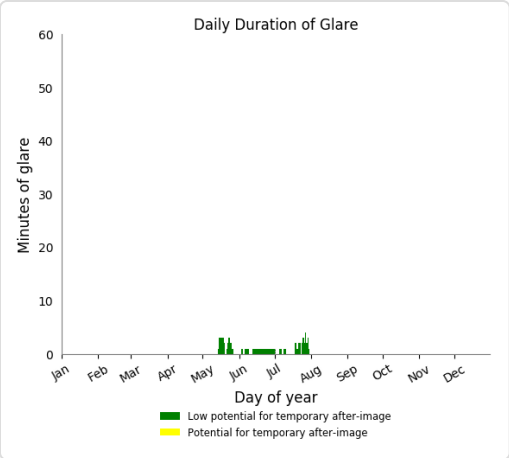
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
80 minutes of green glare





Results for: PV Area 4

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	156	0
HNL RWY 22R	159	0
HNL RWY 26L	311	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	187	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

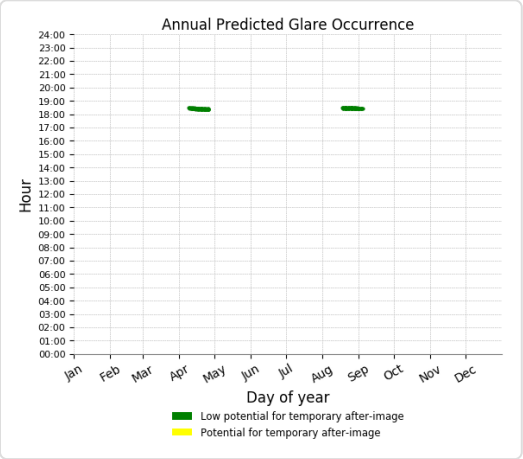
0 minutes of yellow glare
0 minutes of green glare

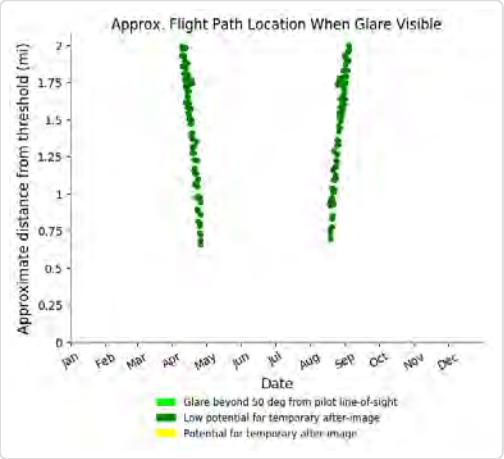
Flight Path: HNL RWY 08R

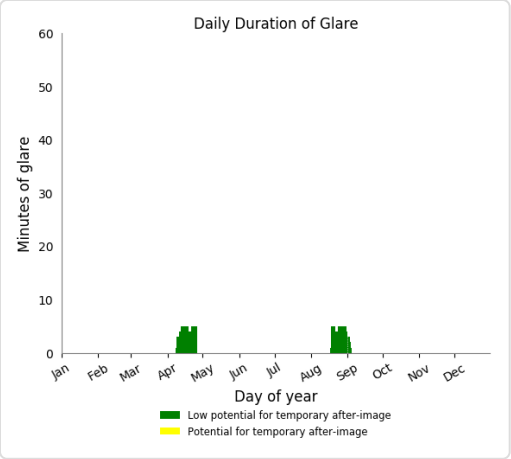
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
156 minutes of green glare



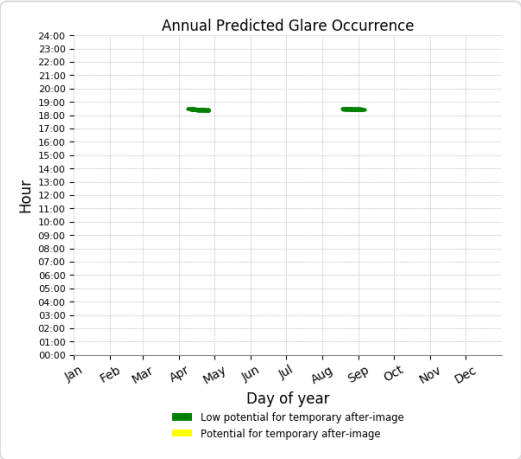


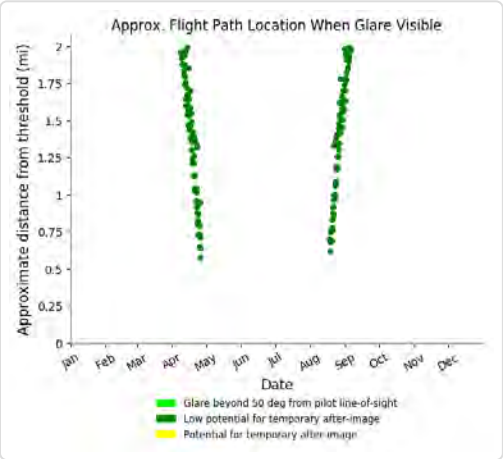


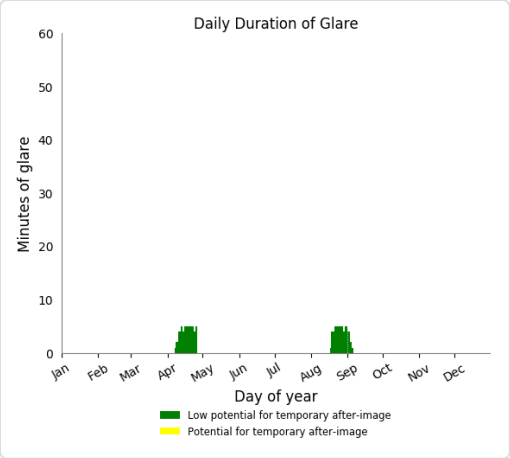
Flight Path: HNL RWY 22R

0 minutes of yellow glare

159 minutes of green glare



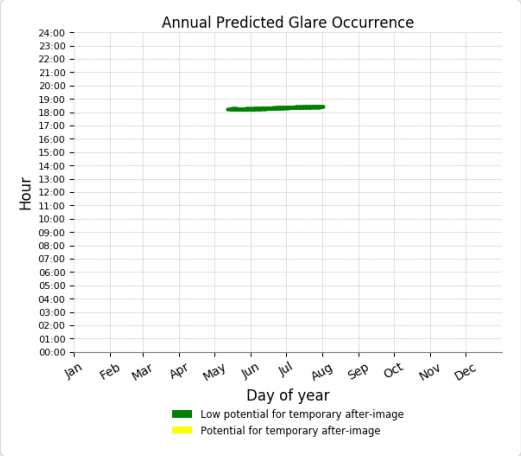


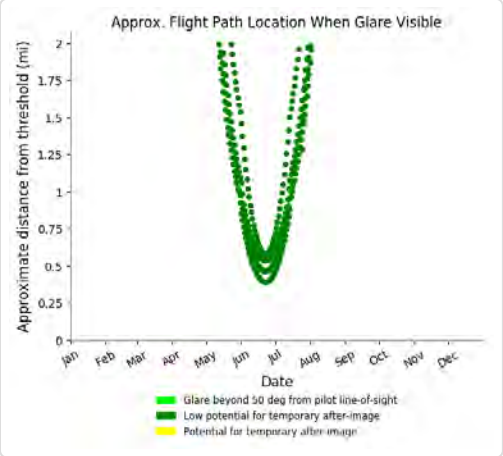


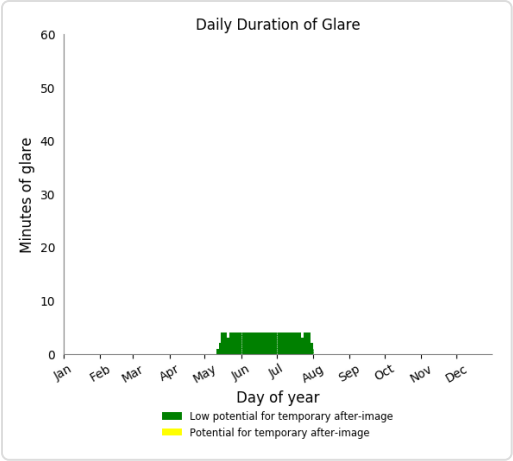
Flight Path: HNL RWY 26L

0 minutes of yellow glare

311 minutes of green glare







Flight Path: JRF RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

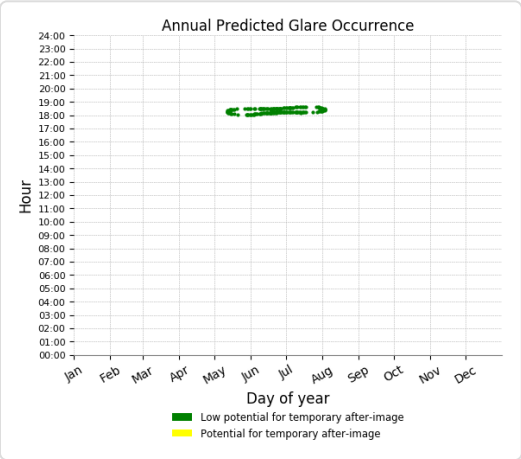
0 minutes of yellow glare
0 minutes of green glare

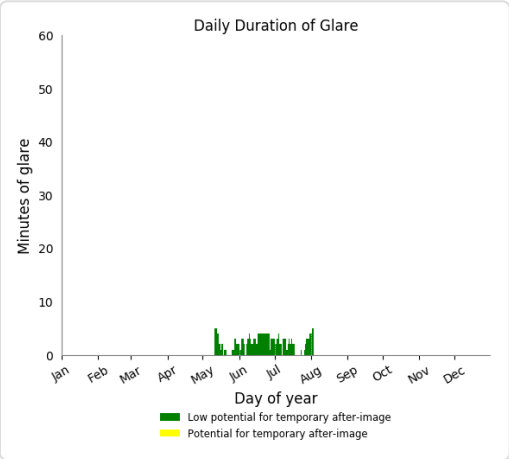
Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
187 minutes of green glare





Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Appendix I
Traffic Impact Assessment Report

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AES WEST OAHU SOLAR PLUS STORAGE PROJECT

TRAFFIC IMPACT ANALYSIS REPORT

KAPOLEI, OAHU, HAWAII

February 18, 2020

Prepared for:
AES Distributed Energy
282 Century Place, Suite 200
Louisville, CO 80027

Austin, Tsutsumi & Associates, Inc.
Civil Engineers • Surveyors
501 Sumner Street, Suite 521
Honolulu, Hawaii 96817-5031
Telephone: (808) 533-3646
Facsimile: (808) 526-1267
E-mail: atahnl@atahawaii.com
Honolulu • Wailuku • Hilo, Hawaii

AES WEST OAHU SOLAR PLUS STORAGE PROJECT
TRAFFIC IMPACT ANALYSIS REPORT

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February 18, 2020

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APPENDICES

AUSTIN, TSUTSUMI & ASSOCIATES, INC. CIVIL ENGINEERS • SURVEYORS
CONTINUING THE ENGINEERING PRACTICE FOUNDED BY H. A. R. AUSTIN IN 1934

TERRANCE S. ARASHIRO, P.E.
ADRIENNE W.L.H. WONG, P.E., LEED AP
DEANNA M.R. HAYASHI, P.E.
PAUL K. ARITA, P.E.
ERIK S. KANESHIRO, L.P.L.S., LEED AP
MATT K. NAKAMOTO, P.E.
GARRETT K. TOKUOKA, P.E.

TRAFFIC IMPACT ANALYSIS REPORT
AES West Oahu Solar Plus Storage Project
Kapolei, Oahu, Hawaii

1. INTRODUCTION

This report documents the findings of a traffic study conducted by Austin, Tsutsumi, and Associates, Inc. (ATA) to evaluate the traffic impacts resulting from the proposed AES West Oahu Solar Plus Storage Project (hereinafter referred to as the "Project") located in Kapolei, Oahu, Hawaii.

1.1 Project Location

The Project is located in Kapolei on the island of Oahu on parcels of land more specifically identified as TMK: (1) 9-2-002:007. The Project will be located on approximately 80 acres of land within the larger mauka lands parcel owned by the University of Hawaii (UH) West Oahu near Makakilo, mauka (mountain side) of the H-1 freeway (H-1).

See Figure 1.1 for Project Location.

1.2 Project Description

The Project is envisioned to develop a solar and battery storage facility on an approximately 80 acre area within the currently undeveloped UH West Oahu mauka lands parcel. The Project will host a 12.5 megawatt (MW) ground-mounted solar photovoltaic (PV) system, 50 MW-hour battery energy storage system, and related interconnection and ancillary facilities. The site will be accessed from Palehua Road at an existing gated entry located north of the Kualakai Parkway intersection with the H-1 westbound on- and off-ramps. The Project is anticipated to be completed by the end of Year 2021.

See Figure 1.2 for a Preliminary Project Site Plan.

AES WEST OAHU SOLAR PLUS STORAGE PROJECT

AustinTsutsumi & ASSOCIATES, INC.
Engineers & Surveyors

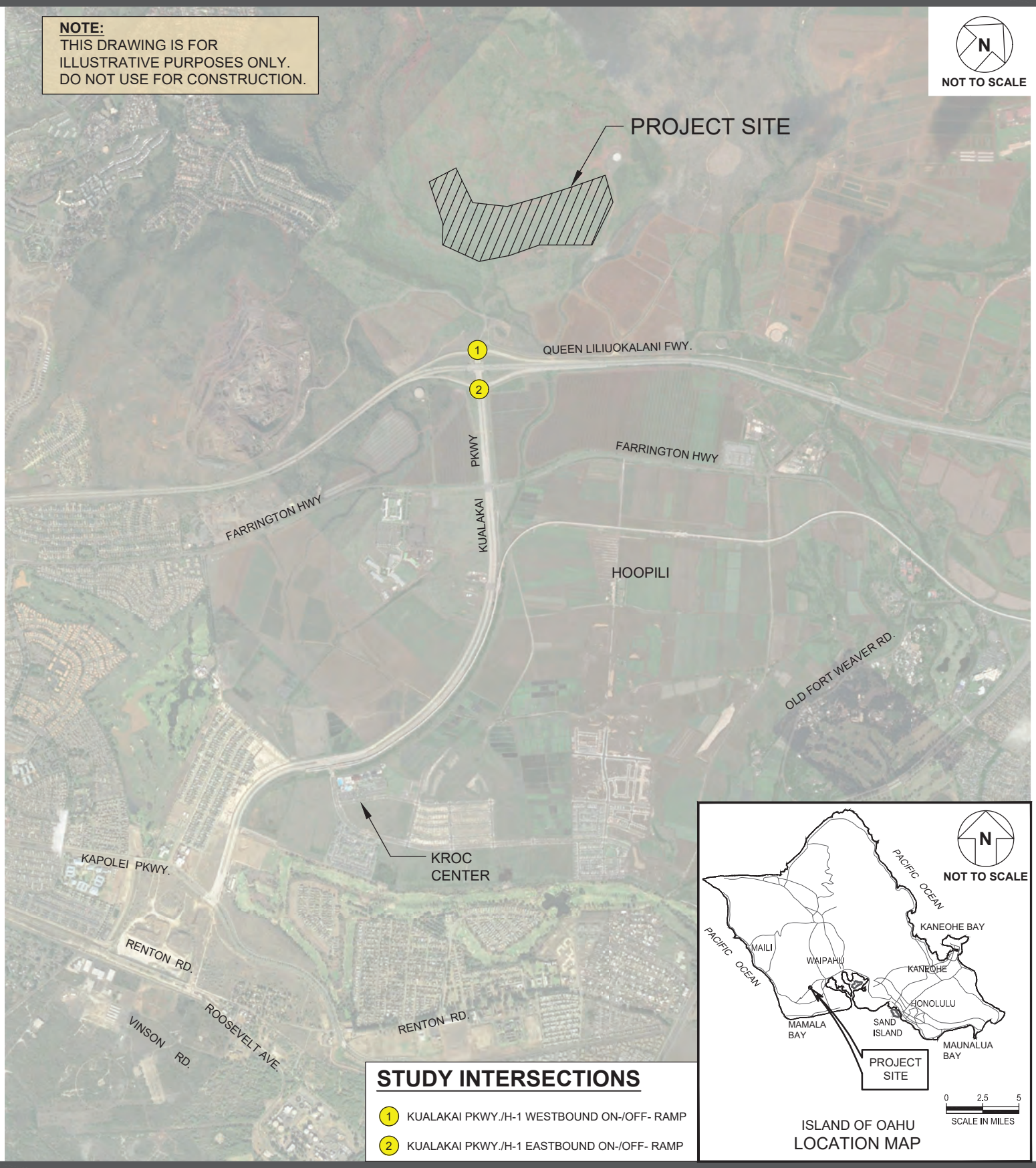
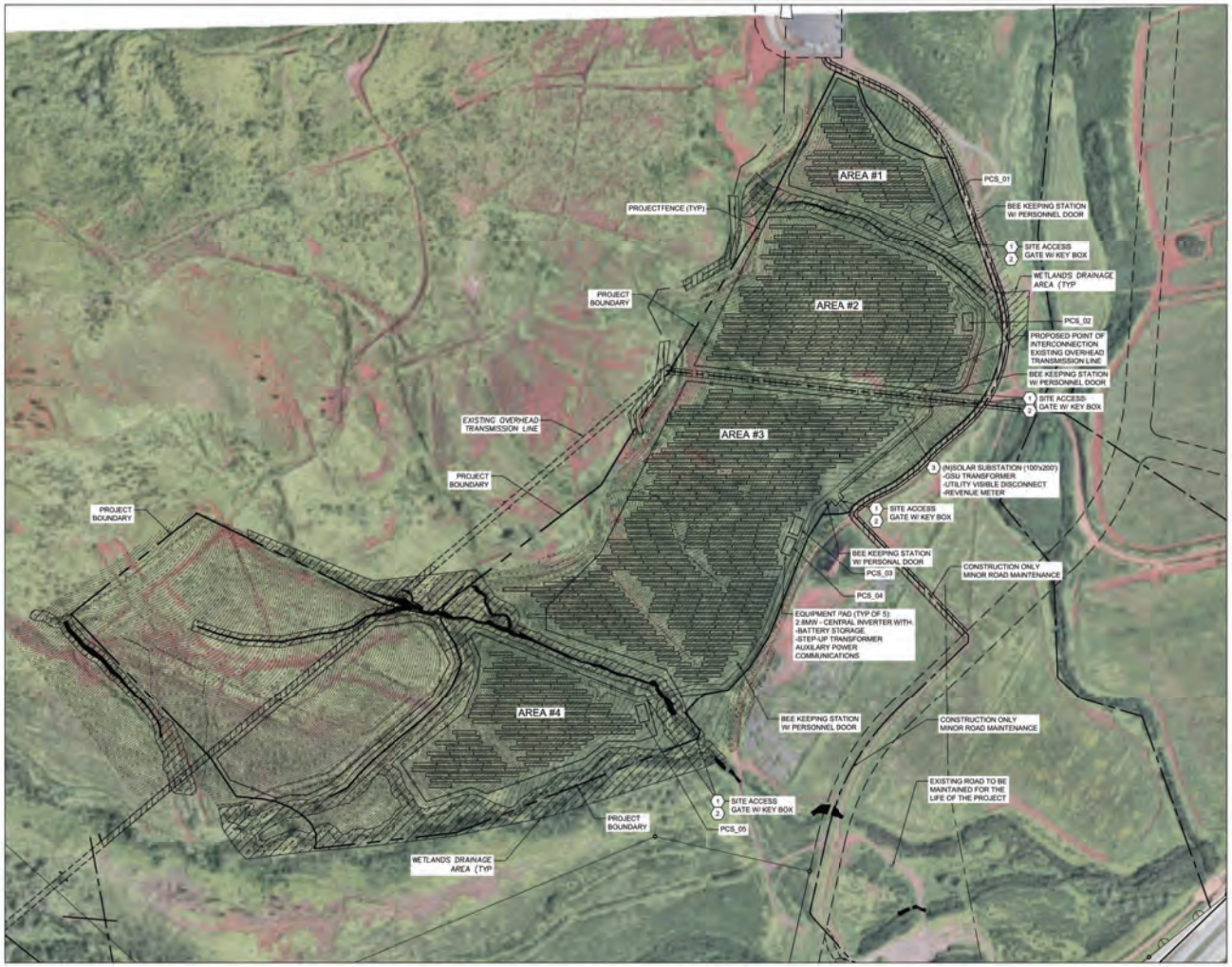


FIGURE 1.1

PROJECT LOCATION

AES WEST OAHU SOLAR PLUS STORAGE PROJECT

AustinTsutsumi & ASSOCIATES, INC.
Engineers & Surveyors



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SITE PLAN OBTAINED FROM AES DISTRIBUTED ENERGY.

LEGEND

PCS — PCS POWER CONVERSION STATION

PCS BOUNDARY

GENERAL NOTES

1. REFER TO CIVIL DRAWINGS FOR PERIMETER FENCE, ROADS AND GATES.
2. REFER TO SOLTEC DRAWINGS FOR TRACKER PILE LOCATIONS.
3. PV SITE WILL NOT HAVE SITE LIGHTING OR SECURITY CAMERAS.

KEYED NOTES

1. CONTRACTOR TO FURNISH AND INSTALL KNOX BOX ACCESS ENCLOSURE AT ENTRANCE TO EVERY ROAD.
2. INSTALL FENCE GROUNDING. SEE E511 FOR DETAILS.
3. SUBSTATION LOCATION IS PENDING, AND SUBJECT TO CHANGE.

DESIGN SPECIFICATIONS

DC SYSTEM VOLTAGE		1500V
ARRAY CAPACITY		17.407MW DC
		12.5MW AC POI
DC/AC RATIO		1.39
MODULE		JINKO - EAGLE BIFACIAL 4C-72M
MODULE WATTAGE		405Wp
MODULE QUANTITY	AREA #1	3,192
	AREA #2	12,656
	AREA #3	20,776
	AREA #4	6,384
	AREA #5	-
	TOTAL	43,008
STRINGS		1,536 STRINGS OF 28 MODULES
INVERTERS (QTY)		(5) 2.8MW CENTRAL INVERTERS WITH INTEGRAL BESS DC/DC CONVERSION
BATTERY STORAGE		(10) 1,300kW BATTERY CONTAINERS
RACKING SYSTEM		FIXED TILT 15°
AZIMUTH		0°
PANEL TILT ANGLE		15°
ROW TO ROW SPACING		21' - 7"
GROUND COVER RATIO		0.62 (TBC)
FENCED IN AREA	AREA #1	APPROX. 4.6 ACRES
	AREA #2	APPROX. 13.28 ACRES
	AREA #3	APPROX. 22.04 ACRES
	AREA #4	APPROX. 8.18 ACRES
	AREA #5	APPROX. 7.79 ACRES
	TOTAL	APPROX. 56.23 ACRES

1. MODULES ARE POSITIONED TWO DEEP IN PORTRAIT ORIENTATION.

NOTE: EACH TRACKER CONTAINS (2) STRINGS OF (28) PV MODULES.

2 TRACKER STRING DETAIL
SCALE: NONE

N W E S

SCALE: 1" = 200'
0 200' 400' FT

AES Distributed Energy

AES Distributed Energy
282 Century Pl. Suite 2000
Louisville, CO 80027 USA

HDR

SYSTEM DESCRIPTION

REVISIONS

REV	BY	DATE	DESCRIPTION

PE STAMP

OVERALL SITE PLAN
WEST OAHU SOLAR
AES DE
OAHU, HI

PROJECT NUMBER 19537
PHASE ISSUED FOR REVIEW
MILESTONE 30% DESIGN
ELECTRICAL DESIGNER
STRUCTURAL DESIGNER
DATE 12-04-2019
SCALE 1"=200'
TITLE
DRAWING C200

FIGURE 1.2

PRELIMINARY SITE PLAN

2. METHODOLOGY

2.1 Study Methodology

This study will address the following:

- Assess existing traffic operating conditions at key intersections during the weekday morning (AM) and afternoon (PM) peak hours of traffic within the study area.
- Traffic projections for Year 2021 without the Project including traffic generated by other known developments in the vicinity of the Project in addition to an ambient growth rate. These other known developments are projects that are currently under construction or known new/future developments that are anticipated to affect traffic demand and operations within the study area.
- Trip generation and traffic assignment characteristics during and after construction for the proposed Project.
- Traffic projections for Year 2021 during Project construction, which includes Year 2021 without Project traffic volumes in addition to traffic volumes generated during construction.
- Traffic projections for Year 2021 with the Project, which includes Year 2021 without Project traffic volumes in addition to traffic volumes generated by the Project.
- Recommendations as needed to mitigate any impacts resulting from Year 2021 conditions during construction or at Project completion.

2.2 Intersection Analysis

Level of Service (LOS) is a qualitative measure used to describe the conditions of traffic flow at intersections, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F. The Highway Capacity Manual (HCM), 6th Edition, includes methods for calculating volume to capacity ratios, delays, and corresponding Levels of Service that were utilized in this study. LOS definitions for signalized and unsignalized intersections are provided in Appendix B.

Analyses for the study intersections were performed using the traffic analysis software Synchro, which is able to prepare reports based on the methodologies described in the HCM. These reports contain control delay results as based on intersection lane geometry, signal timing, and hourly traffic volumes. Based on the vehicular delay at each intersection, a LOS is assigned to each approach and intersection movement as a qualitative measure of performance. These results, as confirmed or refined by field observations, constitute the technical analysis that will form the basis of the recommendations outlined in this report.

2.3 Study Area Intersection Analysis

Intersection analysis within the Project's study area was performed on the following intersections due to their proximity to the Project:

- Palehua Road/H-1 Freeway Westbound on-/off-ramp (Signalized)
- Kualakai Parkway/H-1 Freeway Eastbound on-/off-ramp (Signalized)

3. EXISTING TRAFFIC CONDITIONS

The existing conditions scenario represents the traffic conditions within the Project area as it currently stands, with no build-out of the Project.

3.1 Roadway System

The following are brief descriptions of the studied roadways within the vicinity of the Project:

Palehua Road is generally a two-way, two-lane, undivided, east-west private roadway that begins at its intersection with the H-1 Westbound on-/off-ramps and terminates to the west as the entrance to Makakilo Quarry. The portion of the roadway nearest the Project Access serves as a haul road for Makakilo Quarry and is used exclusively by local traffic. Currently, there is no posted speed limit.

Kualakai Parkway is generally a two-way, 4-6 lane, divided, north-south State roadway that begins at its intersection with the H-1 Westbound on-/off-ramps and terminates to the south at its intersection with Kapolei Parkway. Kualakai Parkway provides regional access to and from locations such as Hoopili, Ka Makana Alii, and the Kroc Center. The posted speed limit is 35 miles per hour (mph).

H-1 Freeway is generally an east-west, two-way divided freeway which begins to the west in the vicinity of the Palailai Interchange then extends through Kapolei, Ewa, Waipahu, Airport Industrial Area and Central Honolulu before terminating to the east and continuing on as Kalanianaole Highway. The H-1 Freeway is approximately 27.1 miles long.

In the vicinity of the Project the H-1 Freeway is a two-way, six lane divided highway which provides three lanes in each direction with a posted speed limit of 60 miles per hour (mph).

3.2 Existing Traffic Volumes

Traffic data utilized in this report was collected on Thursday, October 24, 2019. Traffic count data is provided in Appendix A. Based on the traffic count data, the weekday AM and PM peak hours of traffic were determined to occur between 6:30 AM and 7:30 AM and between 3:45 PM to 4:45 PM, respectively.

3.3 Existing Observations and Intersection Analysis

Traffic along Kualakai Parkway is generally higher in the northbound direction during the AM peak hour and higher in the southbound direction during the PM peak hour largely due to commuter traffic.

Palehua Road & H-1 Freeway Westbound on-/off-ramp – The signalized intersection operates at LOS B or better during both AM and PM peak hours and does not experience significant delays or queuing during either peak period. All individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection operates at overall LOS A and does not experience significant delays or queuing during the AM or PM peak hours. All individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

No pedestrians were observed during the AM or PM peak hours.

See Figure 3.1 for existing lane configuration, traffic volumes, and LOS for the study intersections. See Table 4.1 for a LOS comparison between Existing Conditions and Year 2021 without Project conditions.

AES WEST OAHU SOLAR PLUS STORAGE PROJECT

AustinTsutsumi & ASSOCIATES, INC.
Engineers & Surveyors

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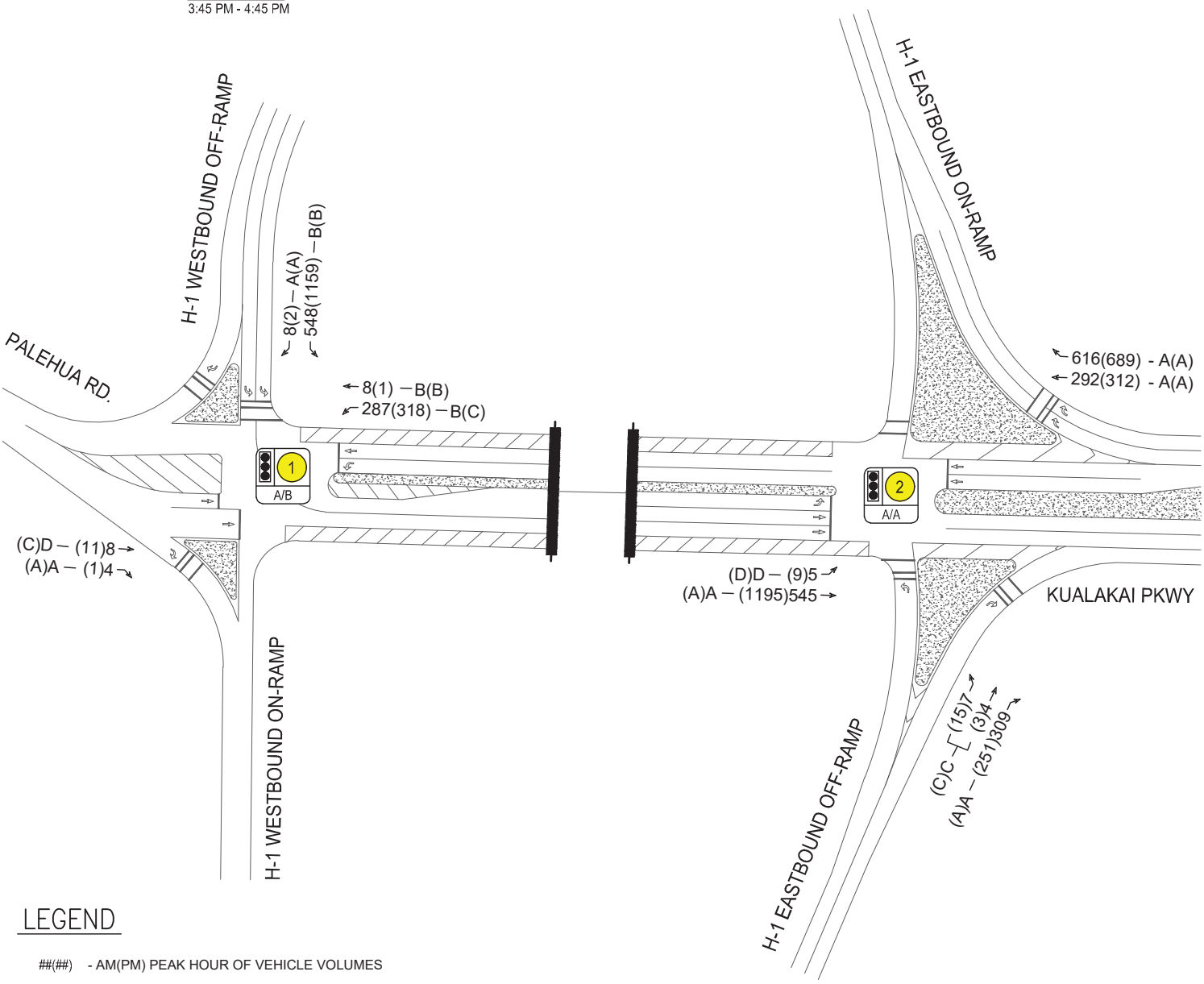
DATE OF COUNTS:
OCTOBER 24, 2019

AM PEAK HOUR:
6:30 AM - 7:30 AM

PM PEAK HOUR:
3:45 PM - 4:45 PM



LEGEND

##(##) - AM(PM) PEAK HOUR OF VEHICLE VOLUMES

Y
X/X
- SIGNALIZED INTERSECTION Y, OVERALL AM/PM LOS

X(X) - AM(PM) LOS

FIGURE 3.1

EXISTING CONDITIONS, LANE CONFIGURATIONS, TRAFFIC VOLUMES AND LOS

TABLE 3.1: LOS SUMMARY TABLE
EXISTING CONDITIONS

Intersection	Existing Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps						
NB LT	15.8	0.75	B	27.8	0.84	C
NB TH	10.9	0.02	B	17.1	0.00	B
WB LT	12.8	0.65	B	15.8	0.82	B
WB RT	-	-	A	-	-	A
SB TH	30.2	0.41	C	39.9	0.45	D
SB RT	-	-	A	-	-	A
OVERALL	13.9	-	A	18.6	-	B
2. Kualakai Pkwy./H1 EB Ramps						
NB TH	7.9	0.36	A	5.6	0.20	A
NB RT	-	-	A	-	-	A
EB LT/TH	28.8	0.52	C	30.7	0.55	C
EB RT	-	-	A	-	-	A
SB LT	48.4	0.51	D	39.2	0.53	D
SB TH	3.8	0.33	A	3.7	0.56	A
OVERALL	5.8	-	A	4.6	-	A

Directions
NB = Northbound approach
SB = Southbound approach
EB = Eastbound approach
WB = Westbound approach

4. YEAR 2021 TRAFFIC CONDITIONS WITHOUT PROJECT

The Year 2021 was selected to reflect the Project completion year. The Base Year 2021 scenario represents the traffic conditions within the study area without the Project. Traffic projections were formulated by applying a defacto growth rate to the existing 2019 traffic count volumes as well as trips generated by known future developments in the vicinity of the Project.

4.1 Defacto Growth Rate

Projections for Year 2021 traffic were based upon the Hawaii Department of Transportation (HDOT) statewide annual count data and Hoopili TIAR, which was revised in 2014 by ATA. This defacto growth rate takes into account the continued development of the Ewa-Kapolei region, including Hoopili. By the Year 2021, Hoopili is anticipated to have completed Phase 1A and be in the process of finishing Phases 1B and 1C. These phases are anticipated to introduce over 3,000 new housing units including single-family housing, multi-family housing, and apartments, as well as neighborhood businesses, a new elementary school and a new high school.

- Kualakai Parkway – From 2014-2019 the annual growth rate was found to be 8% from the HDOT annual count data. This increase was likely due to the completion of Ka Makana Alii (2016), continued expansion of the University of Hawaii West Oahu, as well as other developments in the area. Traffic is anticipated to continue to grow at this rate as Hoopili and other developments are constructed.
- H-1 Eastbound & Westbound Freeway on-/off-ramps – Assumed the same annual growth rate of 8% as Kualakai Parkway during AM(PM) peak hours since all traffic going to and from the on-/off-ramps utilize Kualakai Parkway.

4.2 Planned Roadway Improvements

By Year 2021 without the Project, no major roadway improvements are planned to be constructed in the area. The following roadway improvements have been identified in the ORTP as future roadway improvements that may be constructed beyond Year 2021 and were therefore, not included in this TIAR.

Makakilo Drive Extension – In the vicinity of Palehua Road, Makakilo Drive is to be extended south to the Kualakai Interchange as a four-lane roadway, connecting Makakilo Drive to Kualakai Parkway between 2019-2029. At the time of this report, no information regarding the completion date of the Makakilo Drive Extension was available and was therefore not assumed to be completed prior to the Project.

Kualakai Parkway Extension – Kualakai Parkway is anticipated to be extended from Kapolei Parkway to Franklin D Roosevelt Avenue.

4.3 Year 2021 Analysis without Project

Palehua Road & H-1 Freeway Westbound on-/off-ramp – With the projection of the 8% annual growth rate from 2019 to 2021, the signalized intersection is anticipated to operate at an overall LOS B(C) during AM(PM) peak hours of traffic, respectively. Degradation of LOS from existing conditions can be attributed to background traffic growth in the region as a result of continued

development of West Oahu. However, all movements at the intersection are expected to continue operating at LOS D or better during the AM and PM peak hours of traffic.

Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection is anticipated to continue operating at overall LOS A during the AM and PM peak hours. In addition, all individual movement LOS are expected to remain the same as existing LOS with all approaches operating at LOS D or better during both AM and PM peak hours of traffic.

See Figure 4.1 for base year lane configuration, traffic volumes, and LOS for the study intersections. See Table 4.1 for a LOS comparison between Existing Conditions and Year 2021 without Project conditions.

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AustinTsutsumi & ASSOCIATES, INC.
Engineers & Surveyors

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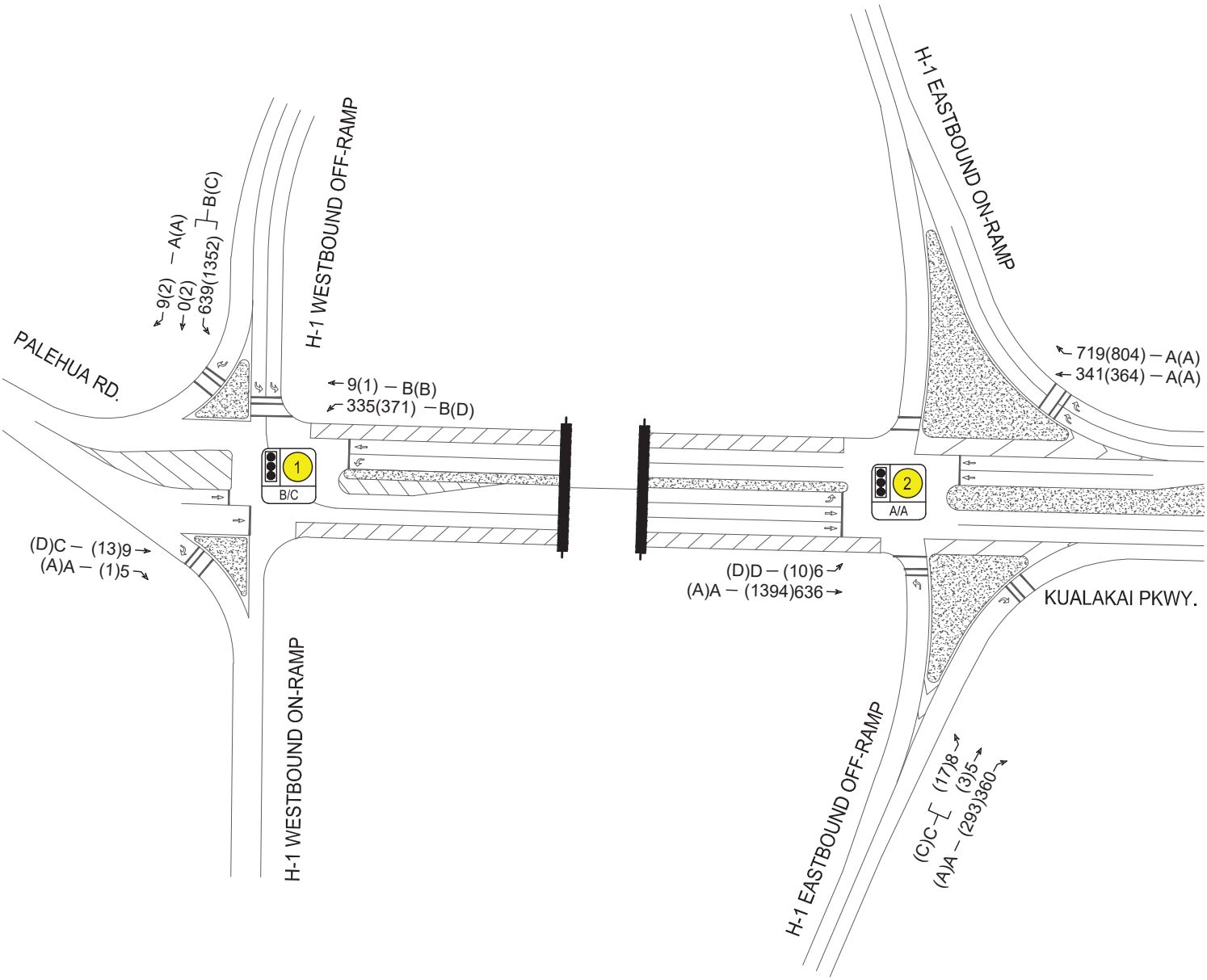

LEGEND

##(##) - AM(PM) PEAK HOUR OF VEHICLE VOLUMES

Y - SIGNALIZED INTERSECTION Y, OVERALL AM/PM LOS

X(X) - AM(PM) LOS

FIGURE 4.1

YEAR 2021 WITHOUT PROJECT, LANE CONFIGURATIONS, TRAFFIC VOLUMES AND LOS

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

TABLE 4.1: LOS SUMMARY TABLE
EXISTING CONDITIONS VS YEAR 2021 WITHOUT PROJECT CONDITIONS

Intersection	Existing Conditions						Year 2021 without Project					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps												
NB LT	15.8	0.75	B	27.8	0.84	C	17.0	0.78	B	42.3	0.90	D
NB TH	10.9	0.02	B	17.1	0.00	B	11.3	0.02	B	19.6	0.00	B
WB LT	12.8	0.65	B	15.8	0.82	B	13.9	0.70	B	22.6	0.90	C
WB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB TH	30.2	0.41	C	39.9	0.45	D	32.0	0.43	C	45.9	0.48	D
SB RT	-	-	A	-	-	A	-	-	A	-	-	A
OVERALL	13.9	-	A	18.6	-	B	15.1	-	B	27.0	-	C
2. Kualakai Pkwy./H1 EB Ramps												
NB TH	7.9	0.36	A	5.6	0.20	A	7.8	0.38	A	4.9	0.20	A
NB RT	-	-	A	-	-	A	-	-	A	-	-	A
EB LT/TH	28.8	0.52	C	30.7	0.55	C	27.3	0.52	C	34.1	0.57	C
EB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB LT	48.4	0.51	D	39.2	0.53	D	40.0	0.52	D	41.8	0.54	D
SB TH	3.8	0.33	A	3.7	0.56	A	3.9	0.38	A	3.6	0.61	A
OVERALL	5.8	-	A	4.6	-	A	5.7	-	A	4.4	-	A

Directions
NB = Northbound approach
SB = Southbound approach
EB = Eastbound approach
WB = Westbound approach

5. YEAR 2021 TRAFFIC CONDITIONS WITH PROJECT

The Year 2021 with project scenario represents the traffic conditions within the Project study area with the full build-out of the Project.

5.1 Background

The Project is envisioned to be a solar and battery storage facility on approximately 80 acres of land. The Project will consist of a 12.5 MW ground-mounted solar PV system with a 50 MW-hour battery energy storage system. The Project is planning to begin construction in late 2020 and complete construction by the end of 2021.

5.2 Trip Distribution

Trips generated during construction or by the Project were assigned throughout the study area generally based upon existing and projected Base Year 2021 travel patterns. The traffic generated by the Project was added to the forecast Base Year 2021 traffic volumes within the vicinity of the Project to constitute the traffic volumes for the Future Year 2021 traffic conditions.

5.3 Year 2021 During Project Construction Conditions

5.3.1 Trip Generation

Information provided by the Client indicates that during construction daily workers on site will range from 10 to 160 workers with an average of 55 daily workers throughout the anticipated 1-year construction schedule.

During construction, an estimated 500 tractor trailer loads (mixture of flat bed and enclosed) will make deliveries to the Project site over the course of the 1-year construction schedule. In addition to the typical tractor trailer loads, a single heavy and wide load delivery will need to be made to the Project site. Due to the size of trailer required as well as its impact to typical traffic patterns, it is assumed that this special transport will be done outside of daily peak hours of traffic and will have no effect on commuter traffic.

Due to the nature of trailer deliveries and its dependence on construction progression and manpower, a worst-case scenario was assumed for the purposes of this study. It is assumed that a maximum of 40 tractor trailers, 20 during both the AM and PM peak hours of traffic, will arrive, unload and depart the project site.

See Table 5.1 below for a summary of construction trip generation and Figure 5.1 for the assignment of construction-generated traffic.

Table 5.1: Construction Trip Generation

	Weekday AM Peak Hour		Weekday PM Peak Hour	
	Enter	Exit	Enter	Exit
Construction Workers	55	0	0	55
Tractor Trailers	20	20	20	20
Total	75	20	20	75

5.3.2 Year 2021 During Project Construction Analysis

Palehua Road & H-1 Freeway Westbound on-/off-ramp – Under worst-case assumptions as stated above, the intersection is expected to continue operating at LOS B(C) during the AM(PM) peak hours, respectively. In addition, all individual movements are expected to continue operating at LOS D or better.

Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection is anticipated to continue operating at overall LOS A during the AM and PM peak hours. In addition, all individual movement LOS are expected to remain the same as existing LOS with all approaches operating at LOS D or better during both AM and PM peak hours of traffic.

The Project site is approximately 80 acres with access off of Palehua Road (private). Due to the ample size of the property as well as the long driveway between Palehua Road and the Project site, it is not expected that any vehicle queues will spill back to the H-1 Westbound intersection and adversely affect traffic operations.

See Figure 5.2 for construction conditions lane configuration, traffic volumes, and LOS for the study intersections. See Table 5.2 for a LOS comparison between Year 2021 without Project conditions and Year 2021 During Project Construction conditions.

AES WEST OAHU SOLAR PLUS STORAGE PROJECT

AustinTsutsumi & ASSOCIATES, INC.
Engineers & Surveyors

N
NOT TO SCALE

NOTE:
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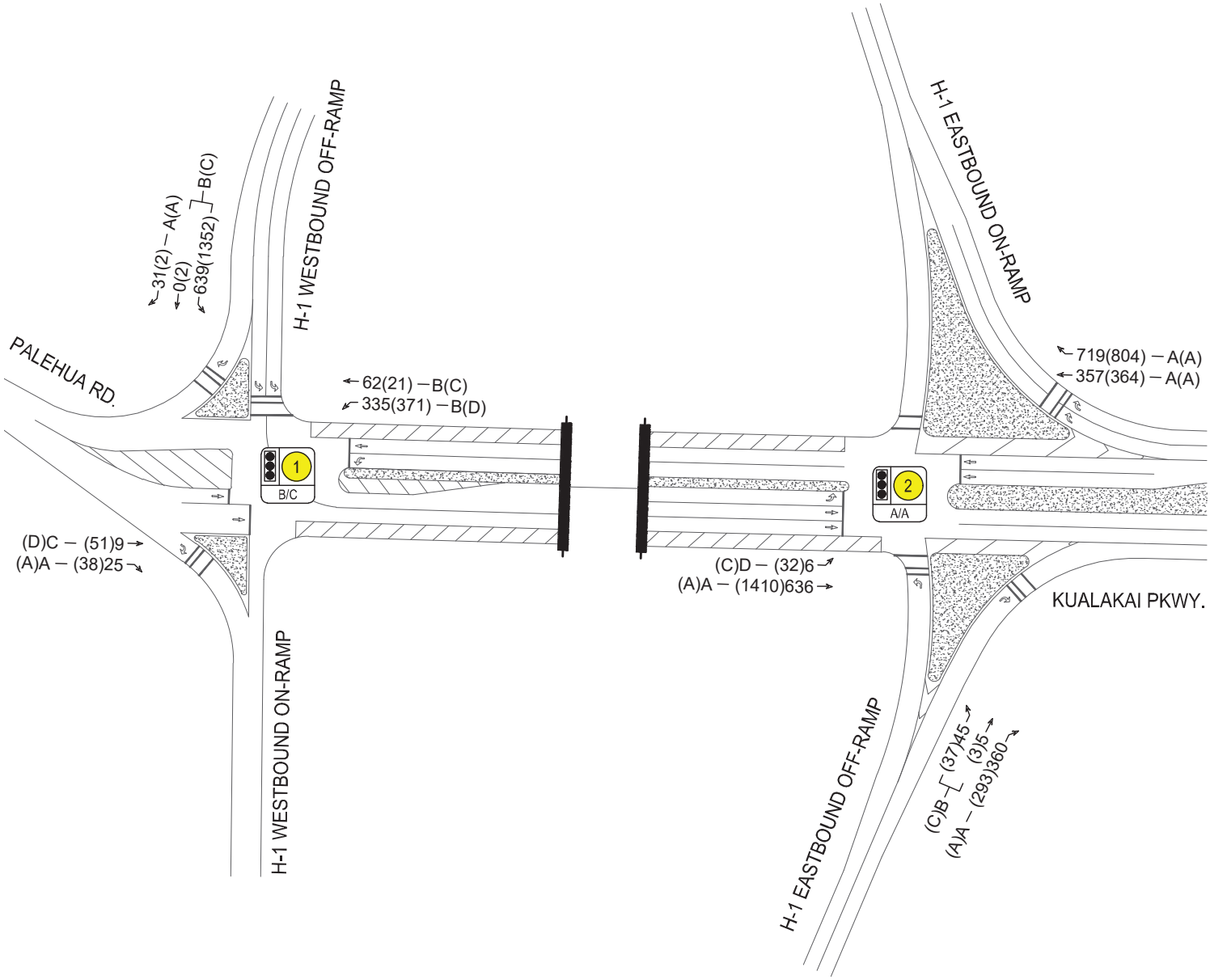
DO NOT USE FOR CONSTRUCTION.



LEGEND

##(##) - AM(PM) PEAK HOUR OF VEHICLE VOLUMES

Y - SIGNALIZED INTERSECTION Y

FIGURE 5.1

YEAR 2021 CONSTRUCTION, LANE CONFIGURATIONS, TRAFFIC VOLUMES AND LOS

AES WEST OAHU SOLAR PLUS STORAGE PROJECT

AustinTsutsumi & ASSOCIATES, INC.
Engineers & Surveyors

N
NOT TO SCALE

NOTE:
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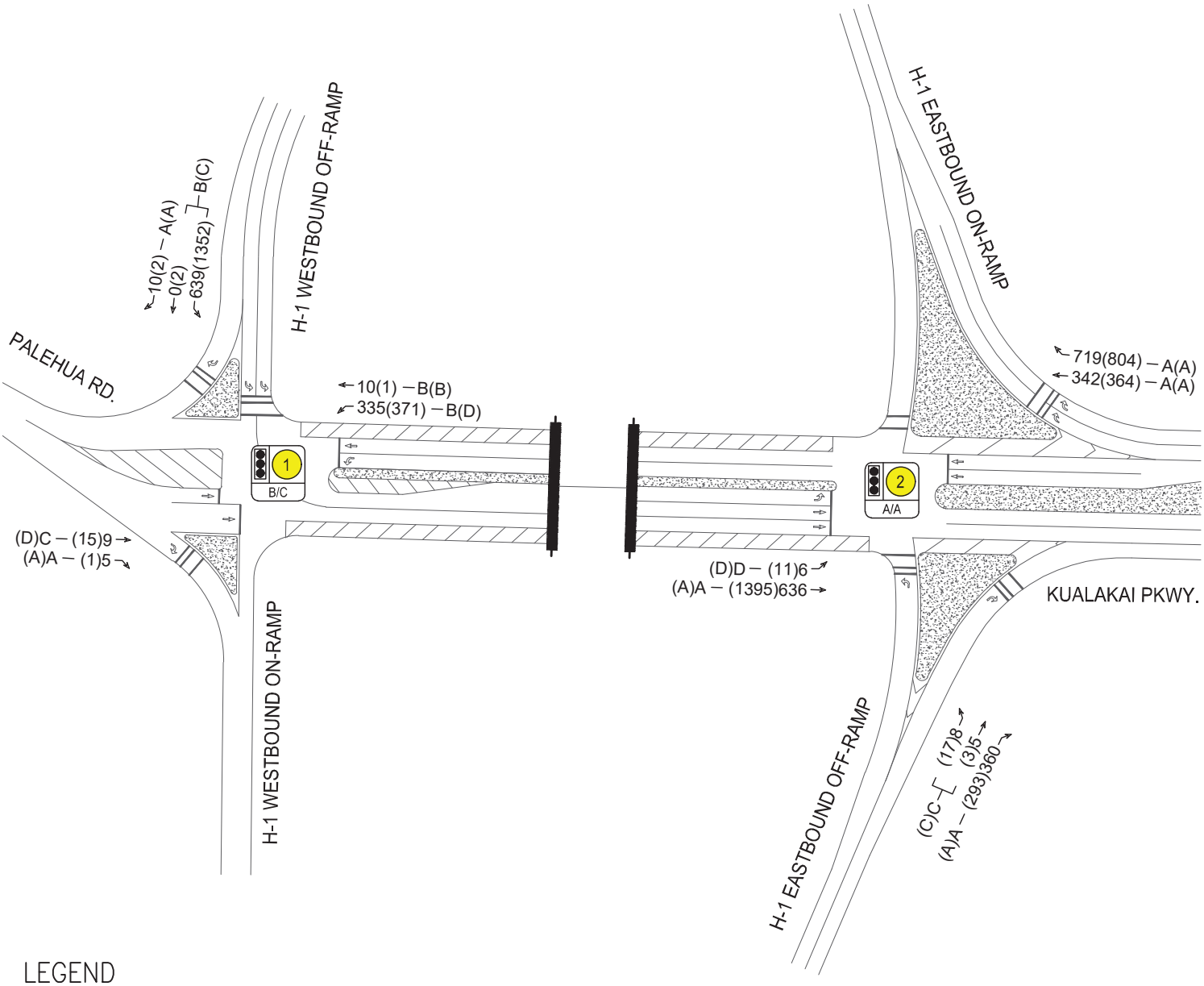

LEGEND

##(##) - AM(PM) PEAK HOUR OF VEHICLE VOLUMES

Y - SIGNALIZED INTERSECTION Y, OVERALL AM/PM LOS
X/X

X(X) - AM(PM) LOS

FIGURE 5.2

YEAR 2021 WITH PROJECT, LANE CONFIGURATIONS, TRAFFIC VOLUMES AND LOS

5.4 Year 2021 with Project Conditions

5.4.1 Trip Generation

Based upon information provided by the client it is expected that during typical weekday operations of the Project, only two full-time employees will be on site during daytime hours. Therefore, the Project is forecast to only generate 2(2) trips during the AM(PM) peak hours of traffic.

5.4.2 Year 2021 with Project Analysis

Upon completion of the Project, with the inclusion of both the 8% annual growth rate from 2019 to 2021 and the new traffic as a result of the Project, all study intersections are projected to operate at the same overall and individual movement LOS as Year 2021 without Project traffic conditions during the AM and PM peak hours of traffic.

Palehua Road & H-1 Freeway Westbound on-/off-ramp –The signalized intersection is anticipated to operate at an overall LOS B(C) during AM(PM) peak hours of traffic, respectively. All movements at the intersection are expected to continue operating at LOS D or better during the AM and PM peak hours of traffic.

Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection is anticipated to continue operating at overall LOS A during the AM and PM peak hours. In addition, all individual movement LOS are expected to remain the same as existing LOS with all approaches operating at LOS D or better during both AM and PM peak hours of traffic.

See Figure 5.2 for Future Year 2021 with project lane configuration, traffic volumes, and LOS for the study intersections. See Table 5.3 for a LOS comparison between Year 2021 without Project conditions and Year 2021 with Project conditions

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CIVIL ENGINEERS • SURVEYORS

TABLE 5.2: LOS SUMMARY TABLE
YEAR 2021 WITHOUT PROJECT VS YEAR 2021 DURING PROJECT CONSTRUCTION CONDITIONS

Intersection	Year 2021 without Project						Year 2021 During Project Construction					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps												
NB LT	17.0	0.78	B	42.3	0.90	D	16.6	0.76	B	46.5	0.90	D
NB TH	11.3	0.02	B	19.6	0.00	B	11.7	0.13	B	21.1	0.05	C
WB LT	13.9	0.70	B	22.6	0.90	C	14.2	0.70	B	25.9	0.91	C
WB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB TH	32.0	0.43	C	45.9	0.48	D	32.3	0.43	C	47.1	0.72	D
SB RT	-	-	A	-	-	A	-	-	A	-	-	A
OVERALL	15.1	-	B	27.0	-	C	14.9	-	B	30.7	-	C
2. Kualakai Pkwy./H1 EB Ramps												
NB TH	7.8	0.38	A	4.9	0.20	A	8.3	0.40	A	5.6	0.21	A
NB RT	-	-	A	-	-	A	-	-	A	-	-	A
EB LT/TH	27.3	0.52	C	34.1	0.57	C	19.1	0.61	B	32.0	0.65	C
EB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB LT	40.0	0.52	D	41.8	0.54	D	40.8	0.52	D	32.7	0.63	C
SB TH	3.9	0.38	A	3.6	0.61	A	4.2	0.39	A	3.9	0.62	A
OVERALL	5.7	-	A	4.4	-	A	6.5	-	A	5.3	-	A

Directions
NB = Northbound approach
SB = Southbound approach
EB = Eastbound approach
WB = Westbound approach

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

TABLE 5.3: LOS SUMMARY TABLE
YEAR 2021 WITHOU PROJECT VS YEAR 2021 WITH PROJECT CONDITIONS

Intersection	Year 2021 without Project						Year 2021 with Project					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps												
NB LT	17.0	0.78	B	42.3	0.90	D	17.0	0.78	B	42.6	0.90	D
NB TH	11.3	0.02	B	19.6	0.00	B	11.3	0.02	B	19.7	0.00	B
WB LT	13.9	0.70	B	22.6	0.90	C	13.9	0.70	B	22.8	0.90	C
WB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB TH	32.0	0.43	C	45.9	0.48	D	32.0	0.43	C	45.6	0.50	D
SB RT	-	-	A	-	-	A	-	-	A	-	-	A
OVERALL	15.1	-	B	27.0	-	C	15.1	-	B	27.0	-	C
2. Kualakai Pkwy./H1 EB Ramps												
NB TH	7.8	0.38	A	4.9	0.20	A	7.8	0.39	A	4.9	0.20	A
NB RT	-	-	A	-	-	A	-	-	A	-	-	A
EB LT/TH	27.3	0.52	C	34.1	0.57	C	27.3	0.52	C	34.2	0.57	C
EB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB LT	40.0	0.52	D	41.8	0.54	D	40.0	0.52	D	40.5	0.54	D
SB TH	3.9	0.38	A	3.6	0.61	A	3.9	0.38	A	3.6	0.61	A
OVERALL	5.7	-	A	4.4	-	A	5.7	-	A	4.4	-	A

Directions
NB = Northbound approach
SB = Southbound approach
EB = Eastbound approach
WB = Westbound approach

6. CONCLUSIONS

The Project is envisioned to be a solar and battery storage facility within the currently undeveloped UH West Oahu mauka lands parcel in Kapolei. Vehicular access to the Project will be provided via Palehua Road at an existing gated entry located north of the Kualakai Parkway intersection with the H-1 westbound on- and off-ramps. The Project is anticipated to be completed by the end of Year 2021.

6.1 Existing Conditions

- Palehua Road & H-1 Westbound on-/off-ramp currently operates at LOS A(B) during the AM(PM) peak hours of traffic, respectively. Additionally, all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

- Kualakai Parkway & H-1 Eastbound on-/off-ramp currently operates at LOS A during both the AM and PM peak hours of traffic. Additionally, all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

6.2 Year 2021 without Project Conditions

Based upon HDOT annual traffic data, the Hoopili TIAR and Traffic Counts taken by ATA, the annual growth rate for the study roadways was determined to be 8%. This growth rate takes into account the continued development of the West Oahu including Hoopili and the University of Hawaii West Oahu campus as well as other developments.

With the inclusion of the 8% annual growth rate from 2019 to 2021,

- Palehua Road & H-1 Westbound on-/off-ramp intersection is projected to operate at LOS B(C) during the AM(PM) peak hours of traffic. Similar to existing conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

- Kualakai Parkway & H-1 Eastbound on-/off-ramp intersection is projected to operate at LOS A during both AM and PM peak hours. Similar to existing conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

6.3 Year 2021 During Project Construction Conditions

During construction, information provided by the client indicates that construction worker presence will vary from 10-160 daily workers with a daily average of 55 workers. In addition, tractor trailers will also be making deliveries to the Project site. A worst-case scenario was assumed for tractor trailer deliveries with 20 deliveries occurring in both the AM and PM peak hours of traffic.

With the inclusion of construction traffic into Year 2021 without Project volumes,

- Palehua Road & H-1 Westbound on-/off-ramp intersection is projected to operate at LOS B(C) during the AM(PM) peak hours of traffic. Similar to Year 2021 without Project

conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

- Kualakai Parkway & H-1 Eastbound on-/off-ramp intersection is projected to operate at LOS A during both AM and PM peak hours. Similar to Year 2021 without Project conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

Due to the large amount of on-site space and driveway length, it is not expected that vehicle queues will spill back to the H-1 Westbound intersection and adversely affect traffic operations.

6.4 Year 2021 with Project Conditions

Upon completion the Project will only have 2 full-time employees on site during typical weekday operations. Therefore, the Project is forecast to only generate 2(2) trips during the AM(PM) peak hours of traffic. These additional trips are anticipated to have no impact on Year 2021 without Project traffic. Therefore, upon completion of the Project, all study intersections are anticipated to operate with the same LOS as Year 2021 without Project traffic conditions.

With the inclusion of the 8% annual growth rate from 2019 to 2021,

- Palehua Road & H-1 Westbound on-/off-ramp intersection is projected to operate at LOS B(C) during the AM(PM) peak hours of traffic. Similar to Year 2021 without Project conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

- Kualakai Parkway & H-1 Eastbound on-/off-ramp intersection is projected to operate at LOS A during both AM and PM peak hours. Similar to Year 2021 without Project conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

As a result of this report, it is found that the Project during construction or upon completion will have no significant impact on the surrounding facilities.

7. REFERENCES

1. Austin Tsutsumi & Associates, Roadway Master Plan Report Hoopili, August 31, 2016.

2. Austin Tsutsumi & Associates, Traffic Impact Analysis Report Hoopili, Updated May 30, 2014.

APPENDICES

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APPENDIX A

TRAFFIC COUNT DATA

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Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
Honolulu, HI 96817-5031
Phone: 533-3646 Fax: 526-1267

File Name : Kualakai Pkwy - H-1 West On and Off-Ramp
Site Code : West Oahu Solar
Start Date : 10/24/2019
Page No : 1

Groups Printed- Motorcycles - Cars & Light Goods - Buses - Unit Trucks - Articulated Trucks - Bicycles on Road - Bicycles on Crosswalk - Pedestrians

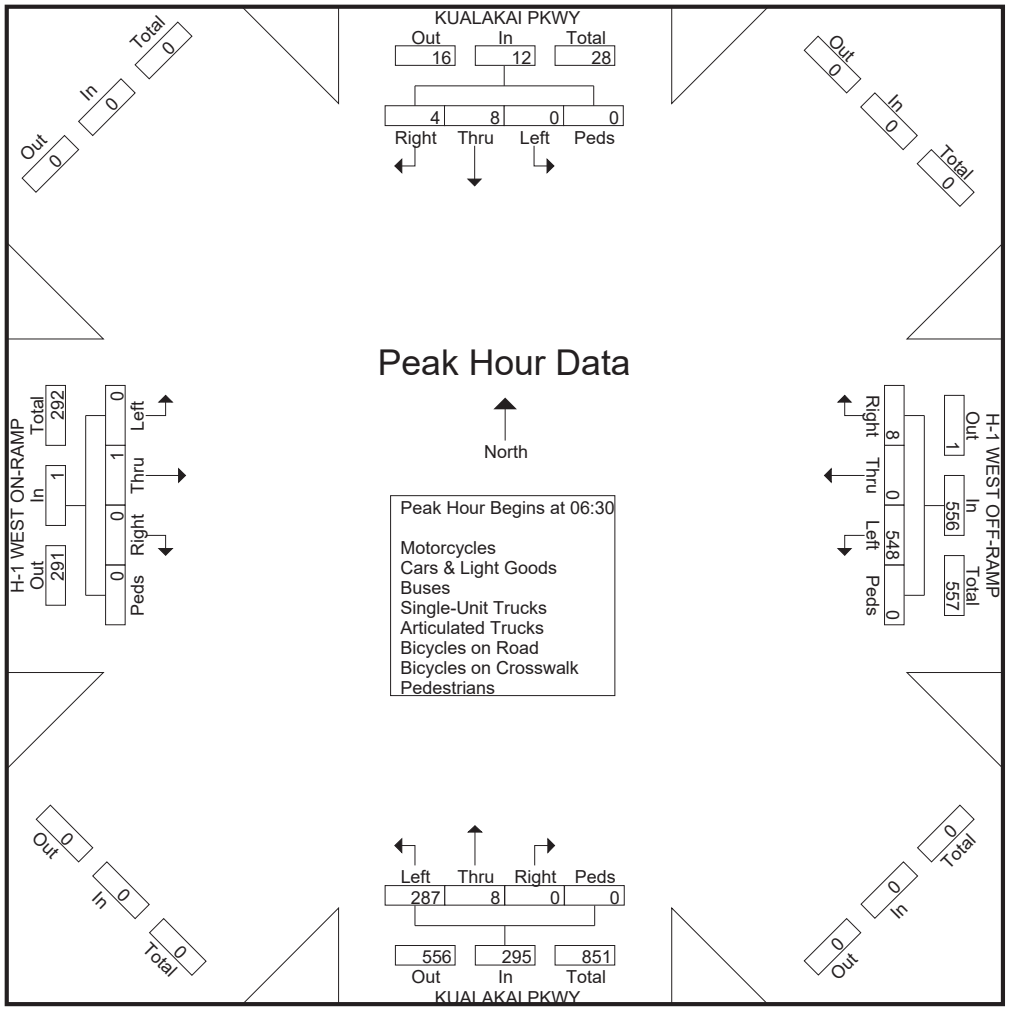
	KUALAKAI PKWY SOUTHBOUND				H-1 WEST OFF-RAMP WESTBOUND				KUALAKAI PKWY NORTHBOUND				H-1 WEST ON-RAMP EASTBOUND				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
06:00	0	0	0	0	137	0	4	0	31	5	0	0	0	0	0	0	177
06:15	0	0	0	0	131	0	5	0	48	4	0	0	0	0	0	0	188
06:30	0	0	1	0	160	0	4	0	65	3	0	0	0	0	0	0	233
06:45	0	3	0	0	149	0	1	0	74	3	0	0	0	0	0	0	230
Total	0	3	1	0	577	0	14	0	218	15	0	0	0	0	0	0	828
07:00	0	4	1	0	116	0	2	0	69	0	0	0	0	1	0	0	193
07:15	0	1	2	0	123	0	1	0	79	2	0	0	0	0	0	0	208
07:30	0	1	3	0	148	0	2	0	104	3	0	0	0	0	0	0	261
07:45	0	3	2	0	148	0	2	0	60	1	0	0	0	0	0	0	216
Total	0	9	8	0	535	0	7	0	312	6	0	0	0	1	0	0	878
08:00	0	1	2	0	140	0	1	0	76	1	0	0	0	0	0	0	221
08:15	0	1	2	0	129	0	2	0	53	3	0	0	0	0	0	0	190
08:30	0	3	2	0	133	0	3	0	46	3	0	0	0	0	0	0	190
08:45	0	3	5	0	119	1	3	0	32	4	0	0	0	0	0	0	167
Total	0	8	11	0	521	1	9	0	207	11	0	0	0	0	0	0	768
Grand Total	0	20	20	0	1633	1	30	0	737	32	0	0	0	1	0	0	2474
Apprch %	0	50	50	0	98.1	0.1	1.8	0	95.8	4.2	0	0	0	100	0	0	
Total %	0	0.8	0.8	0	66	0	1.2	0	29.8	1.3	0	0	0	0	0	0	
Motorcycles	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2
% Motorcycles	0	0	0	0	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0.1
Cars & Light Goods	0	3	5	0	1589	1	14	0	686	12	0	0	0	0	0	0	2310
% Cars & Light Goods	0	15	25	0	97.3	100	46.7	0	93.1	37.5	0	0	0	0	0	0	93.4
Buses	0	0	0	0	2	0	0	0	6	0	0	0	0	0	0	0	8
% Buses	0	0	0	0	0.1	0	0	0	0.8	0	0	0	0	0	0	0	0.3
Single-Unit Trucks	0	13	9	0	36	0	11	0	39	15	0	0	0	1	0	0	124
% Single-Unit Trucks	0	65	45	0	2.2	0	36.7	0	5.3	46.9	0	0	0	100	0	0	5
Articulated Trucks	0	3	6	0	5	0	5	0	5	5	0	0	0	0	0	0	29
% Articulated Trucks	0	15	30	0	0.3	0	16.7	0	0.7	15.6	0	0	0	0	0	0	1.2
Bicycles on Road	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% Bicycles on Road	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
Honolulu, HI 96817-5031
Phone: 533-3646 Fax: 526-1267

File Name : Kualakai Pkwy - H-1 West On and Off-Ramp
Site Code : West Oahu Solar
Start Date : 10/24/2019
Page No : 2

	KUALAKAI PKWY SOUTHBOUND					H-1 WEST OFF-RAMP WESTBOUND					KUALAKAI PKWY NORTHBOUND					H-1 WEST ON-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:30 to 07:15 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 06:30																					
06:30	0	0	1	0	1	**160**	0	**4**	0	**164**	65	**3**	0	0	68	0	0	0	0	0	**233**
06:45	0	3	0	0	3	149	0	1	0	150	74	3	0	0	77	0	0	0	0	0	230
07:00	0	**4**	1	0	**5**	116	0	2	0	118	69	0	0	0	69	0	**1**	0	0	**1**	193
07:15	0	1	**2**	0	3	123	0	1	0	124	**79**	2	0	0	**81**	0	0	0	0	0	208
Total Volume	0	8	4	0	12	548	0	8	0	556	287	8	0	0	295	0	1	0	0	1	864
% App. Total	0	66.7	33.3	0		98.6	0	1.4	0		97.3	2.7	0	0		0	100	0	0		
PHF	.000	.500	.500	.000	.600	.856	.000	.500	.000	.848	.908	.667	.000	.000	.910	.000	.250	.000	.000	.250	.927



Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
Honolulu, HI 96817-5031
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Groups Printed- Motorcycles - Cars & Light Goods - Buses - Unit Trucks - Articulated Trucks - Bicycles on Road - Bicycles on Crosswalk - Pedestrians

	KUALAKAI PKWY SOUTHBOUND				H-1 WEST OFF-RAMP WESTBOUND				KUALAKAI PKWY NORTHBOUND				H-1 WEST ON-RAMP EASTBOUND				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
15:00	0	6	7	0	212	1	1	0	76	0	0	0	0	0	0	0	303
15:15	0	2	1	0	234	1	0	0	66	2	0	0	0	0	0	0	306
15:30	0	3	0	0	267	1	1	0	80	0	0	0	0	0	0	0	352
15:45	0	4	0	0	300	0	0	0	112	0	0	0	0	0	0	0	416
Total	0	15	8	0	1013	3	2	0	334	2	0	0	0	0	0	0	1377
16:00	0	2	0	0	256	1	2	0	62	1	0	0	0	0	0	0	324
16:15	0	0	1	0	295	1	0	0	77	0	0	0	0	0	0	0	374
16:30	0	5	0	0	308	0	0	0	67	0	0	0	0	0	0	0	380
16:45	0	1	1	0	306	0	0	0	58	0	0	0	0	0	0	0	366
Total	0	8	2	0	1165	2	2	0	264	1	0	0	0	0	0	0	1444
17:00	0	2	1	0	293	1	0	0	59	0	0	0	0	0	0	0	356
17:15	0	0	0	0	299	0	0	0	68	0	0	0	0	0	0	0	367
17:30	0	0	0	0	298	1	0	0	54	0	0	0	0	0	0	0	353
17:45	0	1	1	0	279	0	0	0	46	0	0	0	0	1	0	0	328
Total	0	3	2	0	1169	2	0	0	227	0	0	0	0	1	0	0	1404
Grand Total	0	26	12	0	3347	7	4	0	825	3	0	0	0	1	0	0	4225
Apprch %	0	68.4	31.6	0	99.7	0.2	0.1	0	99.6	0.4	0	0	0	100	0	0	
Total %	0	0.6	0.3	0	79.2	0.2	0.1	0	19.5	0.1	0	0	0	0	0	0	
Motorcycles	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	17
% Motorcycles	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0.4
Cars & Light Goods	0	25	11	0	3306	6	3	0	808	3	0	0	0	1	0	0	4163
% Cars & Light Goods	0	96.2	91.7	0	98.8	85.7	75	0	97.9	100	0	0	0	100	0	0	98.5
Buses	0	0	0	0	5	0	0	0	4	0	0	0	0	0	0	0	9
% Buses	0	0	0	0	0.1	0	0	0	0.5	0	0	0	0	0	0	0	0.2
Single-Unit Trucks	0	1	1	0	18	0	1	0	7	0	0	0	0	0	0	0	28
% Single-Unit Trucks	0	3.8	8.3	0	0.5	0	25	0	0.8	0	0	0	0	0	0	0	0.7
Articulated Trucks	0	0	0	0	0	1	0	0	6	0	0	0	0	0	0	0	7
% Articulated Trucks	0	0	0	0	0	14.3	0	0	0.7	0	0	0	0	0	0	0	0.2
Bicycles on Road	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
% Bicycles on Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
Honolulu, HI 96817-5031
Phone: 533-3646 Fax: 526-1267

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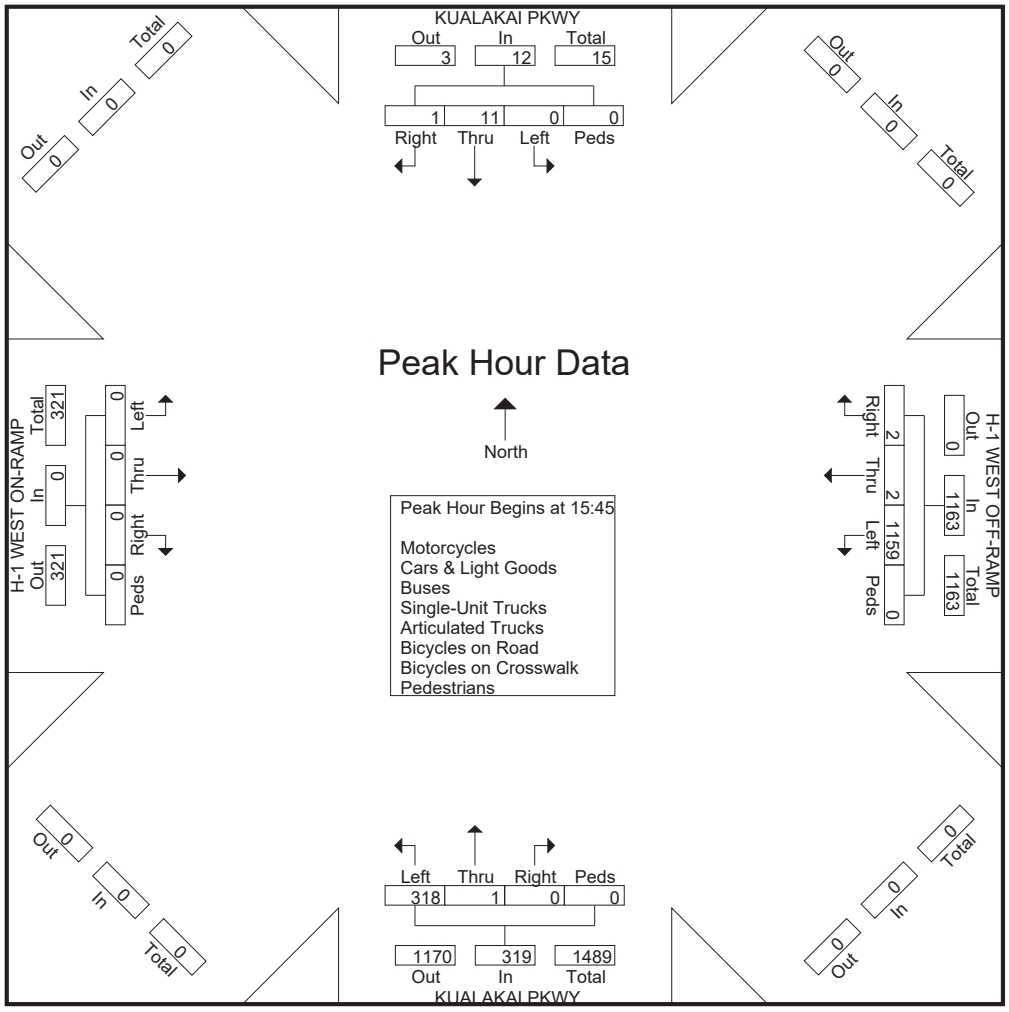
	KUALAKAI PKWY SOUTHBOUND					H-1 WEST OFF-RAMP WESTBOUND					KUALAKAI PKWY NORTHBOUND					H-1 WEST ON-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 15:00 to 17:45 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 15:45																					
15:45	0	4	0	0	4	300	0	0	0	300	**112**	0	0	0	**112**	0	0	0	0	0	**416**
16:00	0	2	0	0	2	256	**1**	**2**	0	259	62	**1**	0	0	63	0	0	0	0	0	324
16:15	0	0	**1**	0	1	295	1	0	0	296	77	0	0	0	77	0	0	0	0	0	374
16:30	0	**5**	0	0	**5**	**308**	0	0	0	**308**	67	0	0	0	67	0	0	0	0	0	380
Total Volume	0	11	1	0	12	1159	2	2	0	1163	318	1	0	0	319	0	0	0	0	0	1494
% App. Total	0	91.7	8.3	0		99.7	0.2	0.2	0		99.7	0.3	0	0		0	0	0	0		
PHF	.000	.550	.250	.000	.600	.941	.500	.250	.000	.944	.710	.250	.000	.000	.712	.000	.000	.000	.000	.000	.898



Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
Honolulu, HI 96817-5031
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Groups Printed- Motorcycles - Cars & Light Goods - Buses - Unit Trucks - Articulated Trucks - Bicycles on Road - Bicycles on Crosswalk - Pedestrians

	KUALAKAI PKWY SOUTHBOUND				H-1 EAST ON-RAMP WESTBOUND				KUALAKAI PKWY NORTHBOUND				H-1 EAST OFF-RAMP EASTBOUND				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
06:00	0	138	0	0	0	0	0	0	0	29	223	0	5	0	46	0	441
06:15	0	134	0	0	0	0	0	0	0	50	181	0	3	2	66	0	436
06:30	0	158	0	0	0	0	0	0	0	73	174	0	3	1	91	0	500
06:45	1	156	0	0	0	0	0	0	0	66	166	0	3	1	74	0	467
Total	1	586	0	0	0	0	0	0	0	218	744	0	14	4	277	0	1844
07:00	4	108	0	0	0	0	0	0	0	69	110	0	0	1	65	0	357
07:15	0	123	0	0	0	0	0	0	0	84	166	0	1	1	79	0	454
07:30	1	149	0	0	0	0	0	0	0	102	137	0	3	0	69	0	461
07:45	4	148	0	0	0	0	0	0	0	61	138	0	1	0	61	0	413
Total	9	528	0	0	0	0	0	0	0	316	551	0	5	2	274	0	1685
08:00	1	131	0	0	0	0	0	0	0	75	170	0	3	0	62	0	442
08:15	4	135	0	0	0	0	0	0	0	51	167	0	3	0	47	0	407
08:30	3	135	0	0	0	0	0	0	0	45	132	0	6	0	34	0	355
08:45	3	122	0	0	0	0	0	0	0	32	121	0	5	0	42	0	325
Total	11	523	0	0	0	0	0	0	0	203	590	0	17	0	185	0	1529
Grand Total	21	1637	0	0	0	0	0	0	0	737	1885	0	36	6	736	0	5058
Apprch %	1.3	98.7	0	0	0	0	0	0	0	28.1	71.9	0	4.6	0.8	94.6	0	
Total %	0.4	32.4	0	0	0	0	0	0	0	14.6	37.3	0	0.7	0.1	14.6	0	
Motorcycles	0	1	0	0	0	0	0	0	0	4	8	0	0	0	0	0	13
% Motorcycles	0	0.1	0	0	0	0	0	0	0	0.5	0.4	0	0	0	0	0	0.3
Cars & Light Goods	9	1595	0	0	0	0	0	0	0	678	1851	0	20	4	697	0	4854
% Cars & Light Goods	42.9	97.4	0	0	0	0	0	0	0	92	98.2	0	55.6	66.7	94.7	0	96
Buses	0	2	0	0	0	0	0	0	0	6	8	0	0	0	7	0	23
% Buses	0	0.1	0	0	0	0	0	0	0	0.8	0.4	0	0	0	1	0	0.5
Single-Unit Trucks	9	32	0	0	0	0	0	0	0	42	16	0	13	0	29	0	141
% Single-Unit Trucks	42.9	2	0	0	0	0	0	0	0	5.7	0.8	0	36.1	0	3.9	0	2.8
Articulated Trucks	3	5	0	0	0	0	0	0	0	6	2	0	3	2	3	0	24
% Articulated Trucks	14.3	0.3	0	0	0	0	0	0	0	0.8	0.1	0	8.3	33.3	0.4	0	0.5
Bicycles on Road	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
% Bicycles on Road	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1
Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Austin Tsutsumi & Associates

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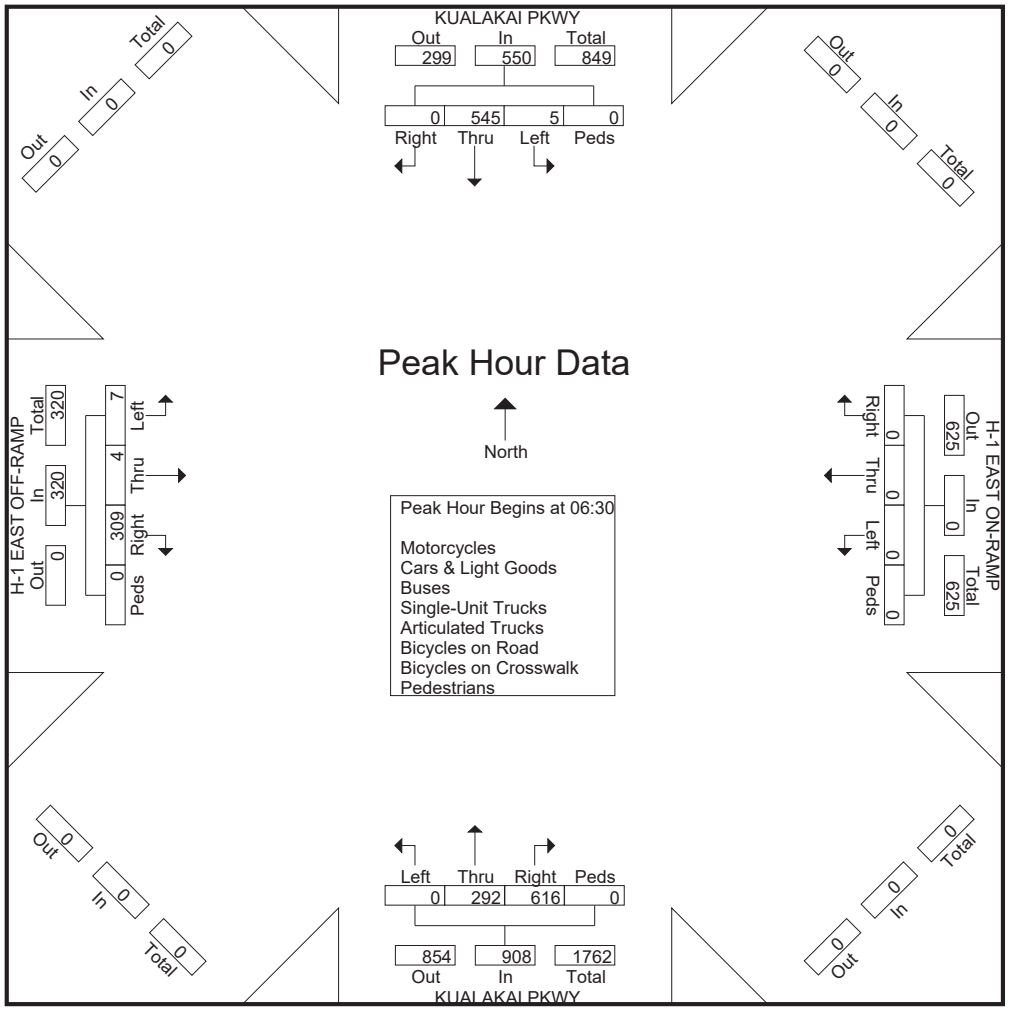
	KUALAKAI PKWY SOUTHBOUND					H-1 EAST ON-RAMP WESTBOUND					KUALAKAI PKWY NORTHBOUND					H-1 EAST OFF-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:30 to 07:15 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 06:30																					
06:30	0	**158**	0	0	**158**	0	0	0	0	0	0	73	**174**	0	247	**3**	**1**	**91**	0	**95**	**500**
06:45	1	156	0	0	157	0	0	0	0	0	0	66	166	0	232	3	1	74	0	78	467
07:00	**4**	108	0	0	112	0	0	0	0	0	0	69	110	0	179	0	1	65	0	66	357
07:15	0	123	0	0	123	0	0	0	0	0	0	**84**	166	0	**250**	1	1	79	0	81	454
Total Volume	5	545	0	0	550	0	0	0	0	0	0	292	616	0	908	7	4	309	0	320	1778
% App. Total	0.9	99.1	0	0		0	0	0	0		0	32.2	67.8	0		2.2	1.2	96.6	0		
PHF	.313	.862	.000	.000	.870	.000	.000	.000	.000	.000	.000	.869	.885	.000	.908	.583	1.00	.849	.000	.842	.889



Austin Tsutsumi & Associates

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Groups Printed- Motorcycles - Cars & Light Goods - Buses - Unit Trucks - Articulated Trucks - Bicycles on Road - Bicycles on Crosswalk - Pedestrians

	KUALAKAI PKWY SOUTHBOUND				H-1 EAST ON-RAMP WESTBOUND				KUALAKAI PKWY NORTHBOUND				H-1 EAST OFF-RAMP EASTBOUND				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
15:00	5	213	0	0	0	0	0	0	0	68	194	0	3	0	52	0	535
15:15	3	240	0	0	0	0	0	0	0	64	189	0	3	1	47	0	547
15:30	2	267	0	0	0	0	0	0	0	82	251	0	0	0	64	0	666
15:45	2	305	0	0	0	0	0	0	0	111	193	0	4	1	55	0	671
Total	12	1025	0	0	0	0	0	0	0	325	827	0	10	2	218	0	2419
16:00	2	263	0	0	0	0	0	0	0	59	161	0	4	0	59	0	548
16:15	0	302	0	0	0	0	0	0	0	72	165	0	2	2	60	0	603
16:30	5	325	0	0	0	0	0	0	0	70	170	0	5	0	77	0	652
16:45	1	314	0	0	0	0	0	0	0	51	157	0	2	0	74	0	599
Total	8	1204	0	0	0	0	0	0	0	252	653	0	13	2	270	0	2402
17:00	2	294	0	0	0	0	0	0	0	58	151	0	5	0	57	0	567
17:15	1	299	0	0	0	0	0	0	0	63	142	0	1	0	46	0	552
17:30	1	292	0	0	0	0	0	0	0	52	122	0	2	0	42	0	511
17:45	2	289	0	0	0	0	0	0	0	48	119	0	3	1	48	0	510
Total	6	1174	0	0	0	0	0	0	0	221	534	0	11	1	193	0	2140
Grand Total	26	3403	0	0	0	0	0	0	0	798	2014	0	34	5	681	0	6961
Apprch %	0.8	99.2	0	0	0	0	0	0	0	28.4	71.6	0	4.7	0.7	94.6	0	
Total %	0.4	48.9	0	0	0	0	0	0	0	11.5	28.9	0	0.5	0.1	9.8	0	
Motorcycles	0	19	0	0	0	0	0	0	0	0	2	0	0	0	4	0	25
% Motorcycles	0	0.6	0	0	0	0	0	0	0	0	0.1	0	0	0	0.6	0	0.4
Cars & Light Goods	24	3365	0	0	0	0	0	0	0	781	1980	0	33	5	673	0	6861
% Cars & Light Goods	92.3	98.9	0	0	0	0	0	0	0	97.9	98.3	0	97.1	100	98.8	0	98.6
Buses	1	4	0	0	0	0	0	0	0	4	2	0	0	0	1	0	12
% Buses	3.8	0.1	0	0	0	0	0	0	0	0.5	0.1	0	0	0	0.1	0	0.2
Single-Unit Trucks	1	14	0	0	0	0	0	0	0	8	24	0	1	0	3	0	51
% Single-Unit Trucks	3.8	0.4	0	0	0	0	0	0	0	1	1.2	0	2.9	0	0.4	0	0.7
Articulated Trucks	0	1	0	0	0	0	0	0	0	5	6	0	0	0	0	0	12
% Articulated Trucks	0	0	0	0	0	0	0	0	0	0.6	0.3	0	0	0	0	0	0.2
Bicycles on Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bicycles on Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Austin Tsutsumi & Associates

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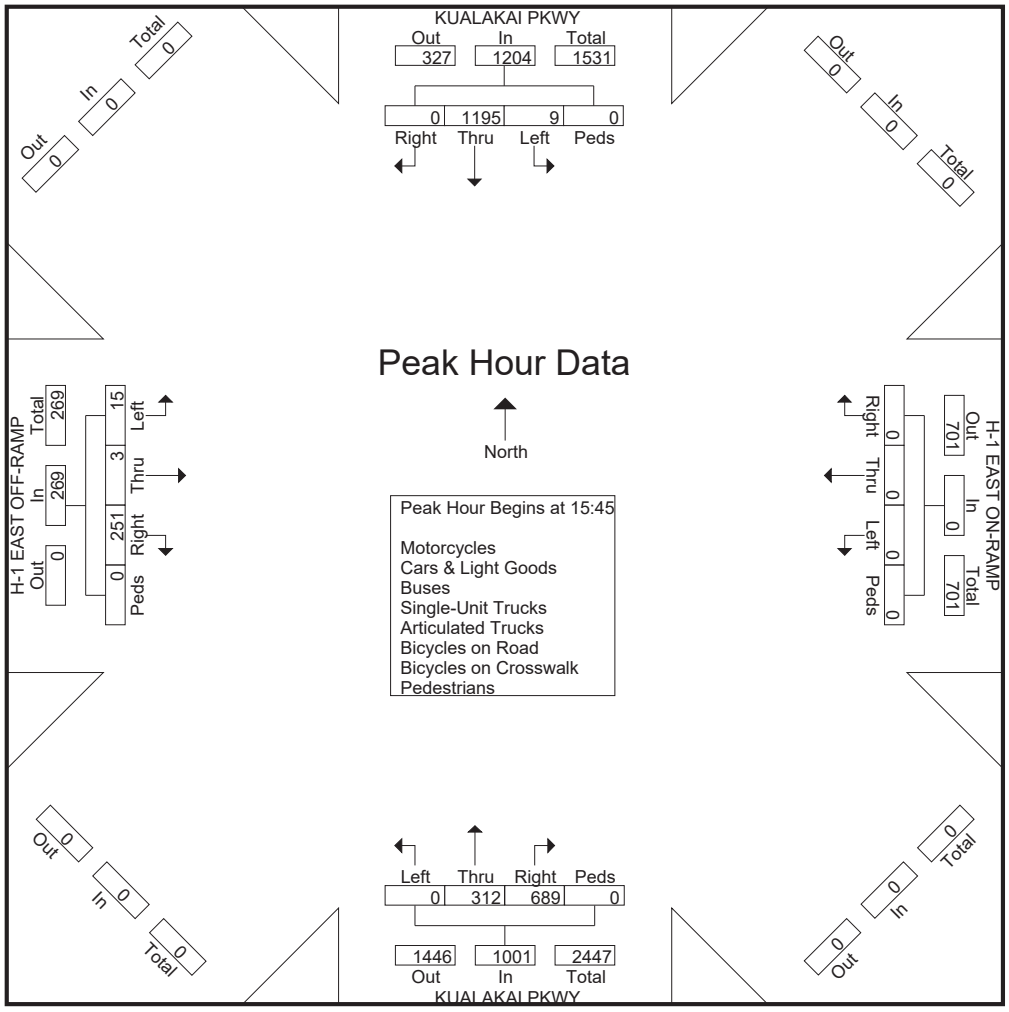
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 15:45 to 16:30 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 15:45																					
15:45	2	305	0	0	307	0	0	0	0	0	0	**111**	**193**	0	**304**	4	1	55	0	60	**671**
16:00	2	263	0	0	265	0	0	0	0	0	0	59	161	0	220	4	0	59	0	63	548
16:15	0	302	0	0	302	0	0	0	0	0	0	72	165	0	237	2	**2**	60	0	64	603
16:30	**5**	**325**	0	0	**330**	0	0	0	0	0	0	70	170	0	240	**5**	0	**77**	0	**82**	652
Total Volume	9	1195	0	0	1204	0	0	0	0	0	0	312	689	0	1001	15	3	251	0	269	2474
% App. Total	0.7	99.3	0	0		0	0	0	0		0	31.2	68.8	0		5.6	1.1	93.3	0		
PHF	.450	.919	.000	.000	.912	.000	.000	.000	.000	.000	.000	.703	.892	.000	.823	.750	.375	.815	.000	.820	.922



APPENDIX B

LEVEL OF SERVICE CRITERIA

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APPENDIX B – LEVEL OF SERVICE (LOS) CRITERIA

VEHICULAR LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 6th EDITION)

Level of service for vehicles at signalized intersections is directly related to delay values and is assigned on that basis. Level of Service is a measure of the acceptability of delay values to motorists at a given intersection. The criteria are given in the table below.

Level-of Service Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (sec./veh.)
A	< 10.0
B	>10.0 and ≤ 20.0
C	>20.0 and ≤ 35.0
D	>35.0 and ≤ 55.0
E	>55.0 and ≤ 80.0
F	> 80.0

Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group or approach in question.

VEHICULAR LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS (HCM 6th EDITION)

The level of service criteria for vehicles at unsignalized intersections is defined as the average control delay, in seconds per vehicle.

LOS delay threshold values are lower for two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections than those of signalized intersections. This is because more vehicles pass through signalized intersections, and therefore, drivers expect and tolerate greater delays. While the criteria for level of service for TWSC and AWSC intersections are the same, procedures to calculate the average total delay may differ.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

PEDESTRIAN AND BICYCLE LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 6th EDITION)

Level of service for pedestrians and bicycles at signalized intersections is determined by calculating an LOS Score for each approach at a signalized intersection, and is assigned on that basis. Level of Service for non-automobile modes at signalized intersections is associated with a score value based on traveler perception research, considering factors of performance measures and intersection characteristics. The criteria are given in the table below.

Level-of Service Criteria for Signalized Intersections

Level of Service	LOS Score
A	< 1.50
B	>1.50 and ≤ 2.50
C	>2.50 and ≤ 3.50
D	>3.50 and ≤ 4.50
E	>4.50 and ≤ 5.50
F	> 5.50

PEDESTRIAN LEVEL OF SERVICE CRITERIA FOR UNCONTROLLED CROSSINGS (HCM 6th EDITION)

The level of service criteria for pedestrians at uncontrolled crossings is defined as the average control delay, in seconds per pedestrian.

LOS delay threshold values for two-way stop-controlled (TWSC) intersections are defined for pedestrians crossing a traffic stream not controlled by a STOP sign; it also applies to midblock pedestrian crossings and crossings at with special treatments such as flashing beacons and signage. Factors such as vehicle and pedestrian volumes, geometric conditions, motorist yield rates, and multiple-stage crossings affect the control delay for pedestrians.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 5
B	>5 and ≤10
C	>10 and ≤20
D	>20 and ≤30
E	>30 and ≤45
F	> 45

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

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APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Existing Conditions AM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	548	0	8	287	8	0	0	8	4
Future Volume (veh/h)	0	0	0	548	0	8	287	8	0	0	8	4
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				596	0	0	312	9	0	0	9	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				918	0		418	439	0	0	22	
Arrive On Green				0.27	0.00	0.00	0.23	0.23	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				596	0	0	312	9	0	0	9	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				5.6	0.0	0.0	6.0	0.1	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				5.6	0.0	0.0	6.0	0.1	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				918	0		418	439	0	0	22	
V/C Ratio(X)				0.65	0.00		0.75	0.02	0.00	0.00	0.41	
Avail Cap(c_a), veh/h				2623	0		1400	1470	0	0	760	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				12.0	0.0	0.0	13.1	10.9	0.0	0.0	18.1	0.0
Incr Delay (d2), s/veh				0.8	0.0	0.0	2.7	0.0	0.0	0.0	12.1	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				1.8	0.0	0.0	2.2	0.0	0.0	0.0	0.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				12.8	0.0	0.0	15.8	10.9	0.0	0.0	30.2	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					596	A		321			9	A
Approach Delay, s/veh					12.8			15.6			30.2	
Approach LOS					B			B			C	

Timer - Assigned Phs			4		6		8					
Phs Duration (G+Y+Rc), s				6.4		15.8		14.7				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		7.6		8.0				
Green Ext Time (p_c), s				0.0		2.2		0.9				

Intersection Summary		
HCM 6th Ctrl Delay		13.9
HCM 6th LOS		B

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	7	4	309	0	0	0	0	292	616	5	545	0
Future Volume (veh/h)	7	4	309	0	0	0	0	292	616	5	545	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	8	4	0				0	317	0	5	592	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	15	8					0	884		10	1772	0
Arrive On Green	0.01	0.01	0.00				0.00	0.25	0.00	0.01	0.50	0.00
Sat Flow, veh/h	1207	603	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	12	0	0				0	317	0	5	592	0
Grp Sat Flow(s),veh/h/ln	1810	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.2	0.0	0.0				0.0	1.8	0.0	0.1	2.5	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0				0.0	1.8	0.0	0.1	2.5	0.0
Prop In Lane	0.67		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	23	0					0	884		10	1772	0
V/C Ratio(X)	0.52	0.00					0.00	0.36		0.51	0.33	0.00
Avail Cap(c_a), veh/h	1106	0					0	6078		1088	9116	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.0	0.0	0.0				0.0	7.6	0.0	12.2	3.7	0.0
Incr Delay (d2), s/veh	16.7	0.0	0.0				0.0	0.2	0.0	36.3	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.0				0.0	0.4	0.0	0.1	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	28.8	0.0	0.0				0.0	7.9	0.0	48.4	3.8	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		12	A					317	A		597	
Approach Delay, s/veh		28.8						7.9			4.2	
Approach LOS		C						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	6.1	12.1		6.3		18.2
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	15.0	42.0		15.0		63.0
Max Q Clear Time (g_c+I1), s	2.1	3.8		2.2		4.5
Green Ext Time (p_c), s	0.0	2.3		0.0		4.7

Intersection Summary	
HCM 6th Ctrl Delay	5.8
HCM 6th LOS	A

Notes

User approved pedestrian interval to be less than phase max green.

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Existing Conditions PM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1159	0	2	318	1	0	0	11	1
Future Volume (veh/h)	0	0	0	1159	0	2	318	1	0	0	11	1
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1260	0	0	346	1	0	0	12	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1531	0		412	432	0	0	26	
Arrive On Green				0.44	0.00	0.00	0.23	0.23	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1260	0	0	346	1	0	0	12	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				18.5	0.0	0.0	10.7	0.0	0.0	0.0	0.4	0.0
Cycle Q Clear(g_c), s				18.5	0.0	0.0	10.7	0.0	0.0	0.0	0.4	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1531	0		412	432	0	0	26	
V/C Ratio(X)				0.82	0.00		0.84	0.00	0.00	0.00	0.45	
Avail Cap(c_a), veh/h				2214	0		617	648	0	0	486	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				14.1	0.0	0.0	21.2	17.1	0.0	0.0	28.2	0.0
Incr Delay (d2), s/veh				1.7	0.0	0.0	6.6	0.0	0.0	0.0	11.6	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				6.4	0.0	0.0	4.8	0.0	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				15.8	0.0	0.0	27.8	17.1	0.0	0.0	39.9	0.0
LnGrp LOS				B	A		C	B	A	A	D	
Approach Vol, veh/h					1260	A		347			12	A
Approach Delay, s/veh					15.8			27.7			39.9	
Approach LOS					B			C			D	

Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.8		31.6		19.4				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		37.0		20.0				
Max Q Clear Time (g_c+I1), s				2.4		20.5		12.7				
Green Ext Time (p_c), s				0.0		5.1		0.7				

Intersection Summary	
HCM 6th Ctrl Delay	18.6
HCM 6th LOS	B

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	15	3	251	0	0	0	0	312	689	9	1195	0
Future Volume (veh/h)	15	3	251	0	0	0	0	312	689	9	1195	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	16	3	0				0	339	0	10	1299	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	29	5					0	1689		19	2313	0
Arrive On Green	0.02	0.02	0.00				0.00	0.48	0.00	0.01	0.65	0.00
Sat Flow, veh/h	1511	283	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	19	0	0				0	339	0	10	1299	0
Grp Sat Flow(s),veh/h/ln	1795	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.4	0.0	0.0				0.0	2.0	0.0	0.2	7.3	0.0
Cycle Q Clear(g_c), s	0.4	0.0	0.0				0.0	2.0	0.0	0.2	7.3	0.0
Prop In Lane	0.84		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	34	0					0	1689		19	2313	0
V/C Ratio(X)	0.55	0.00					0.00	0.20		0.53	0.56	0.00
Avail Cap(c_a), veh/h	740	0					0	4105		735	6157	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	17.7	0.0	0.0				0.0	5.5	0.0	17.9	3.5	0.0
Incr Delay (d2), s/veh	13.0	0.0	0.0				0.0	0.1	0.0	21.3	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	0.0				0.0	0.5	0.0	0.2	0.7	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	30.7	0.0	0.0				0.0	5.6	0.0	39.2	3.7	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		19	A					339	A		1309	
Approach Delay, s/veh		30.7						5.6			4.0	
Approach LOS		C						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	6.4	23.3		6.7		29.7
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	15.0	42.0		15.0		63.0
Max Q Clear Time (g_c+I1), s	2.2	4.0		2.4		9.3
Green Ext Time (p_c), s	0.0	2.4		0.0		14.3

Intersection Summary		
HCM 6th Ctrl Delay		4.6
HCM 6th LOS		A

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 Without Project Conditions AM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	639	0	9	335	9	0	0	9	5
Future Volume (veh/h)	0	0	0	639	0	9	335	9	0	0	9	5
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				695	0	0	364	10	0	0	10	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1000	0		467	491	0	0	23	
Arrive On Green				0.29	0.00	0.00	0.26	0.26	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				695	0	0	364	10	0	0	10	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1000	0		467	491	0	0	23	
V/C Ratio(X)				0.70	0.00		0.78	0.02	0.00	0.00	0.43	
Avail Cap(c_a), veh/h				2343	0		1251	1313	0	0	679	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				13.1	0.0	0.0	14.1	11.3	0.0	0.0	20.2	0.0
Incr Delay (d2), s/veh				0.9	0.0	0.0	2.9	0.0	0.0	0.0	11.7	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				2.4	0.0	0.0	2.9	0.1	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				13.9	0.0	0.0	17.0	11.3	0.0	0.0	32.0	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					695	A		374			10	A
Approach Delay, s/veh					13.9			16.8			32.0	
Approach LOS					B			B			C	

Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.5		17.9		16.8				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		9.4		9.8				
Green Ext Time (p_c), s				0.0		2.6		1.1				

Intersection Summary	
HCM 6th Ctrl Delay	15.1
HCM 6th LOS	B

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	8	5	360	0	0	0	0	341	719	6	636	0
Future Volume (veh/h)	8	5	360	0	0	0	0	341	719	6	636	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	9	5	0				0	371	0	7	691	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	17	10					0	964		14	1828	0
Arrive On Green	0.01	0.01	0.00				0.00	0.27	0.00	0.01	0.51	0.00
Sat Flow, veh/h	1165	647	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	14	0	0				0	371	0	7	691	0
Grp Sat Flow(s),veh/h/ln	1812	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Prop In Lane	0.64		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	27	0					0	964		14	1828	0
V/C Ratio(X)	0.52	0.00					0.00	0.38		0.52	0.38	0.00
Avail Cap(c_a), veh/h	995	0					0	6135		979	8924	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.5	0.0	0.0				0.0	7.6	0.0	12.6	3.7	0.0
Incr Delay (d2), s/veh	14.8	0.0	0.0				0.0	0.3	0.0	27.4	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.0				0.0	0.5	0.0	0.1	0.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	27.3	0.0	0.0				0.0	7.8	0.0	40.0	3.9	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		14	A					371	A		698	
Approach Delay, s/veh		27.3						7.8			4.2	
Approach LOS		C						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	6.2	12.9		6.4		19.1
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	14.0	44.0		14.0		64.0
Max Q Clear Time (g_c+I1), s	2.1	4.2		2.2		5.0
Green Ext Time (p_c), s	0.0	2.7		0.0		5.7

Intersection Summary	
HCM 6th Ctrl Delay	5.7
HCM 6th LOS	A

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 Without Project Conditions PM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	13	1
Future Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	13	1
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1470	0	0	403	1	0	0	14	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1641	0		450	472	0	0	29	
Arrive On Green				0.47	0.00	0.00	0.25	0.25	0.00	0.00	0.02	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1470	0	0	403	1	0	0	14	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				27.2	0.0	0.0	15.3	0.0	0.0	0.0	0.5	0.0
Cycle Q Clear(g_c), s				27.2	0.0	0.0	15.3	0.0	0.0	0.0	0.5	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1641	0		450	472	0	0	29	
V/C Ratio(X)				0.90	0.00		0.90	0.00	0.00	0.00	0.48	
Avail Cap(c_a), veh/h				1825	0		508	534	0	0	400	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				16.8	0.0	0.0	25.3	19.6	0.0	0.0	34.2	0.0
Incr Delay (d2), s/veh				5.8	0.0	0.0	17.0	0.0	0.0	0.0	11.7	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				10.7	0.0	0.0	8.2	0.0	0.0	0.0	0.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				22.6	0.0	0.0	42.3	19.6	0.0	0.0	45.9	0.0
LnGrp LOS				C	A		D	B	A	A	D	
Approach Vol, veh/h					1470	A		404			14	A
Approach Delay, s/veh					22.6			42.3			45.9	
Approach LOS					C			D			D	

Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				7.1		39.3		23.7				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		37.0		20.0				
Max Q Clear Time (g_c+I1), s				2.5		29.2		17.3				
Green Ext Time (p_c), s				0.0		4.0		0.4				

Intersection Summary	
HCM 6th Ctrl Delay	27.0
HCM 6th LOS	C

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	17	3	293	0	0	0	0	364	804	10	1394	0
Future Volume (veh/h)	17	3	293	0	0	0	0	364	804	10	1394	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	18	3	0				0	396	0	11	1515	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	32	5					0	1972		20	2502	0
Arrive On Green	0.02	0.02	0.00				0.00	0.56	0.00	0.01	0.70	0.00
Sat Flow, veh/h	1537	256	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	21	0	0				0	396	0	11	1515	0
Grp Sat Flow(s),veh/h/ln	1793	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Cycle Q Clear(g_c), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Prop In Lane	0.86		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	37	0					0	1972		20	2502	0
V/C Ratio(X)	0.57	0.00					0.00	0.20		0.54	0.61	0.00
Avail Cap(c_a), veh/h	370	0					0	4647		245	5625	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.2	0.0	0.0				0.0	4.9	0.0	21.4	3.3	0.0
Incr Delay (d2), s/veh	13.0	0.0	0.0				0.0	0.0	0.0	20.4	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	0.0				0.0	0.6	0.0	0.2	1.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	34.1	0.0	0.0				0.0	4.9	0.0	41.8	3.6	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		21	A					396	A		1526	
Approach Delay, s/veh		34.1						4.9			3.8	
Approach LOS		C						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	6.5	30.2		6.9		36.7
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	6.0	57.0		9.0		69.0
Max Q Clear Time (g_c+I1), s	2.3	4.4		2.5		11.6
Green Ext Time (p_c), s	0.0	2.9		0.0		19.1

Intersection Summary	
HCM 6th Ctrl Delay	4.4
HCM 6th LOS	A

Notes

User approved pedestrian interval to be less than phase max green.

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 During Project Construction Conditions AM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	639	0	31	335	62	0	0	9	25
Future Volume (veh/h)	0	0	0	639	0	31	335	62	0	0	9	25
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				695	0	0	364	67	0	0	10	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				996	0		479	503	0	0	23	
Arrive On Green				0.29	0.00	0.00	0.27	0.27	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				695	0	0	364	67	0	0	10	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				7.5	0.0	0.0	7.9	1.1	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				7.5	0.0	0.0	7.9	1.1	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				996	0		479	503	0	0	23	
V/C Ratio(X)				0.70	0.00		0.76	0.13	0.00	0.00	0.43	
Avail Cap(c_a), veh/h				2314	0		1236	1297	0	0	671	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				13.3	0.0	0.0	14.0	11.6	0.0	0.0	20.5	0.0
Incr Delay (d2), s/veh				0.9	0.0	0.0	2.5	0.1	0.0	0.0	11.8	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				2.5	0.0	0.0	2.9	0.4	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				14.2	0.0	0.0	16.6	11.7	0.0	0.0	32.3	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					695	A		431			10	A
Approach Delay, s/veh					14.2			15.8			32.3	
Approach LOS					B			B			C	

Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.5		18.0		17.2				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		9.5		9.9				
Green Ext Time (p_c), s				0.0		2.6		1.4				

Intersection Summary	
HCM 6th Ctrl Delay	14.9
HCM 6th LOS	B

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	45	5	360	0	0	0	0	357	719	6	636	0
Future Volume (veh/h)	45	5	360	0	0	0	0	357	719	6	636	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	49	5	0				0	388	0	7	691	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	80	8					0	965		13	1787	0
Arrive On Green	0.05	0.05	0.00				0.00	0.27	0.00	0.01	0.50	0.00
Sat Flow, veh/h	1624	166	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	54	0	0				0	388	0	7	691	0
Grp Sat Flow(s),veh/h/ln	1789	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.8	0.0	0.0				0.0	2.4	0.0	0.1	3.2	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0				0.0	2.4	0.0	0.1	3.2	0.0
Prop In Lane	0.91		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	88	0					0	965		13	1787	0
V/C Ratio(X)	0.61	0.00					0.00	0.40		0.52	0.39	0.00
Avail Cap(c_a), veh/h	934	0					0	5833		930	8484	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.5	0.0	0.0				0.0	8.0	0.0	13.3	4.1	0.0
Incr Delay (d2), s/veh	6.7	0.0	0.0				0.0	0.3	0.0	27.5	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.0				0.0	0.6	0.0	0.1	0.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	19.1	0.0	0.0				0.0	8.3	0.0	40.8	4.2	0.0
LnGrp LOS	B	A					A	A		D	A	A
Approach Vol, veh/h		54	A					388	A		698	
Approach Delay, s/veh		19.1						8.3			4.6	
Approach LOS		B						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	6.2	13.3		7.3		19.5
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	14.0	44.0		14.0		64.0
Max Q Clear Time (g_c+I1), s	2.1	4.4		2.8		5.2
Green Ext Time (p_c), s	0.0	2.8		0.1		5.7

Intersection Summary		
HCM 6th Ctrl Delay		6.5
HCM 6th LOS		A

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 During Project Construction Conditions AM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1352	0	2	371	21	0	0	51	38
Future Volume (veh/h)	0	0	0	1352	0	2	371	21	0	0	51	38
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1470	0	0	403	23	0	0	55	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1610	0		446	468	0	0	76	
Arrive On Green				0.47	0.00	0.00	0.25	0.25	0.00	0.00	0.04	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1470	0	0	403	23	0	0	55	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				29.3	0.0	0.0	16.2	0.7	0.0	0.0	2.2	0.0
Cycle Q Clear(g_c), s				29.3	0.0	0.0	16.2	0.7	0.0	0.0	2.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1610	0		446	468	0	0	76	
V/C Ratio(X)				0.91	0.00		0.90	0.05	0.00	0.00	0.72	
Avail Cap(c_a), veh/h				1726	0		481	505	0	0	379	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				18.4	0.0	0.0	26.9	21.1	0.0	0.0	35.1	0.0
Incr Delay (d2), s/veh				7.5	0.0	0.0	19.6	0.0	0.0	0.0	12.0	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				12.1	0.0	0.0	9.0	0.3	0.0	0.0	1.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				25.9	0.0	0.0	46.5	21.1	0.0	0.0	47.1	0.0
LnGrp LOS				C	A		D	C	A	A	D	
Approach Vol, veh/h					1470	A		426			55	A
Approach Delay, s/veh					25.9			45.1			47.1	
Approach LOS					C			D			D	

Timer - Assigned Phs	4	6	8
Phs Duration (G+Y+Rc), s	9.0	40.5	24.5
Change Period (Y+Rc), s	6.0	6.0	6.0
Max Green Setting (Gmax), s	15.0	37.0	20.0
Max Q Clear Time (g_c+I1), s	4.2	31.3	18.2
Green Ext Time (p_c), s	0.1	3.2	0.3

Intersection Summary	
HCM 6th Ctrl Delay	30.7
HCM 6th LOS	C

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	37	3	293	0	0	0	0	364	804	32	1410	0
Future Volume (veh/h)	37	3	293	0	0	0	0	364	804	32	1410	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	40	3	0				0	396	0	35	1533	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	61	5					0	1906		56	2486	0
Arrive On Green	0.04	0.04	0.00				0.00	0.54	0.00	0.03	0.70	0.00
Sat Flow, veh/h	1663	125	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	43	0	0				0	396	0	35	1533	0
Grp Sat Flow(s),veh/h/ln	1787	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	1.1	0.0	0.0				0.0	2.6	0.0	0.9	10.4	0.0
Cycle Q Clear(g_c), s	1.1	0.0	0.0				0.0	2.6	0.0	0.9	10.4	0.0
Prop In Lane	0.93		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	66	0					0	1906		56	2486	0
V/C Ratio(X)	0.65	0.00					0.00	0.21		0.63	0.62	0.00
Avail Cap(c_a), veh/h	353	0					0	4451		235	5388	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.6	0.0	0.0				0.0	5.5	0.0	21.8	3.6	0.0
Incr Delay (d2), s/veh	10.4	0.0	0.0				0.0	0.1	0.0	10.9	0.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	0.0				0.0	0.7	0.0	0.5	1.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.0	0.0	0.0				0.0	5.6	0.0	32.7	3.9	0.0
LnGrp LOS	C	A					A	A		C	A	A
Approach Vol, veh/h		43	A					396	A		1568	
Approach Delay, s/veh		32.0						5.6			4.5	
Approach LOS		C						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	7.4	30.4		7.7		37.8
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	6.0	57.0		9.0		69.0
Max Q Clear Time (g_c+I1), s	2.9	4.6		3.1		12.4
Green Ext Time (p_c), s	0.0	2.9		0.1		19.5

Intersection Summary	
HCM 6th Ctrl Delay	5.3
HCM 6th LOS	A

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 With Project Conditions AM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	639	0	10	335	10	0	0	9	5
Future Volume (veh/h)	0	0	0	639	0	10	335	10	0	0	9	5
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				695	0	0	364	11	0	0	10	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1000	0		467	491	0	0	23	
Arrive On Green				0.29	0.00	0.00	0.26	0.26	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				695	0	0	364	11	0	0	10	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1000	0		467	491	0	0	23	
V/C Ratio(X)				0.70	0.00		0.78	0.02	0.00	0.00	0.43	
Avail Cap(c_a), veh/h				2343	0		1251	1313	0	0	679	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				13.1	0.0	0.0	14.1	11.3	0.0	0.0	20.2	0.0
Incr Delay (d2), s/veh				0.9	0.0	0.0	2.8	0.0	0.0	0.0	11.7	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				2.4	0.0	0.0	2.9	0.1	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				13.9	0.0	0.0	17.0	11.3	0.0	0.0	32.0	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					695	A		375			10	A
Approach Delay, s/veh					13.9			16.8			32.0	
Approach LOS					B			B			C	

Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.5		17.9		16.8				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		9.4		9.8				
Green Ext Time (p_c), s				0.0		2.6		1.1				

Intersection Summary	
HCM 6th Ctrl Delay	15.1
HCM 6th LOS	B

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	8	5	360	0	0	0	0	342	719	6	636	0
Future Volume (veh/h)	8	5	360	0	0	0	0	342	719	6	636	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	9	5	0				0	372	0	7	691	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	17	10					0	966		14	1829	0
Arrive On Green	0.01	0.01	0.00				0.00	0.27	0.00	0.01	0.51	0.00
Sat Flow, veh/h	1165	647	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	14	0	0				0	372	0	7	691	0
Grp Sat Flow(s),veh/h/ln	1812	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Prop In Lane	0.64		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	27	0					0	966		14	1829	0
V/C Ratio(X)	0.52	0.00					0.00	0.39		0.52	0.38	0.00
Avail Cap(c_a), veh/h	995	0					0	6132		978	8919	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.5	0.0	0.0				0.0	7.6	0.0	12.6	3.7	0.0
Incr Delay (d2), s/veh	14.8	0.0	0.0				0.0	0.3	0.0	27.4	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.0				0.0	0.5	0.0	0.1	0.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	27.3	0.0	0.0				0.0	7.8	0.0	40.0	3.9	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		14	A					372	A		698	
Approach Delay, s/veh		27.3						7.8			4.2	
Approach LOS		C						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	6.2	12.9		6.4		19.1
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	14.0	44.0		14.0		64.0
Max Q Clear Time (g_c+I1), s	2.1	4.2		2.2		5.0
Green Ext Time (p_c), s	0.0	2.7		0.0		5.7

Intersection Summary	
HCM 6th Ctrl Delay	5.7
HCM 6th LOS	A

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 With Project Conditions PM Peak Hour

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	15	1
Future Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	15	1
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach					No			No			No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1470	0	0	403	1	0	0	16	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1639	0		450	472	0	0	32	
Arrive On Green				0.47	0.00	0.00	0.25	0.25	0.00	0.00	0.02	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1470	0	0	403	1	0	0	16	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				27.4	0.0	0.0	15.4	0.0	0.0	0.0	0.6	0.0
Cycle Q Clear(g_c), s				27.4	0.0	0.0	15.4	0.0	0.0	0.0	0.6	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1639	0		450	472	0	0	32	
V/C Ratio(X)				0.90	0.00		0.90	0.00	0.00	0.00	0.50	
Avail Cap(c_a), veh/h				1818	0		507	532	0	0	399	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				16.9	0.0	0.0	25.4	19.7	0.0	0.0	34.3	0.0
Incr Delay (d2), s/veh				5.9	0.0	0.0	17.2	0.0	0.0	0.0	11.3	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				10.8	0.0	0.0	8.2	0.0	0.0	0.0	0.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				22.8	0.0	0.0	42.6	19.7	0.0	0.0	45.6	0.0
LnGrp LOS				C	A		D	B	A	A	D	
Approach Vol, veh/h					1470	A		404			16	A
Approach Delay, s/veh					22.8			42.5			45.6	
Approach LOS					C			D			D	

Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				7.2		39.4		23.7				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		37.0		20.0				
Max Q Clear Time (g_c+I1), s				2.6		29.4		17.4				
Green Ext Time (p_c), s				0.0		4.0		0.4				

Intersection Summary	
HCM 6th Ctrl Delay	27.2
HCM 6th LOS	C

Notes

Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	17	3	293	0	0	0	0	364	804	11	1395	0
Future Volume (veh/h)	17	3	293	0	0	0	0	364	804	11	1395	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	18	3	0				0	396	0	12	1516	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	32	5					0	1970		22	2503	0
Arrive On Green	0.02	0.02	0.00				0.00	0.55	0.00	0.01	0.70	0.00
Sat Flow, veh/h	1537	256	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	21	0	0				0	396	0	12	1516	0
Grp Sat Flow(s),veh/h/ln	1793	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Cycle Q Clear(g_c), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Prop In Lane	0.86		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	37	0					0	1970		22	2503	0
V/C Ratio(X)	0.57	0.00					0.00	0.20		0.54	0.61	0.00
Avail Cap(c_a), veh/h	370	0					0	4643		245	5621	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.2	0.0	0.0				0.0	4.9	0.0	21.4	3.3	0.0
Incr Delay (d2), s/veh	13.0	0.0	0.0				0.0	0.0	0.0	19.1	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	0.0				0.0	0.6	0.0	0.2	1.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	34.2	0.0	0.0				0.0	4.9	0.0	40.5	3.6	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		21	A					396	A		1528	
Approach Delay, s/veh		34.2						4.9			3.9	
Approach LOS		C						A			A	

Timer - Assigned Phs	1	2		4		6
Phs Duration (G+Y+Rc), s	6.5	30.2		6.9		36.7
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	6.0	57.0		9.0		69.0
Max Q Clear Time (g_c+I1), s	2.3	4.4		2.5		11.6
Green Ext Time (p_c), s	0.0	2.9		0.0		19.1

Intersection Summary	
HCM 6th Ctrl Delay	4.4
HCM 6th LOS	A

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

Appendix J
Economic Analysis

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Economic Impact Assessment of the West O‘ahu Solar Plus Storage Project

University of Hawai‘i West O‘ahu Mauka Property
‘Ewa District, O‘ahu, Hawai‘i

February 2020

Prepared for:

AES Distributed Energy

Prepared by:

Tetra Tech
737 Bishop St., Suite 2340, Mauka Tower, Honolulu, HI 96813

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1.0 Project Description and Overview of Key Findings

AES Distributed Energy (AES DE) is proposing to construct and operate the West Oahu Solar Plus Storage Project (Project). The Project involves construction and operation of a solar photovoltaic and battery energy storage system near Kapolei in West Oahu. The Project area encompasses approximately 95.5 acres of land owned by the University of Hawaii (Figure 1).

The major components of the Project will be an approximately 12.5-megawatt (MW) ground-mounted solar photovoltaic system coupled with a battery energy storage system, and related interconnection and ancillary facilities. The solar photovoltaic panels will be mounted on a fixed-tilt racking system arranged in evenly-spaced rows, and the energy storage system will consist of containerized lithium-ion battery units distributed across the Project area. The solar panels and battery units will connect via underground electrical wiring and collector lines. Interconnection of the Project with the Hawaiian Electric Company (Hawaiian Electric) electrical grid will be via an existing 46kV sub-transmission line that traverses the Project area; a Project substation and interconnection equipment will be located immediately proximate to the existing transmission line, with a short overhead electrical connection to the sub-transmission line.

The Project area will be accessed via the existing gated entry off Palehua Road, which extends west from the intersection of Kualakai Parkway and H-1 Freeway; the Project will utilize a network of existing and new onsite access roads. The Project area will be secured for use by AES DE through an agreement with the University of Hawaii. The Project will be owned and operated by AES DE, and the power generated by the Project will be sold to Hawaiian Electric under a new 25-year power purchase agreement (PPA). The Project will require significant capital investment, with construction expected to take place from December 2020 through December 2021.

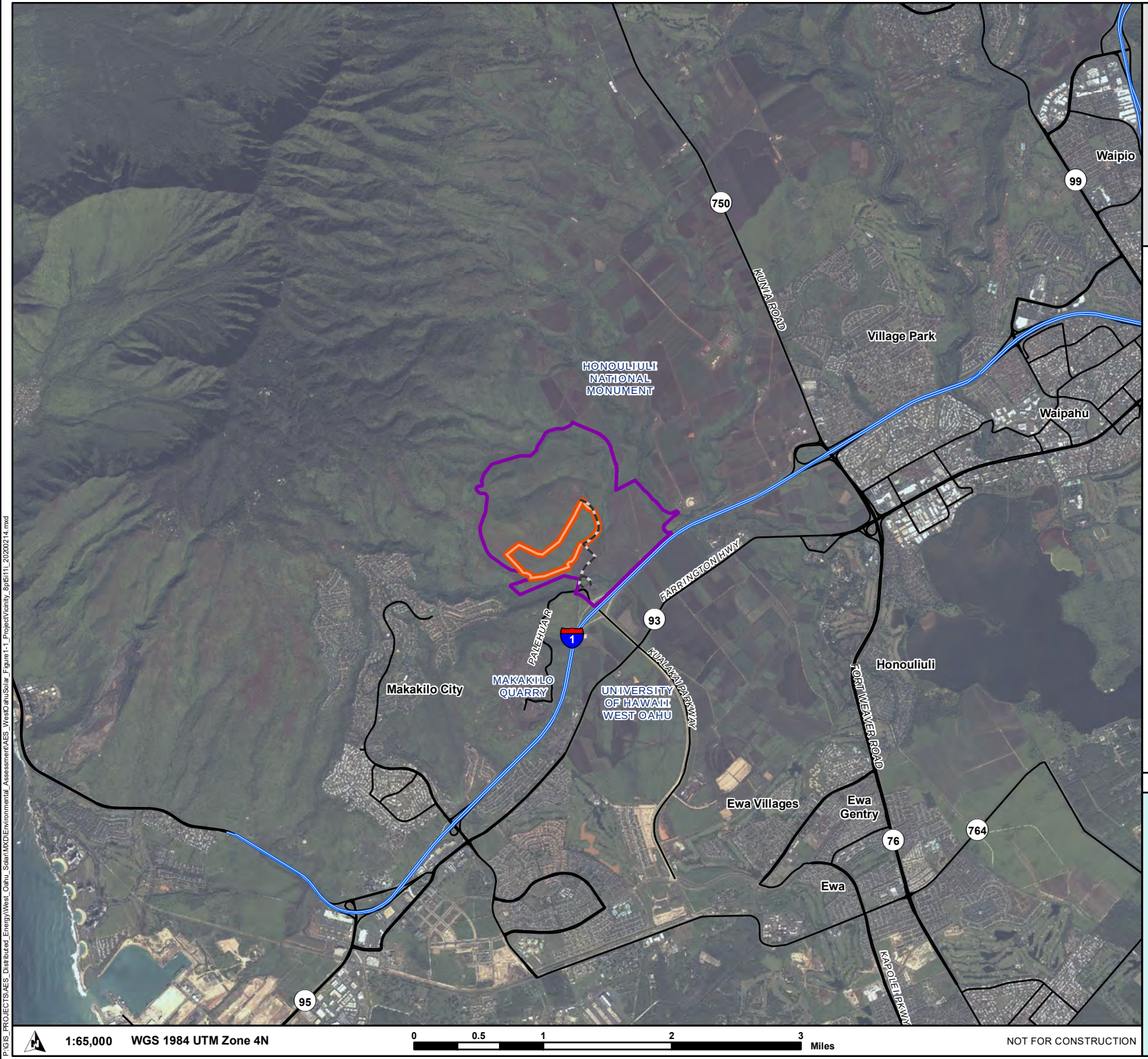
This report, prepared on behalf of AES DE, assesses the economic impact of construction, operation, and decommissioning of the Project. Regional economic impacts are assessed in terms of employment, labor income, and economic output using the IMPLAN economic modeling package, with separate analyses presented for the construction and operation phases.

1.1 One-time Impacts Related to Project Construction

The Project will directly employ workers from Hawaii during construction, as well as support additional secondary (indirect and induced) benefits elsewhere in the state economy (Table 1). In-state expenditures on Project materials and equipment, professional services, such as engineering design, surveying, and permitting, and per diem expenditures by workers on lodging and food, as well as spending on household goods and services by workers living in the area will all support additional economic activity (jobs, labor income, and economic output) elsewhere in the state economy. Economic impacts related to Project construction are considered one-time impacts because they are limited to the construction period.

Key findings related to the economic impacts of Project construction are listed below. Additional detail regarding this analysis is provided throughout the report.

- Overall, Project construction is estimated to support approximately 118 total (direct, indirect, and induced) jobs in the state of Hawaii and approximately $11.3 million in labor income, with a total economic output of approximately $20.2 million.



1:65,000 WGS 1984 UTM Zone 4N

0 0.5 1 2 3 Miles

NOT FOR CONSTRUCTION

P:\GIS_PROJECTS\AES_Distributed_Energy\West_Oahu_Solar\MXD\Environmental_Assessment\AES_WestOahuSolar_Figure1-1_ProjectVicinity_8p5i11_20200214.mxd

Figure 1-1

West Oahu Solar Plus Storage Project

AES Distributed Energy

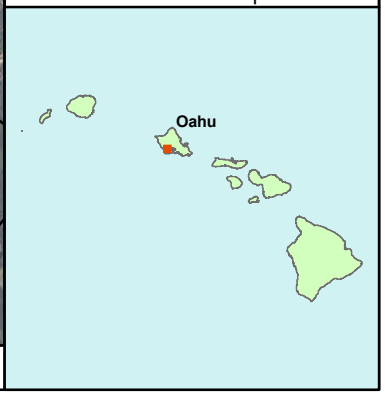
Project Vicinity

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Existing Access Road
- Interstate Highway
- Roadway

TETRA TECH

Reference Map



- Project construction is estimated to result in direct on-site employment of approximately 41 jobs that will be filled by Hawaii residents, with an estimated $6.6 million in related payroll (labor income). Solar construction (and operation) jobs, like these, are part of the innovative renewable energy industry and are considered "green jobs."
- Construction of the Project is also estimated to support employment, income, and output elsewhere in the state economy. Construction of the Project is expected to support an estimated 38 indirect jobs and 38 induced jobs, along with an estimated $2.5 million and $2.2 million in indirect and induced labor income. Indirect and induced output is estimated to be $6.5 million and $7.2 million, respectively.

Table 1. Overview of Estimated Economic Impacts from the West Oahu Solar Project

Type of Impact[1/]	**Employment (FTE)**[2/]	**Labor Income ($000s)**[3/]	**Economic Output ($000s)**[3/]
Construction – One-Time Impacts			
Direct Impacts	41.3	6,577	6,577
Indirect Impacts	37.9	2,520	6,460
Induced Impacts	38.3	2,207	7,199
Total Impacts	**117.5**	**11,303**	**20,236**
Operation – Annual Impacts			
Direct Impacts	2.1	302	437
Indirect Impacts	3.2	251	373
Induced Impacts	2.3	134	437
Total Impacts	**7.6**	**687**	**1,247**

Notes:
1/ Numbers may not sum due to rounding.
2/ Jobs are full-time equivalent (FTE) for a period of one year (1 FTE = 2,080 hours).
3/ Labor income and economic output are expressed in thousands of dollars in Year 2020 dollars.

1.2 Annual Impacts Related to Project Operation

Once the construction phase is complete, operation and maintenance of the Project will continue to contribute to the state economy over the operating life of the Project (Table 1). The Project will provide direct operation-related employment, as well as support secondary (indirect and induced) economic benefits elsewhere in the state economy. In-state expenditures on materials, equipment, and services, as well as Project-related payments to the University of Hawaii for use of the land will all support additional economic activity elsewhere in the state economy. These annual impacts are expected to occur each year the Project operates.

Key findings related to the economic impacts of Project operations are listed below. Additional detail regarding this analysis is provided throughout the report.

- Operation of the Project in the first year following construction is estimated to support approximately 7.6 total (direct, indirect, and induced) jobs in Hawaii and approximately $0.7 million in labor income, with total economic output of approximately $1.2 million. These are annual impacts that will continue for the operating life of the Project.

- In accordance with Hawai‘i Revised Statutes (HRS) 205-4.5(a)(21)(A), AES DE will make the Project area available for compatible agricultural activities (such as honey production and cattle grazing) at a lease rate that is at least 50 percent the fair market rent for comparable properties and also provide support for the long-term success of these activities. These activities will support additional employment opportunities and economic benefits beyond those described above.

1.3 One-Time Impacts Related to Project Decommissioning

As required by HRS 205-4.5(a)(21)(B), the Project will be decommissioned at the end of the its operational life, with all facilities removed and the Project area returned to substantially the same condition as existed prior to Project development. The Project will directly employ workers from Hawaii during decommissioning, as well as support additional secondary (indirect and induced) benefits elsewhere in the regional economy. In-state expenditures on equipment and material recycling/salvage and disposal, and per diem expenditures by workers on lodging and food, as well as spending on household goods and services by workers living in the area will all support additional economic activity elsewhere in the state economy. Economic impacts related to decommissioning are considered one-time impacts because they are limited to the decommissioning period, which will occur at least 25 years in the future. These impacts are not quantified as part of this analysis but are expected to be broadly similar to those anticipated during construction.

2.0 Methodology

2.1 Economic Impact Analysis

The economic impact of the Project will occur in three phases: 1) the initial construction phase; 2) following construction, the operations and maintenance phase, and 3) decommissioning of the Project at the end of the operational phase. This report assesses secondary employment and economic activity related to the construction and operations phases using IMPLAN, a commercially available economic modeling package widely used to assess the economic impacts of renewable energy and many other types of projects. Impacts are assessed at the state-level using IMPLAN data for 2018, the most recent year for which data are available. The analysis assesses secondary impacts associated with project-related expenditures in the analysis area (the state of Hawaii), with separate analyses prepared for the construction and operation phases of the project. Secondary impacts, estimated as indirect and induced effects, are expressed in terms of employment, labor income, and economic output. Economic impacts associated with decommissioning are addressed qualitatively.

2.1.1 Economic Impact Model (IMPLAN)

The IMPLAN model divides the economy into 546 sectors including government, households, farms, and various industries, and models the linkages between the various sectors. The linkages are modeled through input-output tables that account for all dollar flows between different sectors of the economy. Using national industry and state-level economic data derived from the U.S. Bureau of Economic Analysis, U.S. Census, and other government sources, IMPLAN models how spending in one sector of the economy is spent and re-spent in other sectors of the economy. By tracing these linkages, the model approximates the flows of initial project spending through the local economy based on the supply lines connecting the various economic sectors. These linkages vary by sector and also through regional

differences in spending and employment patterns. The amount spent locally decreases with each successive transaction away from the initial expenditure due to the effects of savings, taxes, or other activities that happen outside the local economy, known as leakages.

The economic relationships modeled by IMPLAN allow the user to estimate the overall change in the economy that would result from construction and operation of a proposed project. The dollars spent on project construction and operation within the selected analysis area (the state of Hawaii, in this case) are analyzed to determine the total economic impact within that area. The direct investments in project construction and operation trigger successive rounds of spending that result in an overall increase in employment, labor income, and economic output in the local economy. Construction-related impacts are assessed as one-time impacts; operations and maintenance-related impacts are modeled as annual impacts.

2.1.2 Impact Types

Economic multipliers derived from the model are used to estimate total economic impacts. Total economic impacts consist of three components: direct, indirect, and induced impacts. These three components may be described as follows:

- The *direct* impact component consists of expenditures made specifically for the proposed facility, such as construction labor and materials. These direct impacts generate economic activity elsewhere in the local economy through the multiplier effect, as initial changes in demand "ripple" through the local economy and generate indirect and induced impacts.
- *Indirect* impacts are generated by the expenditures on goods and services by suppliers who provide goods and services to the construction project. Indirect effects are often referred to as "supply-chain" impacts because they involve interactions among businesses.
- *Induced* impacts are generated by the spending of households associated either directly or indirectly with the proposed facility. Workers employed during construction, for example, will use their income to purchase groceries and other household goods and services. Workers at businesses that supply the facility during construction or operation will do the same. Induced effects are sometimes referred to as "consumption-driven" impacts.

2.1.3 Impact Measures

Impacts are assessed using the following measures that are reported by the IMPLAN model:

- *Output* – the value of goods and services produced, which serves as a broad measure of economic activity.
- *Jobs* – measured as the average number of employees engaged in full- or part-time work. For this analysis, model outputs are subsequently adjusted to full-time equivalents (FTEs) using coefficients provided by IMPLAN. [1]
- *Personal income* (or labor income) – expressed as the sum of employee compensation and proprietary income.

[1] One FTE job equates to one full-time job for one year or 2,080-hour units of labor. Part-time or temporary jobs constitute a fraction of a job. For example, if an engineer works just 3 months on a solar project, that would be considered one-quarter of an FTE job. FTEs are also sometimes referred to as job-years.

- Employee compensation (wages) includes workers' wages and salaries, as well as other benefits such as health, disability, and life insurance; retirement payments; and non-cash compensation.
- Proprietary income (business income) represents the payments received by small-business owners or self-employed workers.

2.2 Impact Sources

2.2.1 Construction

Project construction is expected to start in December 2020, with construction activities expected to extend approximately 12 months through December 2021. Based on similar project experience, AES DE estimates that Project construction will directly employ an average of 55 workers on-site, including technicians, laborers, foremen, equipment operators, and construction managers, with 75 percent of these positions expected to be filled by Hawaii residents (for a total of 41 jobs). These estimates do not include workers directly employed elsewhere in Hawaii providing Project-related technical services such as engineering design and permitting. Additional workers will also be employed to develop the interconnection facilities required to facilitate the transfer of electricity from the Project to the Hawaiian Electric grid.

AES DE has indicated that relationships and access to local labor are one of the major criteria they consider when selecting contractors or subcontractors. AES DE makes it a priority to hire skilled labor from the area where a Project is to be located, with relatively few outside consultants except for specialty trades and professions, many of whom are employed to train the local workforce. This emphasis on local hiring has also been noted elsewhere in the solar industry (see, for example, The Solar Foundation 2019).[2]

Construction and procurement costs for this analysis were provided by AES DE. The largest share of the overall Project cost consists of the procurement of Project-related materials and equipment (solar modules, inverters, battery energy storage system, electrical components, and mounting), which together account for more than half of the total estimated Project cost. Procurement expenditures are expected to occur almost entirely outside the state of Hawaii, with only a very small share of expenditures on electrical components and cabling assumed to occur in-state.

Expenditures that are expected to occur in Hawaii include those related to Project development, engineering and surveying, legal services, interconnection, and other costs. The shares of these expenditures expected to occur in-state were estimated by AES DE. Installation labor-related expenditures will also occur in-state and result in secondary economic impacts elsewhere in the state economy. Installation labor costs in this context refers to wage and salary payments to construction workers employed directly on-site. Payments to construction workers who normally reside in Hawaii are assessed as household income, a share of which will be spent in-state and are captured in the IMPLAN model as induced impacts. Out-of-state workers relocating to the Project area for the duration of their on-site employment will also spend money locally. In-state expenditures by these workers were estimated

[2] The Solar Foundation 2018. National Solar Jobs Census 2018. The Solar Foundation. Available online at: https://www.thesolarfoundation.org/national/

using per diem information provided by AES DE and assigned to the appropriate economic sectors in IMPLAN, primarily those related to lodging/housing, food, transportation, and incidentals.

2.2.2 Operation

Once the Project construction phase is complete, operation and maintenance of the Project will continue to contribute to the state economy over the operating life of the Project, which is expected to be up to 25 years. The Project will provide direct operation-related employment, as well as support secondary (indirect and induced) economic benefits elsewhere in the state economy. Direct employment over the operating life of the Project will include jobs related to operations and maintenance, as well development and engineering. In-state expenditures on materials, equipment, and services, as well as Project-related payments to the University of Hawaii for the use of the land will all support additional economic activity elsewhere in the state economy. Project-specific operation and maintenance and development and engineering costs developed by AES DE were used for this analysis. Operation impacts are annual impacts that are expected to occur each year the Project operates.

2.2.3 Decommissioning

Based on the approved PPA with Hawaiian Electric, the Project is expected to have an operational life of at least 25 years (through 2046). At that point in time, the facility may be re-powered under a re-negotiated PPA or decommissioned. In accordance with the requirements of HRS Chapter 205-4.5(a)(21), financial assurance for decommissioning will be provided to the City & County of Honolulu Planning Commission prior to the commencement of commercial generation.

Decommissioning will involve removal of all equipment and materials associated with the Project and return of the Project area to substantially the same condition as existed prior to Project development. The Project will directly employ workers from Hawaii as part of equipment and material removal and site restoration activities. Decommissioning will also indirectly support economic activity elsewhere in the state economy, as equipment and materials are either salvaged or recycled or disposed of at authorized sites on O‘ahu, in accordance with applicable laws. Salvage/recycle and disposal activities will involve licensed sub-contractors, local waste haulers and/or other facilities that recycle and/or accept construction/demolition waste. Spending on household goods and services by workers directly or indirectly employed during decommissioning will also support additional economic activity (jobs, labor income, and economic output) elsewhere in the state economy.

2.3 Study Limitations

The results presented in this report are indicative, preliminary estimates based on a certain set of assumptions and estimated model inputs. These assumptions and inputs are based on the best data and information available at this stage in the Project development process. Other key modeling inputs include the share of expenditures expected to occur in-state, as well as the share of workers expected to be hired in-state. The share of equipment, materials, and labor procured locally could vary, as could the duration of construction. Material and labor costs could also vary based on market conditions at the time of procurement and/or construction.

This analysis does not assess net jobs, rather it presents total or gross jobs that would be supported by Project construction and operation. A person employed during Project construction could, for example, have been employed elsewhere in the state beforehand, and, as a result, not all direct jobs represent a net

additional job. A net jobs analysis would subtract job losses in other areas from the direct job gains of the new project to identify only the net increase in jobs. This type of analysis is speculative and dependent on numerous interactions and, therefore, it is more reliable and standard practice to limit the analysis to total or gross jobs created by the Project. Similarly, jobs supported elsewhere in the economy (i.e., indirect and induced jobs), identified as FTEs, are not necessarily additional jobs. Secondary impacts may support workers in their existing positions, helping them retain their jobs or expand their hours.

3.0 Economic Impacts

3.1 Construction Phase Impacts

Estimated construction phase impacts for the state of Hawaii are summarized in Table 2. These estimates are one-time impacts for the 12-month construction period developed using the IMPLAN model for the state of Hawaii. Job estimates are presented in FTEs or job-years, with each identified job representing 12 months (2,080 hours) of employment. Construction of the Project is estimated to involve approximately 41 on-site FTE jobs that would be filled by in-state workers. On-site jobs expected to be filled by in-state workers include those associated with site work, foundations, electrical work, and other related labor needed to construct the Project. Additional on-site positions that would be filled by out-of-state workers are not included in these estimates. The impact of estimated per diem spending by out-of-state workers is, however, captured in the indirect and induced impact estimates.

As noted above, out-of-state hires are expected to be limited to specialty trades and professions, many of whom will be employed to train the local workforce. Further, jobs directly related to the construction and operation of solar facilities are considered "green jobs," which are generally defined as jobs related to preserving or restoring the environment.[3]

Construction of the Project would also support employment, labor income, and economic output in other sectors of the state economy, with indirect impacts estimated to support approximately 38 jobs and induced impacts estimated to support a further 38 jobs (Table 2). Indirect impacts include workers directly employed elsewhere in Hawaii providing Project-related technical services such as engineering design and permitting, as well as workers employed to interconnect the Project to the Hawaiian Electric electrical grid. Overall, construction of the Project is estimated to support a total of 118 jobs in the state of Hawaii and approximately $11.3 million in labor income, with total economic output of approximately $20.2 million.

[3] See, for example, U.S. Bureau of Labor Statistics, *Measuring Green Jobs*. Available online at: https://www.bls.gov/green/home.htm#definition

Table 2. Estimated One-Time Construction Phase Impacts

Type of Impact[1/]	Employment (FTE)[2/]	Labor Income ($000s)[3/]	Economic Output ($000s)[3/]
Direct Impacts	41.3	6,577	6,577
Indirect Impacts	37.9	2,520	6,460
Induced Impacts	38.3	2,207	7,199
Total Impacts	**117.5**	**11,303**	**20,236**

Notes:
1/ Estimates are for the entire 12-month construction period. Numbers may not sum due to rounding.
2/ Jobs are FTE for a period of one year (1 FTE = 2,080 hours). Direct jobs include those directly employed on-site during construction. Additional on-site positions that would be filled by out-of-state workers are not included in these estimates.
3/ Labor income and economic output are expressed in thousands of dollars in Year 2020 dollars.

3.2 Annual Operation Phase Impacts

Estimated operation phase impacts for the state of Hawaii are summarized in Table 3. These estimates are annual impacts based on estimated expenditures for the first year of operation. Operation of the Project is estimated to support the annual equivalent of approximately 2.1 direct jobs. Operation of the Project will also support employment, labor income, and economic output in other sectors of the state economy. Indirect impacts are estimated to support approximately 3.2 jobs, with induced impacts estimated to support approximately 2.3 jobs (Table 3). Estimated indirect and induced impact estimates include the impacts of Project-related payments to the University of Hawaii for use of the land, which will potentially support employment at the university, as well as elsewhere in the statewide economy. Overall, operation of the Project in the first year following construction is estimated to support approximately 7.6 total (direct, indirect, and induced) jobs in Hawaii and approximately $0.7 million in labor income, with total economic output of approximately $1.2 million. These estimated annual impacts are expected to occur each year that the Project operates.

Table 3. Estimated Annual Operation Phase Impacts

Type of Impact[1/]	Employment (FTE)	Labor Income ($000s)[1/]	Economic Output ($000s)[1/]
Direct Impacts	2.1	302	437
Indirect Impacts	3.2	251	373
Induced Impacts	2.3	134	437
Total Impacts	**7.6**	**687**	**1,247**

Notes:
FTE – Full-time equivalent
1/ Estimates are annual impacts that would occur each year the Project is in operation. Estimates are for the first year of operation. Numbers may not sum due to rounding.
2/ Jobs are FTE for a period of one year (1 FTE = 2,080 hours).
3/ Labor income and economic output are expressed in thousands of dollars in Year 2020 dollars.

In addition, in accordance with HRS 205-4.5(a)(21)(A), AES will make the Project area available for compatible agricultural activities (such as honey production and cattle grazing) at a lease rate that is at least 50 percent the fair market rent for comparable properties and also provide support for the long-term

success of these activities. These activities will support additional employment opportunities and economic benefits beyond those described above.

3.3 Decommissioning Impacts

The Project will directly employ workers from Hawaii during decommissioning, as well as support additional secondary (indirect and induced) benefits elsewhere in the state economy. In-state expenditures on equipment and material recycling/salvage and disposal, and per diem expenditures by workers on lodging and food, as well as spending on household goods and services by workers living in the area will all support additional economic activity (jobs, labor income, and economic output) elsewhere in the state economy. Economic impacts related to decommissioning are considered one-time impacts that are limited to the decommissioning period, which will occur at least 25 years in the future. These impacts are not estimated here but are expected to be broadly similar to those anticipated during construction.

Appendix K
Community Meeting and Outreach Summary Report

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West Oahu Solar-Plus-Storage Project
COMMUNITY MEETING AND OUTREACH
SUMMARY REPORT

Prepared For:
AES Distributed Energy

March 31, 2019

Background
AES Distributed Energy was recently selected by The Hawaiian Electric Companies (HECO) to develop a solar-plus-storage project on Oahu on the leeward portion of the island near Makakilo.

As an initial step in the process, HECO has directed AES Distributed Energy to conduct a community meeting to describe the proposed project in further detail and gather community input. AES Distributed Energy retained the services of Peters Communications to assist with this initiative.

This report is a preliminary summary of the outreach activities conducted to date along with the community's feedback and questions received thus far. A community meeting was conducted on Tuesday, February 26, 2019 from 5:30 p.m. to 7:30 p.m. at Kapolei High School.

Community Outreach
Prior to the scheduled community meeting, the AES project team conducted a strategic outreach effort to engage and inform key elected officials and community leaders.

- *Council Member Kymberly Pine* – CM Pine was reached early in the process to discuss project details and to introduce principals of AES Distributed Energy. Her preliminary comments cited visual impacts as the probable primary source of concern from community members. She also asserted that the community is growing increasingly concerned that the process for renewable energy projects is being rushed without meaningful opportunities for the community to consider and comment. Her suggestions:
    - Proactively offer solutions/mitigation measures for visual impacts including landscaping. She also suggested that AES consider using native plants and potentially partner with the Malama Learning Center. She urged AES to show visualizations of the project with landscaping to indicate to the community that AES is mindful of their concerns.
    - CM Pine recommended that AES respectfully inform the community that there will be ample opportunity to participate in the approval process for the project. She also recommended AES explain that the project is not approved until it goes through the land use and entitlement process which will be months down the road.

Community Outreach (Cont'd)

- *Rep. Ty Cullen* – Preliminary outreach was conducted with Rep. Cullen's office on Monday, February 11, 2019 to provide a project factsheet along with the community meeting notice. A follow up meeting with Rep. Cullen was conducted on Tuesday, February 19, 2019. He thought the project seemed fine but was mindful that visual impacts would probably be an issue of concern.
- *Rep. Sharon Har* – Preliminary outreach was conducted with Rep. Har's office on Monday, February 11, 2019 to provide a project factsheet along with the community meeting notice. A follow up meeting with Rep. Har was conducted on Thursday, February 21, 2019. Rep. Har was very supportive. She was familiar with the coal plant in Kalaeloa and thought that AES had a good reputation. She did not anticipate significant opposition.
- *Sen. Mike Gabbard* – Preliminary outreach was conducted with Sen. Gabbard's office on Monday, February 11, 2019 to provide a project factsheet along with the community meeting notice. A follow up meeting with Sen. Gabbard was conducted on Thursday, February 21, 2019. Sen. Gabbard shared his support for the project. He further suggested partnering with Gary Maunakea-Forth of Ma'o Farms to explore agricultural opportunities as a component of the project. Mr. Maunakea-Forth provides work and education opportunities at his farm for disadvantaged youth from the leeward area. He also suggested UH West Oahu's agriculture program might be a good partner.
- *Maeda Timson* – An AES project consultant conducted early outreach with well-known community leader Maeda Timson (former neighborhood board chair and member of the Hawaii Community Development Authority Kalaeloa board). Based on project information she was provided, Ms. Timson thought AES was being thorough and careful with its initial community outreach efforts and meeting. She did not think the project would be as controversial as other renewable energy projects being proposed in West Oahu given its location and the partnership with landowner University of Hawaii.
- *Dr. Kioni Dudley* – Preliminary outreach was conducted with Dr. Dudley, former neighborhood board chair and community activist. The project team is awaiting a response to a request for a follow up in-person meeting to discuss the project in further detail.
- *Jack Legal* – Preliminary outreach was conducted with Mr. Legal, current neighborhood board chair. The project team is awaiting a response to a request for a follow up in-person meeting to discuss the project in further detail.

Community Meeting Notification

In addition to strategic community outreach, the AES project team issued a community meeting notice via first class mail through the US Postal Service to approximately 2,264 addresses in east Makakilo. See 'Appendix A' for a copy of the meeting notice. See 'Appendix B' for a map of the area targeted for direct mail.

Community Meeting Details

Date: Tuesday, February 26, 2019
Time: 5:30 – 7:30 p.m.
Location: Kapolei High School Cafeteria
91-5007 Kapolei Parkway
Kapolei, HI 96707
Presenters: Rob Cooper – Business Development Director, AES
Sam Ley – Senior Energy Systems Engineer, AES

ATTENDEES

19 individuals attended the community meeting. Notable attendees included West Oahu community member and former Kapolei/Makakilo neighborhood Board Chair Maeda Timson as well as staff from Sen. Gabbard's office.

COMMUNITY QUESTIONS/COMMENTS

Following the presentation by AES project representatives Cooper and Ley, meeting participants posed a number of questions in the following categories:

- **Subject: Vandalism and Safety**

  Questions/Comments
  - We have vandalism problems around here. How do you propose to address that?

  Responses
  - Safety is our main concern. If someone breaks a panel, we'll be a little disappointed but we're more concerned about the broken glass hurting someone.
  - We will have fencing and surveillance cameras to help prevent this. We'll also have operators on site to help deter people from entering the property to damage equipment.
  - During construction, we'll also have 24-hour security to prevent theft and damage.
  - It is also important to know that the primary access to the site is currently secured with through a gate and roadway that is maintained by Grace Pacific. They have onsite security at that gate so it would be another layer of safety and security to deter vandalism.

Community Meeting Details (Cont'd)

- **Subject: Agricultural Land**

  Questions/Comments:

  - You mentioned agriculture lands B, D and E for the property. Can you explain how good the agricultural lands are? Not just for grazing animals because we graze cows there now. Is this area good to plant?

  Responses:

  - The State categorizes lands in order from A through E. A represents the prime ag lands that are currently being used for agricultural use. B lands are just below that tier but are typically not used for active farming. We have some B lands and as you mentioned this are currently used for grazing. In the past, it was used for sugarcane production.
  - The good news is that we're sensitive to this and our operations are design to be completely removed so that the land can be restored to previous conditions and return to agricultural use.
  - D and E lands are generally considered poor conditions for growing crops. They're typically very rocky or very steep and are generally considered unproductive.
  - It should be noted that UH West Oahu has A lands below that they intend to continue to use for agricultural purposes. They set aside the less productive B, D and E lands for renewable energy production.
  - Another thing we want to be sure everyone is aware of is that our intention here is to find compatible agriculture uses on the B lands. The good thing about solar is that it is not an exclusive use of the land. We want to be able to do both agricultural production as well as solar energy. There are multiple benefits here. The community receives renewable energy and reduces carbon footprint, the University receives revenue, and we can still generate agricultural production.

  Questions/Comments:

  - Just to be clear, the B lands here were only categorized as such because they were inaccessible. Now that there will be access, I would urge you to consider partnering with others like Malama Learning Center to do some planting; just something to think about.

- **Subject: Traffic and Access**

  Questions/Comments:

  - How do you intend to access the site? Is it through Makakilo Drive or through the quarry road? This is important because using Makakilo Drive will add to traffic and damage the road with heavy trucks.

  Responses:

  - AES has already reached out to Grace Pacific. We will be accessing the property through their quarry road and security gate. We're very sensitive to the traffic concerns. By utilizing the quarry road, we'll have direct access to the freeway and will be able to minimize area traffic.

Community Meeting Details (Cont'd)

- **Subject: Decommissioning**

  Questions/Comments:

  - With regard to your comment about decommissioning, is that part of a written agreement or is that something you're just saying? I ask because we've been burned before by developers who've said one thing but done another.

  Responses:

  - Yes, it will be in writing. We will have an agreement with UH West Oahu. In addition, we will float a bond to cover the cost of decommissioning and the removal of all equipment, which will be disposed and recycled as appropriate. In doing so, we will be restoring the property to the same condition in which we started.
  - We should also note, this isn't just a promise or agreement. This is also a requirement under state law. Under the rules for use of agricultural lands for renewable energy projects, we will be required by the Land Use Commission and Public Utilities Commission to decommission our property as described and issue a bond at the start to cover those costs.

Email Comments

AES has also established a dedicated email address to capture additional comments and feedback from the community. AESWestOahuSolar@aes.com has been shared with members of the community, area leaders and elected officials to raise awareness of the continuing opportunity for the community to weigh in on the project. The email address has been active from February 12 and will remain active until March 28, 2019 (30 days after the public meeting).

As of March 28, 2019, AES received only one email from an individual indicating their regrets for not being able to attend the meeting in person.

Conclusion

The AES project team recognizes we are still in the preliminary phases of the project and that significant outreach activities must be undertaken as we proceed. If the project receives preliminary approval from the Public Utilities Commission, AES has indicated a strong commitment to continuing outreach efforts to address potential concerns and raise awareness about the benefits of the project.

If you have any questions or concerns regarding this preliminary summary and report, please don't hesitate to contact Shane Peters at shane@peters-comm.com or (808) 421-9879.

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APPENDIX A

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AES Distributed Energy, Inc.
West Oahu Solar-Plus-Storage Project
Invitation to Community Meeting – Feb 26th

Purpose:

The AES Distributed Energy, Inc. (AES) team would like to invite you to a community meeting for a proposed solar + energy storage project in the West Oahu region. The project is in its initial stages and AES hopes to share information, solicit feedback and questions, and engage the community.

Community Meeting Location & Time:

DATE:	Tuesday, February 26
TIME:	5:30 p.m. to 7:30 p.m.
LOCATION:	Kapolei High School - Cafeteria 91-5007 Kapolei Parkway Kapolei, HI 96707

About AES:

AES Distributed Energy was recently selected by the Hawaiian Electric Companies for three of its eight solar-plus-storage projects in Hawaiʻi, representing the largest addition of renewable energy in the state's history. One of AES Distributed Energy's projects is on the island of Oahu with Hawaiian Electric Company and the other two projects are on Hawaiʻi Island and Maui.

AES Distributed Energy is a wholly owned subsidiary of The AES Corporation (NYSE: AES).
With a presence in Hawaiʻi for more than 25 years, AES shares the state's commitment to a greener energy future and is helping the state realize its goal of reaching 100% renewable energy by 2045.

Project Location:

The proposed AES West Oahu project is located on a portion of land owned by the University of Hawaii located mauka of the University of Hawaii West Oahu campus and the H-1 freeway near Kualakai Parkway.

AES West Oahu Project Details:

- 12.5 MW of solar PV plus 50 MWh battery energy storage system
- Enough energy to offset ~2,335 homes electricity use per year

Questions/Comments:

AES welcomes questions and comments by email at AESWestOahuSolar@aes.com.

AES Distributed Energy
4875 Pearl East Circle, Suite 200
Boulder, CO 80301
aesdistributedenergy.com

Project Location Map:

AES Distributed Energy
4875 Pearl East Circle, Suite 200
Boulder, CO 80301
aesdistributedenergy.com

APPENDIX B

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COMPACT
MAKAKILO HEIGHTS
MAKAKILO CITY
EAST KAPOLEI
Makakilo Drive
Makakilo Drive
Farrington Highw
Kualakai Parkway
Kualakai Parkway
93
93
93
93
93
Fort Barrette Road
Kapolei Parkway
Kapolei Parkway
Kapolei Parkway
Kapolei Parkway
0.5 mi.
Map Dimensions: 2.86 mi x 4.3 mi
Map data © OpenStreetMap contributors, CC BY-SA

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Appendix L
Pre-Assessment Scoping Letter

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August 23, 2019

Subject: AES West O'ahu Solar Plus Storage Project, 'Ewa District, O'ahu; TMK 9-2-002:007
Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment

Dear Interested Party,

AES Distributed Energy, Inc. (AES) is proposing to construct and operate a solar photovoltaic and battery energy storage project on land owned by the University of Hawai'i (UH) approximately three miles northeast of Kapolei on the island of O'ahu. The project area encompasses a total of approximately 80 acres in an area commonly referred to as the UH West O'ahu Mauka Property and is within tax map key (TMK) 9-2-002:007. As the land is owned by UH, the project would involve use of State-owned land, thus requiring compliance with Hawaii Revised Statutes (HRS) Chapter 343. Pursuant to the requirements of HRS Chapter 343 and Hawaii Administrative Rules (HAR) §11-200, AES is preparing an environmental assessment (EA) to evaluate the potential environmental effects of the project.

As part of the environmental review process, pre-assessment consultation is being conducted to obtain input on the scope of issues to be considered in the Draft EA. An overview of the project and a location map are attached. We are requesting input regarding the project, including concerns related to particular environmental resources, as well as relevant information that should be considered in the evaluation.

Please provide comments regarding the scope of the EA in writing via U.S. postal mail or e-mail to Lisa Kettley at Tetra Tech (737 Bishop Street, Suite 2340, Honolulu, Hawaii 96813 or lisa.kettley@tetratech.com). Comments must be postmarked by September 30, 2019 to be considered in the Draft EA.

Thank you for your participation in the environmental review process for the proposed project.

Sincerely,

Nick Molinari
AES Distributed Energy

Attachments: Project Overview
Location Map

AES West Oahu Solar Plus Storage Project

AES Distributed Energy (AES) is proposing to construct and operate the West Oahu Solar Plus Storage Project (Project) on land owned by University of Hawaii (UH) approximately 3 miles northeast of Kapolei, on the southwest side of Oʻahu. The Project area encompasses approximately 80 acres in an area commonly referred to as the UH West Oʻahu Mauka Property and is within tax map key (TMK) 9-2-002:007. The Project area is shown in the attached figure.

The concept for a renewable energy facility on the UH West Oʻahu Mauka Property was originally identified by UH as part of their 2014 Land Master Plan. In coordination with UH, AES developed a preliminary layout for a solar plus storage facility and submitted a proposal to Hawaiian Electric Company (Hawaiian Electric) in response to their *Request for Proposals for Variable Renewable Dispatchable Generation for the Island of Oʻahu*, issued in February 2018. This competitive procurement process for renewable energy projects specifically targeted projects that would satisfy the resource needs identified in Hawaiian Electric's 2016 Power Supply Improvement Plan as part of the effort to meet Hawaii's goal of generating 100 percent of its energy needs from renewable sources by 2045. The Project is one of three selected by Hawaiian Electric for the island of Oʻahu.

The Project would consist of an approximately 12.5-megawatt (MW) ground-mounted solar PV system, coupled with a 50 MW-hour battery energy storage system and related interconnection and ancillary facilities. The major components of the Project would include:

- **Solar Panels:** The solar PV system would include a series of panels arranged into arrays consisting of evenly-spaced rows. The panels would be mounted on a racking system installed on posts.
- **Battery Energy Storage System:** The battery energy storage system would include containerized lithium-ion battery units (each approximately the size of a shipping container) distributed across the Project area. The battery units would incorporate several layers of protection to avoid failures and to contain potential hazardous substances, including integrated monitoring and circuit protection, a self-contained heating ventilation air cooling system, and a fire detection and suppression system.
- **Electrical Conduit:** The solar panels and battery units would connect with a Project substation via underground electrical conduit. The conduit would be installed in trenches located at the terminus of each solar panel array.
- **Substation and Interconnection Facilities:** The substation would be constructed adjacent to an existing Hawaiian Electric 46kV transmission line that traverses the Project area and would facilitate interconnection with the electrical grid; an overhead electrical connection between the substation and existing transmission line may be required for interconnection.
- **Access and Site Work:** The Project would be accessed via the existing gated entry off Kualakai Parkway (near the intersection with Interstate H-1) and would utilize a network of existing and new onsite access roads. Some road improvements may be needed to facilitate access within the Project area. In addition, some site grading would be needed to accommodate the Project facilities and to comply with stormwater and civil engineering requirements.
- **Agricultural Activities:** The Project would be located within the State agricultural district with soils that are classified by the Land Study Bureau as Class B, D and E. Pursuant to Hawaiʻi Revised Statutes (HRS) Chapter 205, the Project area would also be made available for compatible agricultural activities.

The Project area will be secured for use by AES through a long-term lease with UH. The Project would be constructed and operated by AES, and the power generated by the Project would be sold to Hawaiian Electric under a new 25-year power purchase agreement (PPA). The PPA was executed in February 2019 and is currently under review by the Public Utilities Commission (PUC). It is anticipated that construction would require approximately 12-15 months, with commercial operations commencing in 2021 or 2022. Once operational, the Project would provide the energy needed to power approximately 4,600 homes on Oʻahu each year, offsetting approximately 545,794 barrels of fuel and approximately 244,394 tons of greenhouse gas emissions over the life of the Project.[1]

[1] Hawaiian Electric Company PUC filing

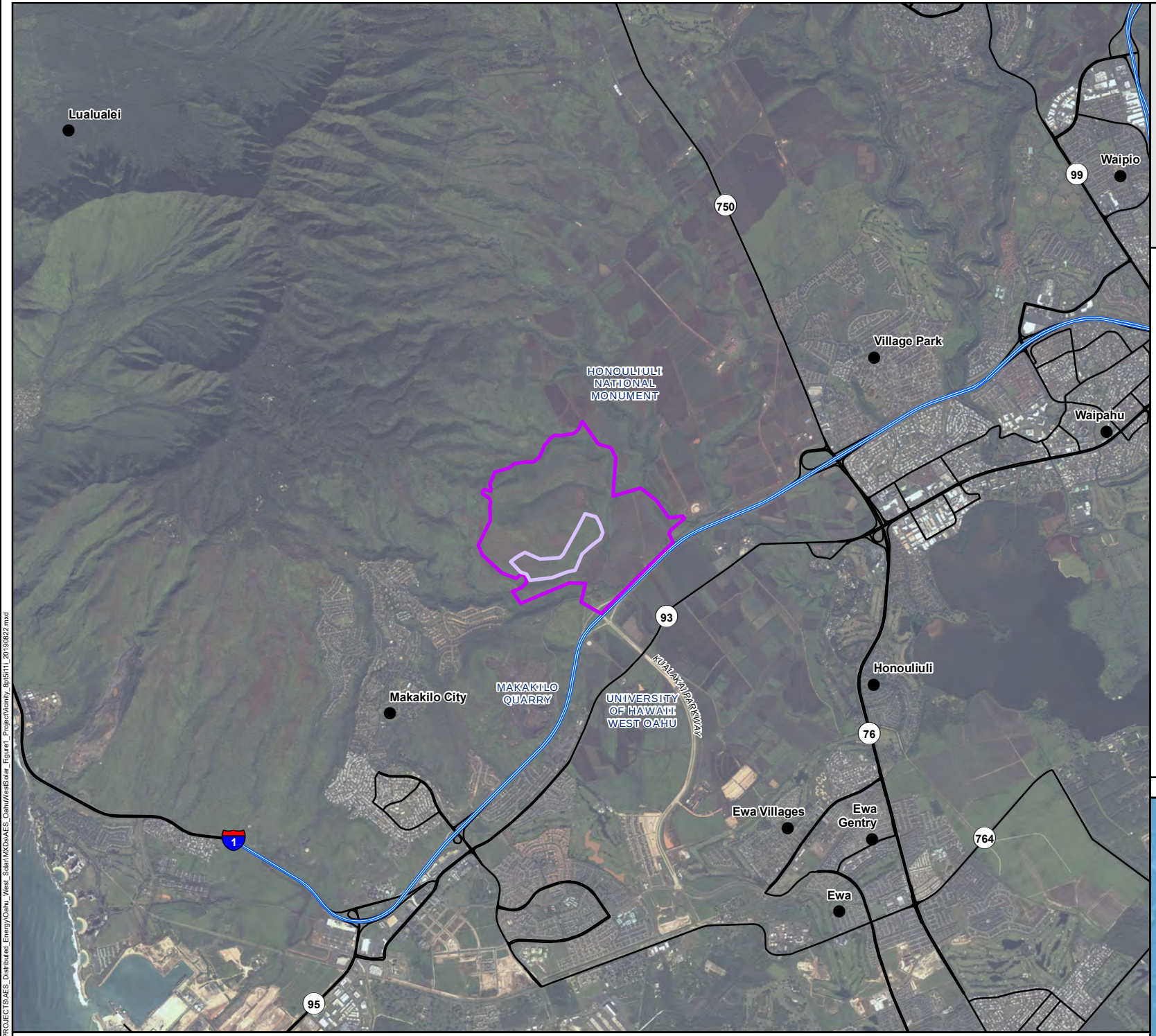
Figure 1

Oahu West Solar Project

AES Distributed Energy

Project Vicinity

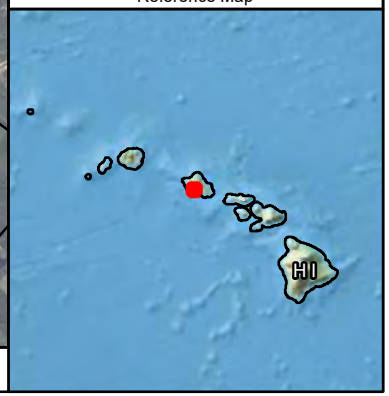
HONOLULU COUNTY, HI



Project Area
Property Boundary
Interstate Highway
Roadway
City/Town

TETRA TECH

Reference Map



1:65,000 WGS 1984 UTM Zone 4N

0 0.5 1 2 3 Miles

NOT FOR CONSTRUCTION

P:\GIS_PROJECTS\AES_Distributed_Energy\Oahu_West_Solar\MXDs\AES_OahuWestSolar_Figure1_ProjectVicinity_8p15x11_20190822.mxd

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Appendix M
Scoping Comments and Responses

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AES Distributed Energy West Oahu Solar Plus Storage Project
Pre-Assessment Scoping Comments and Responses

Pre-Assessment Scoping Comment[1]	Response
City and County of Honolulu Department of Parks and Recreation (letter dated August 29, 2019)	
The Department of Parks and Recreation has no comment. As the proposed project will have no impact on any program or facility of the Department, you may remove us as a consulted party to the balance of the EIS process.	It is noted that the Project would not impact any Department of Parks and Recreation programs or facilities. As requested, the Department of Parks and Recreation has been removed from the distribution list for notification of the Draft EA.
City and County of Honolulu Department of Facility Maintenance (letter dated September 5, 2019)	
We have no comments at this time, as we do not have any facilities or easements on the subject property. Please note that the H-1 Freeway is under the jurisdiction of the State of Hawaii, Department of Transportation-Highways Division and Palehua Road is a private road.	It is noted that the Project would not impact any Department of Facility Maintenance facilities or easement. A discussion of potentially affected roads, including H-1 Freeway and Pālehua Road, is provided in Section 3.12 of the Draft EA.
State of Hawaii Department of Business, Economic Development and Tourism, Land Use Commission (letter dated September 5, 2019)	
Take note that the OEQC has recently had an update to their administrative rules. Your compliance with HRS Chapter 343 will now be subject to these new rules and should be referenced as such: HAR 11-200.1. Preparer should pay particular attention to changes in the significance criteria.	The Draft EA has been prepared in compliance with HRS Chapter 343 and the recently updated implementing rules, HAR 11-200.1. The analysis of significance criteria relative to the Project, which is presented in Section 6.1 of the Draft EA, is based on these updated rules.
Provide maps and a specific discussion of the project area and its Land Study Bureau classifications. A discussion of any limitations to solar development on those lands should be included per HRS Chapter 205-2 and 205-4.5.	The LSB classification of soils within the Project area is discussed in Section 3.7 and shown in Figure 3-4 of the Draft EA. A discussion of the relevant limitations for solar facilities pursuant to HRS Chapter 205-2 and 205-4.5 is provided in Section 5.1.1.
Provide a discussion of the State Special Permit process that will be required for the Project.	A discussion of the requirement for a State Special Use Permit and the associated process is provided in Section 5.1.1.1 of the Draft EA.
The Project will take place in the upper portion of the Kaloi Gulch drainage basin. The Draft EA should discuss drainage issues and proposed mitigation measures as appropriate.	A discussion of existing conditions and potential impacts associated with drainage and stormwater runoff, including proposed mitigation measures, is provided in Section 3.3 of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
The location of the Project will be within 5 miles of an airport. The Draft EA should discuss compliance with any applicable FAA requirements such as a glint and glare analysis.	A discussion of the potential glare hazards associated with the Project, including compliance with applicable FAA requirements, is provided in Sections 3.8.2.3 and 3.12.2.5 of the Draft EA.
State of Hawaii Department of Accounting and General Services (letter dated September 9, 2019)	
We have no comments to offer at this time, as the subject project does not appear to directly impact any of the Department of Accounting and General Services' managed facilities. However, we do intend to monitor this project as it develops, given the relative proximity of certain State facilities that are located within Kapolei.	It is noted that the Project is not expected to impact any Department of Accounting and General Services' facilities. AES will provide notification to the Department of Accounting and General Services regarding availability of the Draft EA for review.
City and County of Honolulu Department of Design and Construction (letter dated September 10, 2019)	
The Department of Design and Construction does not have any comments at this time.	It is noted that the Department of Design and Construction does not have any comments.
State of Hawaii Department of Hawaiian Home Lands (letter dated September 11, 2019)	
The inclusion of energy storage capacity in the proposal is commendable. However, the use of lithium-ion battery storage increases the risk of potentially hazardous situations. The EA should include a detailed description of the proposed safety controls, contingency plans, as well as end-of-lifecycle treatment of the battery storage system. While lithium-ion battery is a reasonable energy storage method, the Draft EA should include a review of other options including other batteries, compressed air, hydroelectric, and cryogenic energy storage systems.	A discussion of lithium-ion batteries, including the potential hazards, safety measures, and end-of-lifecycle treatment is provided in Section 3.11.2 of the Draft EA. A discussion of alternative energy storage methods is provided in Section 4.3 of the Draft EA.
The Project is located within the State Land Use Commission's Agriculture District. The type of mounting system proposed could provide opportunities for other agriculture uses within the same footprint. The elevation of the panels could allow the land to still be utilized for farming, or other uses. Additional details regarding the proposed mix-use of the Project area should be included in the Draft EA.	The Project area will be made available for compatible agricultural uses, pursuant to the requirements of HRS Chapter 205-4.5. A discussion of compatible agricultural uses is provided in Section 2.1.7 of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
The Project is located less than three miles from six Hawaiian Homestead communities with 1,195 active DHHL lessee households. DHHL recommends considering this community when short and/or long-term job opportunities arise from this Project.	As discussed in Section 3.16.2, construction and operation of the Project would provide opportunities for "green jobs" and it is expected that the majority of jobs would be filled by Hawaiʻi residents. A discussion of anticipated economic benefits is provided in Section 3.16 of the Draft EA.
The Project has the potential to impact DHHL's beneficiaries in ʻEwa Moku. We highly encourage you to consult with Hawaiian Homestead community associations and other (N)native Hawaiian organizations when preparing the Draft EA (and associated documents assessing cultural impact, and historic resources) and to better assess potential impacts to cultural and natural resources, access and other rights of Native Hawaiians. A list of some of DHHL beneficiary homestead associations may be found at https://dhhl.hawii.gov/homestead-associations/.	Representatives associated with Hawaiian Homestead communities that are proximate to the Project area, including Hoʻolimalima, Kānehili, Kapolei, Kaʻuluokahaʻi, Kaupeʻa, and Maluʻohai, were contacted as part of the Cultural Impact Assessment (CIA); a complete list of the Native Hawaiian Organizations, individuals, organizations, and agencies contacted as part of the CIA are listed in Appendix G. A notice regarding availability of the Draft EA for public review will also be sent to representatives of the above-referenced Hawaiian Homestead communities, as noted in Table 7.2 of the Draft EA.
Honolulu Fire Department (letter dated September 12, 2019)	
Fire department access roads shall be provided such that any portion of the facility or any portion of an exterior wall of the first story of the building is located not more than 150 feet (46 meters) from fire department access roads as measured by an approved route around the exterior of the building or facility (National Fire Protection Association [NFPA] 1; 2012 Edition, Sections 18.2.3.2.2 and 18.2.3.2.2.1). A fire department access road shall extend to within 50 feet (15 meters) of at least one exterior door that can be opened from the outside and that provides access to the interior of the building (NFPA 1; 2012 Edition, Section 18.2.3.2.1).	As discussed in Section 3.14.1.2 of the Draft EA, consistent with requirements articulated by the Honolulu Fire Department (HFD), the Project would include service roads that can accommodate fire apparatus; it is anticipated that the Project would not need to provide water supply for fire flow as no occupied buildings would be constructed within the Project area.

Pre-Assessment Scoping Comment[1]	Response
A water supply approved by the county, capable of supplying the required fire flow for fire protection, shall be provided to all premises upon which facilities or building, or portions thereof, are hereafter constructed, or moved into or within the county. When any portion of the facility or building is in excess of 150 feet (45,720 millimeters) from a water supply on a fire apparatus access road, as measured by an approved route around the exterior of the facility or building, on-site fire hydrants and mains capable of supplying the required fire flow shall be provided when required by the authority having jurisdiction (NFPA 1; 2012 Edition, Section 18.3.1, as amended).	As discussed in Section 3.14.1.2 of the Draft EA, consistent with requirements articulated by the HFD, the Project would include service roads that can accommodate fire apparatus; it is anticipated that the Project would not need to provide water supply for fire flow as no occupied buildings would be constructed within the Project area.
The unobstructed width and unobstructed vertical clearance of a fire apparatus access road shall meet county requirements (NFPA 1; 2012 Edition, Sections 18.2.3.4.1.1 and 18.2.3.4.1.2, as amended).	As discussed in Section 3.14.1.2 of the Draft EA, consistent with requirements articulated by the HFD, the Project would include service roads that can accommodate fire apparatus.
The Project shall comply with all fire code requirements for photovoltaic systems (NFPA 1; 2012 Edition, Section 11.12).	As discussed in Section 3.13.2, the Project is being designed in accordance with the NFPA 1 and NEC rules for fire prevention for large-scale solar.
The Project shall comply with all fire code requirements for battery storage systems (NFPA 1; 2012 Edition, Chapter 52).	AES acknowledges that the Project must comply with all fire code requirements for battery storage systems (NFPA 1; 2012 Edition, Chapter 52).
Submit civil drawings to the HFD for review and approval.	Drawings will be submitted to the HFD for review and approval. AES will review drawings and consult with the HFD during the planning and design phase, permitting, construction and provide on-site orientation and training (or as requested by the HFD) prior to commercial operation.
State of Hawaii Department of Education (letter dated September 12, 2019)	
The Project will not impact any HIDOE schools or facilities.	It is noted that the Project will not impact any Department of Education schools or facilities.

Pre-Assessment Scoping Comment[1]	Response
Board of Water Supply (letter dated September 23, 2019)	
The existing water system is adequate to accommodate the proposed solar power storage facility. However, please be advised that this information is based upon current data, and therefore, the Board of Water Supply (BWS) reserves the right to change any position or information stated herein up until the final approval of the building permit application. The final decision on the availability of water will be confirmed when the building permit application is submitted for approval.	Construction and operation of the solar facility is not expected to require water from the Board of Water Supply water system. AES acknowledges that if water is required, the final decision on the availability of water will be confirmed when the building permit application is submitted for approval.
Proposed water connection designs for the solar storage facility shall be submitted for our review and approval. The construction schedule shall be coordinated with the BWS to minimize impacts to our water system.	Construction and operation of the solar facility is not expected to require a connection to the Board of Water Supply water system. AES acknowledges that if a connection is required, the proposed water connection design must be submitted for review and approval, and the construction schedule must be coordinated with Board of Water Supply.
If water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission and daily storage.	Construction and operation of the solar facility is not expected to require water from the Board of Water Supply water system. AES acknowledges that if water is made available for the Project, payment will be required for resource development, transmission and daily storage.
The BWS cannot sufficiently determine the water availability adequacy for the proposed compatible agriculture activities because no information regarding domestic and irrigation demands were provided.	As part of the Project development process, AES has proactively sought partners to develop a compatible agricultural plan for the Project. In doing so, various options for agricultural activities that could be conducted in parallel with the solar energy facilities within Project area were examined based on a variety of considerations, including water requirements. The results of this effort indicate that the most promising agricultural activities that could be implemented as part of the Project are honey production and/or cattle grazing and production. At this time, it is not anticipated that the proposed agricultural activities would require water from Board of Water Supply, however, AES will continue working with Board of Water Supply to determine availability of water should it be required. A discussion of compatible agricultural activities is provided in Section 3.1.7 of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
The developer should investigate the feasibility of using non-potable water for irrigation of the proposal agricultural activities. If non-potable water is unavailable and/or infeasible, a report of the investigation including proposed irrigation demands should be submitted to us before we will consider the use of potable water for irrigation demands.	AES acknowledges that if a connection for potable water is required, an investigation into the use of non-potable water and the proposed irrigation demands should be submitted to Board of Water Supply.
The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.	As stated in Section 3.13.2 of the Draft EA, the Honolulu Fire Department was consulted as part of the pre-assessment scoping process and consultation will continue during the design of the Project, with on-site training and orientation prior to commercial operation.
City and County of Honolulu Department of Transportation Services (letter dated September 23, 2019)	
A Traffic Management Plan (TMP) should be prepared for this project that is jointly revised and accepted by the Department of Transportation Services (DTS) and the Department of Planning and Permitting. The TMP shall include the following: a. A discussion of the traffic impacts that the project may have on any surrounding City roadways and facilities, including short-term impacts during construction with corresponding measures to mitigate these impacts by applying Complete Street principles. b. Construction materials and equipment should be transferred to and from the project site during off-peak traffic hours (8:30 a.m. to 3:30 p.m.) to minimize any possible disruption to traffic on the local streets.	A Traffic Impact Assessment Report (TIAR) has been prepared for the Project; based on this information, a discussion of the potential Project-related impacts on surrounding roadways and proposed anticipated measures to mitigate those impacts is provided in Section 3.12.2.2 of the Draft EA. As noted in this discussion, a Traffic Management Plan (TMP) will be prepared and submitted to the Department of Transportation Services and the Department of Planning and Permitting prior to construction.
If there are any roadway, sidewalk or crosswalk closures, alternate routes should be provided for vehicles, pedestrians, and bicyclists that are safe and clearly marked.	Project implementation is not expected to require any roadway, sidewalk or crosswalk closures. However, as noted in Section 3.12.2.2 of the Draft EA, AES acknowledges that in the event that closures are required, alternate routes should be provided for vehicles, pedestrians and bicyclists that are safe and clearly marked.

Pre-Assessment Scoping Comment[1]	Response
Any existing pedestrian, bicycle and vehicle access/crossing shall be maintained with the highest safety measures during construction.	Construction of the Project is not expected to affect any pedestrian, bicycle or vehicle access/crossing. However, as noted in Section 3.12.2.2 of the Draft EA, AES acknowledges that in the event that closures are required, alternate routes would be provided for vehicles, pedestrians and bicyclists that are safe and clearly marked.
BMP controls should be included at the construction site to prevent trailing of dirt and debris onto adjacent roadways.	The measures to avoid and minimize impacts will include site controls to prevent trailing of dirt and debris onto adjacent roadways, as noted in Section 3.3.2.2 of the Draft EA.
Any damage to the existing roadway and sidewalk area caused by the project should be repaired to current City standards as well as meet Americans with Disabilities Act requirements.	The measures to avoid and minimize impacts to transportation resources will include a provision that any Project-related damage to an existing roadway or sidewalk is repaired in accordance with City standards and Americans with Disabilities Act requirements, as noted in Section 3.12.2.2 of the Draft EA.
The area representatives, neighborhood board, as well as the area residents, businesses, emergency personnel (fire, ambulance, and police), Oahu Transit Services, Inc. (TheBus and TheHandi-Van), etc., should be kept apprised of the details and status throughout the project and the impacts that the project may have on the adjoining local street area network.	The measures to avoid and minimize impacts to transportation resources will include notification of area representatives, neighborhood board, as well as the area residents, businesses, emergency personnel, and Oahu Transit Services, Inc. regarding any construction-related impacts to the adjoining local street area network, as noted in Section 3.12.2.2 of the Draft EA.
A street usage permit from the DTS should be obtained for any construction-related work that may require the temporary closure of any traffic lane on a City street.	The Project is not expected to involve any construction-related work on a City street. However, AES acknowledges that a street usage permit would be required if the Project involves temporary closure of any traffic lane on a City street.
State of Hawaii Department of Transportation (letter dated September 25, 2019)	
The Project is approximately 3.64 miles from Kalaeloa Airport (JRF). All projects within five miles from Hawaii State airports are advised to read the Technical Assistance Memorandum (TAM) for guidance with development and activities that may require further assessment and permits. The TAM can be viewed at this link: http://files.hawaii.gov/dbedt/ op/docs/TMA-FAA-DOT-Airports_08-01-2016.pdf.	Section 3.12.2.5 of the Draft EA describes the proximity of the Project to the Kalaeloa Airport and discusses the potential impacts that could occur as a result of Project implementation; the referenced Technical Assistance Memorandum was reviewed and considered as part of this assessment.

Pre-Assessment Scoping Comment[1]	Response
We recommend that you submit a Federal Aviation Administration (FAA) Form 7460-1, Notice of Proposed Construction or Alteration for the site of the proposed solar PV system. Note that you will need latitude, longitude, ground elevation, and the above ground elevation data for the installation site in order to fully complete this form. The form and criteria for submittal can be found at the following website: https://oeaaa.faa.gov/oeaaa/external/portal.jsp.	As noted in Section 3.12.2.5 and Table 5-7 of the Draft EA, a Federal Aviation Administration (FAA) Form 7460-1, Notice of Proposed Construction or Alteration will be submitted for the Project prior to construction.
A glint and glare analysis must be attached to your submittal of FAA Form 7460-1. The following website may assist you with preparation of a glint and glare analysis: www.sandia.gov/glare. When you have received the FAA determination from your submittal of FAA Form 7460-1, please provide DOT-AIR with a copy for our files.	A glare analysis was prepared for the Project and is included as Appendix H in the Draft EA. A copy of the analysis will be submitted with FAA Form 7460-1.
The proposed installation of solar PV system location in or near the approach path of aircrafts into HRF can create a hazardous condition for pilots due to possible glint and glare reflected from the PV array. If glint or glare from the PV array creates a hazardous condition for the pilots, the owner of the PV system shall be prepared to immediately mitigate the hazard upon notification by DOT-AIR and/or FAA.	The potential for the Project to create a hazardous condition for pilots due to possible glare reflected from the PV modules is discussed in Section 3.12.2.5 of the Draft EA. As stated in this discussion, if glare from the Project creates a hazardous condition for the pilots, AES would immediately mitigate the hazard upon notification by FAA and/or DOT Airports Division.
PV systems have also been known to emit radio frequency interference (RFI) to aviation-dedicated radio signals, disrupting the reliability of air-to-ground communications. An owner must ensure than an operating PV installation will not create any RFI that interferes with any aviation communication frequency. If the proposed project creates an RFI situation, the owner of the PV shall be prepared to immediately mitigate the RFI hazard upon notification by DOT-AIR and/or FAA.	The potential for the Project to emit radio frequency interference (RFI) that would disrupt the reliability of air-to-ground communications is discussed in Section 3.12.2.5 of the Draft EA. As stated in this discussion, in the event of an unexpected RFI situation, AES would immediately mitigate the RFI hazard upon notification by FAA or DOT Airports Division.
The Draft EA should include a traffic impact assessment that addresses: (a) trip generation during construction and operations; (b) additional site access points that may be utilized during construction; and (c) potential construction phase impacts to nearby DOT roadways (e.g., Kualakai Parkway and H-1) and intersections, proposed mitigation measures.	A Traffic Impact Assessment Report (TIAR) was prepared for the Project, including the specific topics listed in the comment; the results of the assessment are summarized in Section 3.12.2.2 and a copy of the assessment report is contained in Appendix I of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
The Draft EA should include a discussion of the existing and proposed overhead and underground linear utility alignments (e.g., powerlines) and the potential for new alignments to impact DOT roadways.	As detailed in Section 3.15.2 of the Draft EA, proposed utility alignments associated with the Project would be limited to electrical connections sited on land owned by UH West Oahu; no impacts to DOT roadways are anticipated.
State of Hawaii Department of Land and Natural Resources Engineering Division (letter dated September 27, 2019)	
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 Special Flood Hazard Area (high risk areas). State projects are required to comply with 44CFR regulations as stipulated in Section 60.12. Be advised that 44CFR reflects the minimum standards as set forth by the NFIP. Local community flood ordinances may stipulate higher standards that can be more restrictive and would take precedence over the minimum NFIP standards.	As discussed in Section 3.13, the Project area is not located within a Special Flood Hazard Area; therefore, it is understood that the rules and regulations of the NFIP and local community flood ordinances are not applicable.
The owner of the project property and/or their representative is responsible to research the Flood Hazard Zone designation for the project. Flood Hazard Zones are designated on FEMA's Flood Insurance Rate Maps (FIRM), which can be viewed on our Flood Hazard Assessment Tool (http://gis.hawaiinfip.org/FHAT).	As discussed in Section 3.13, the flood hazard zone designation for the Project area is Zone D (possible but undetermined flood hazards).
State of Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife (letter dated September 27, 2019)[2]	
The State endangered Hawaiian Short-eared Owl or Pueo (*Asia flammeus sandwichensis*) is known to occur in the project site vicinity. Pueo are a crepuscular species, most active during dawn and dusk twilights. DOFAW recommends twilight pre-construction surveys by a qualified biologist prior to clearing vegetation. If Pueo nests are present, a buffer zone should be established in which no clearing occurs until nesting ceases, and DOFAW staff should be notified.	The potential for pueo to occur within the Project area and measures that would be implemented to avoid and minimize impacts (should the species occur), including the recommended pre-construction surveys and establishment of a buffer zone, is discussed in Section 3.4 of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
We note that artificial lighting can adversely impact seabirds that may pass through the area at night by causing disorientation. This disorientation can result in collision with manmade artifacts or grounding of birds. For nighttime lighting that might be required, DOFAW recommends that all lights be fully shielded and directed to avoid reflecting off the panels to minimize impacts. Solar panels may also reflect moonlight during moonlit nights that may attract and disorient seabirds; monitoring during moon phases should be considered to assess if impacts are occurring. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season from September 15 through December 15. This is the period when young seabirds take their maiden voyage to the open sea.	The potential for seabirds to traverse the Project area and measures that would be implemented to avoid and minimize impacts (should the species occur), including the recommendations relative to nighttime lighting and nighttime work, is discussed in Section 3.4 of the Draft EA.
Studies have shown that solar power facilities on the mainland have been linked with avian mortality of a variety of bird species including waterbirds and raptors. As aforementioned, the project area is on open habitat where the Pueo may transit or reside near. In addition to preconstruction surveys, you should consider implementing avian mortality avoidance measures during design and conducting surveys and monitoring during operation to assess the impacts of the project on listed species.	The potential for various avian species to occur within the Project area and measures that would be implemented to avoid and minimize impacts to those species (should they occur), including avian mortality avoidance measures during design and monitoring during operation, is discussed in Section 3.4 of the Draft EA.
State of Hawaii Commission on Water Resource Management (letter dated September 27, 2019)	
We recommend the use of best management practices (BMP) for stormwater management to minimize the impact of the project to the existing area's hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events. Stormwater management BMPs may earn credit toward LEED certification. More information on stormwater BMPs can be found at: http://planning.hawaii.gov/czm/initiatives/low-impact-development/	A discussion of the BMPs that would be implemented to provide long-term retention and biofiltration of stormwater within the Project area and to prevent and minimize discharge of pollutants to downstream waters is provided in Section 3.3.2.2 of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
We recommend adopting landscape irrigation conservation best management practices endorsed by the Landscape Industry Council of Hawaii. These practices can be found online at: http://www.hawaiiscape.com/ wp-content /uploads/2013/04/ LICH_lrrigation_Conservation_BMPs.pdf.	AES acknowledges the recommendation to use landscape irrigation conservation BMPs endorsed by the Landscape Industry Council of Hawaii should landscape irrigation be required.
There may be the potential for ground or surface water degradation/ contamination and recommend that approvals for this project be conditioned upon a review by the State Department of Health and the developer's acceptance of any resulting requirements related to water quality.	The potential for Project-related impacts to ground or surface water and measures that would be implemented to avoid and minimize impacts to water quality is discussed in Section 3.3.2 of the Draft EA. AES will acquire all necessary permits, and acknowledges the need to comply with permit conditions, including those related to water quality.
State of Hawaii Department of Land and Natural Resources Land Division (letter dated September 27, 2019)	
We have no comments at this time.	It is noted that the Land Division does not have any comments at this time.
State of Hawaii Office of Planning (letter dated October 1, 2019)	
According to the Land Study Bureau ratings map, the project area has soils designated as B, D and E. In accordance with HRS Chapter 205-4.5(21), a Special Permit is required, and must meet the requirements for agricultural uses and decommissioning among other requirements. The Draft EA should address the special permit guidelines relative to determining the "unusual and reasonable" use of lands for the proposed solar facility. Also, OP notes that since the project is over 15 acres, the State Land Use Commission would be issuing the final decision on the Special Permit for the proposed facility.	The LSB classification of soils within the Project area is shown in Figure 3-4, and a discussion of the requirement for a State Special Use Permit and the permit guidelines is provided in Sections 5.1.1 and 5.1.1.1 of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
Pursuant to HAR 11-200-10(4) – general description of the action's technical, economic, social, and environmental characteristics, this project must demonstrate that it is consistent with state environmental, social, economic goals, and polices. HRS Chapter 226, the Hawaii State Planning Act, provides goals, objectives, policies, planning coordination and implementation, and priority guidelines for growth, development, and the allocation of resources throughout the state. The Draft EA should include a discussion on the project and its consistency of all three parts of HRS Chapter 226. We note that the proposed solar farm and storage facility is consistent with the principles of sustainability as a renewable energy production facility. This is applicable to HRS Chapter 226-108 - sustainability priority guidelines. The Draft EA should include, but not be limited to, this provision in its analysis on HRS Chapter 226.	A discussion of the extent to which the Project would be consistent with all three parts of HRS Chapter 226 is provided in Section 5.1.3 of the Draft EA.
The CZM area is defined as "all lands of the State and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the U.S. territorial sea" (HRS Chapter 205A-1). Pursuant to HRS Chapter 205A-4, in implementing the objectives of the CZM program, agencies shall consider ecological, cultural, historic, aesthetic, recreational, scenic, open space values, coastal hazards, and economic development. As this project will require the approval of a government agencies, the Draft EA should include analysis on the project's consistency with the objectives and supporting policies of the Hawaii CZM Program, as listed in HRS Chapter 205A-2. Compliance with HRS Chapter 205A-2 is an important component for satisfying the requirements of HRS Chapter 343.	A discussion of the extent to which the Project would be consistent with the objectives and supporting policies of the Hawaii CZM Program as listed in HRS Chapter 205A-2 is provided in Section 5.1.2 of the Draft EA.

Pre-Assessment Scoping Comment[1]	Response
Pursuant to HAR 11-200-10(6) – identification and summary of impacts and alternatives considered; to ensure that the surface water and nearshore marine resources near the coastal area of the West Oahu remain protected, the negative effects of stormwater inundation from this cesspool closure and wastewater system construction action should be evaluated in the Draft EA. As this project will involve lands classified in the State Land Use Agricultural District, and involve activities that create impermeable surface areas, the effects of stormwater runoff emanating from the project area should be evaluated in the Draft EA. The evaluation on stormwater runoff, erosion control, and any benefits on water quality should involve steps taken during the construction phase, as well as during the operational life of the proposed solar energy facility. Issues that may be examined include, but are not limited to, project site characteristics in relation to flood and erosion prone areas, potential vulnerability of water resources, soil absorption characteristics of the area, and examining the amount of permeable versus impervious surfaces in the area. Developing mitigation measures for the protection for surface water resources and the coastal ecosystem should take this into account, pursuant to HAR 11-200-10(7).	It was confirmed with State Office of Planning staff that the first component of the comment was included in error and is not applicable to this Project. A discussion of the increase in impermeable surfaces and the potential impacts associated with erosion and stormwater runoff as a result of Project implementation is provided in Section 3.3 of the Draft EA.
City and County of Honolulu Department of Planning and Permitting (letter dated October 1, 2019)	
According to the Land Study Bureau (LSB) classification maps, the Department of Planning and Permitting (DPP) estimates the proposed BESS Project is primarily on soils with productivity ratings of B, D, and E. However, to accurately determine what LSB soils the proposed BESS Project is on, a metes and bounds survey of the proposed BESS Project area, overlaid on a LSB map, is necessary to determine compliance with Chapter 205-4.5(21), Hawaii Revised Statutes (HRS). The site plan should include the proposed BESS Project area, the layout of the proposed BESS Project components, roadways and any related support uses and structures.	Figure 3-6 of the Draft EA includes a metes and bounds survey of the Project area and the layout of the Project facilities, overlaid on a map of the LSB soils classifications.

Pre-Assessment Scoping Comment[1]	Response
Once compliance with Sections 205-4.5(20) and 205-4.5(21), HRS, is verified, you may apply for a Special Use Permit. Since the proposed BESS Project involves more than 15 acres, it is subject to approval by the State Land Use Commission, per Section 205-6(d), HRS.	As summarized in Section 5.1.1.1 of the Draft EA, it is understood that the Project will require a Special Use Permit subject to approval by the State Land Use Commission.
The DEA should address how the proposed BESS Project conforms to the vision, policies, and guidelines of the Ewa Development Plan. In addition, the DEA should address the proposed BESS Project's consistency with each of the applicable Objectives and Policies of the Oahu General Plan.	A discussion of the extent to which the Project is consistent with the vision, policies and guidelines of the 'Ewa Development Plan, as well as the applicable objectives and policies of the Oahu General Plan is provided in Sections 5.2.2 and 5.2.1 of the Draft EA, respectively.
Although the DPP gave preliminary confirmation in a July 17, 2019 letter that the BESS Project is considered a Type B Utility Installation, the DEA should include detailed information to determine the use of the site as either a Type A or Type B Utility Installation. If it is considered a Type B Utility Installation, then a Minor Conditional Use Permit will be necessary. There is not enough information to determine if the Project will meet all development standards of the AG-1 Restricted Agricultural District. If the Project does not comply with all the development standards, then a Zoning Waiver will be necessary.	A discussion of the Project's classification as either a Type A or Type B Utility Installation and the need for a Minor Conditional Use Permit and Zoning Waiver is provided in Sections 5.2.3 and 5.2.3.1 of the Draft EA.
The DEA should include an analysis of the visual impacts associated with the proposed BESS Project.	An analysis of the potential visual impacts associated with the Project is provided in Section 3.8.2 of the Draft EA.
The DEA shall include a narrative describing how the proposed BESS Project's post-construction storm water quality strategic plan complies with the Rules Relating to Water Quality (Rules), City and County of Honolulu Administrative Rules, Title 20, DPP, Chapter 3. The strategic plan shall include a written description of the proposed development, expected activities and pollutants that will be generated by such activities at the site, low impact development site design strategies that will be used to comply with the Rules, and an anticipated development schedule. The DEA should also disclose how the proposed BESS Project shall comply with the City and County's prevailing Storm Drainage Standards.	A discussion of the low impact site design strategies and other measures that would be implemented to avoid and minimize potential water quality impacts is provided in Section 3.3.2.2 of the Draft EA. This section includes a discussion of the post-construction Storm Water Quality Strategic Plan and compliance with the City and County of Honolulu's Rules Relating to Water Quality and Rules Relating to Storm Drainage Standards.

Pre-Assessment Scoping Comment[1]	Response
The DPP recommends consultation with the Federal Aviation Administration and the Hawaii State Department of Transportation-Airports, as the location of the proposed BESS Project will be within five miles of the Kalaeloa Airport. Refer to the Technical Assistance Memorandum (TAM-2016-1) for guidance with the development and activities that may require further permits. The TAM-2016-1 can be viewed at: http://files.hawaii.gov/dbedt/ op/docs/TAM-FAA-DOT-Airports_08-01-02016.pdf	Section 3.12.2.5 of the Draft EA describes the proximity of the Project to the Kalaeloa Airport and discusses the potential impacts that could occur as a result of Project implementation; the referenced Technical Assistance Memorandum was reviewed and considered as part of this assessment.
The DEA should list all federal, state, and city permits required for the proposed BESS project.	A list of all federal, state, and city permits that are expected to be required for the Project is provided in Section 5.3 of the Draft EA.

NOTES:

[1] Copies of the pre-assessment scoping comment letters are provided in Appendix M of the Draft EA.

[2] DOFAW's response to the pre-assessment scoping letter is a copy of a previous letter dated June 28, 2019, sent in response to a request for input on the Project.

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DEPARTMENT OF PARKS & RECREATION

CITY AND COUNTY OF HONOLULU

1000 Uluohia Street, Suite 309, Kapolei, Hawaii 96707
Phone: (808) 768-3003 • Fax: (808) 768-3053
Website: www.honolulu.gov

KIRK CALDWELL
MAYOR

MICHELE K. NEKOTA
DIRECTOR

JEANNE C. ISHIKAWA
DEPUTY DIRECTOR

August 29, 2019

Ms. Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Ms. Kettley:

SUBJECT: Pre Assessment Consultation-Environmental Assessment
AES West Oahu Solar Plus Storage Project
Tax Map Key: 9-2-002:007
Ewa District, Oahu

Thank you for the opportunity to review and comment at the Pre-Consultation stage of the subject environmental assessment.

The Department of Parks and Recreation has no comment. As the proposed project will have no impact on any program or facility of the Department, you may remove us as a consulted party to the balance of the EIS process.

Should you have any questions, please contact John Reid, Planner at 768-3017.

Sincerely,

Michele K. Nekota
Director

MKN:jr
(784521)

DEPARTMENT OF FACILITY MAINTENANCE

CITY AND COUNTY OF HONOLULU

1000 Ulu'ohia Street, Suite 215, Kapolei, Hawaii 96707
Phone: (808) 768-3343 • Fax: (808) 768-3381
Website: www.honolulu.gov

KIRK CALDWELL
MAYOR

ROSS S. SASAMURA, P.E.
DIRECTOR AND CHIEF ENGINEER

EDUARDO P. MANGLALLAN
DEPUTY DIRECTOR

IN REPLY REFER TO:
DRM 19-495

September 5, 2019

Mr. Nick Molinari
AES Distributed Energy
c/o Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Mr. Molinari:

Subject: AES West Oahu Solar Plus Storage Project, Ewa; TMK: 9-2-002:007
Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment

Thank you for the opportunity to review and comment on the subject project.

We have no comments at this time, as we do not have any facilities or easements on the subject property. Please note that the H-1 Freeway is under the jurisdiction of the State of Hawaii, Department of Transportation-Highways Division and Palehua Road is a private road.

If you have any questions, please call Mr. Kyle Oyasato of the Division of Road Maintenance at 768-3697.

Sincerely,

Ross S. Sasamura, P.E.
Director and Chief Engineer

cc: Tetra Tech - Ms. Lisa Kettley

DAVID Y. IGE
Governor

JOSH B. GREEN
Lieutenant Governor

MIKE MCCARTNEY
Director

LAND USE COMMISSION
Department of Business, Economic Development & Tourism
State of Hawai`i

DANIEL E. ORODENKER
Executive Officer

BERT SARUWATARI
Planner

SCOTT A.K. DERRICKSON AICP
Planner

RASMI AGRAHARI
Planner

RILEY K. HAKODA
Planner/Chief Clerk

FRED A. TALON
Drafting Technician

September 5, 2019

Tetra Tech
Attn: Lisa Kettley
737 Bishop Street, Suite 2340
Honolulu, HI 96813

Aloha Ms. Kettley:

The State Land Use Commission ("LUC") received your request for comments on a pre-assessment consultation for AES West O`ahu Solar Plus Storage Project on September 3, 2019. After review of the submitted documentation the LUC staff has the following comments:

1. Take note that the State Department of Health, Office of Environmental Quality Control ("OEQC") has recently had an update to their administrative rules. Your compliance with Hawai`i Revised Statutes ("HRS") Chapter 343 will now be subject to these new rules and should be referenced as such: Hawai`i Adminstrative Rules ("HAR") 11-200.1. Preparer should pay particular attention to changes in the significance criteria.

2. Provide maps and a specific discussion of the project area and its Land Study Bureau classifications. A discussion of any limitations to solar development on those lands should be included per HRS §§205-2 and 205-4.5.

3. Provide a discussion of the State Special Permit process that will be required for the Project.

4. The proposed Project will take place in the upper portion of the Kaloi Gulch drainage basin. The draft EA should discuss drainage issues and proposed mitigation measures as appropriate.

5. The location of the proposed Project will be within five (5) miles of an airport. The draft EA should discuss compliance with any applicable FAA requirements such as a glint and glare analysis.

235 SOUTH BERETANIA STREET ✿ SUITE 406 ✿ HONOLULU, HAWAI`I 96813 ✿ TEL (808) 587-3822 ✿ FAX (808) 587-3827 ✿ EMAIL: luc@dbedt.hawaii.gov
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

DAVID Y. IGE
Governor

SHAN S. TSUTSUI
Lieutenant Governor

LUIS P. SALAVERIA
Director

LAND USE COMMISSION
Department of Business, Economic Development & Tourism
State of Hawai'i

DANIEL ORODENKER
Executive Officer
BERT SARUWATARI
Planner
SCOTT A.K. DERRICKSON AICP
Planner
RILEY K. HAKODA
Planner/Chief Clerk
FRED A. TALON
Drafting Technician

The Commission reserves the right to comment further based on any additional information that may be provided during the environmental assessment process. Should you have any further questions please contact Scott A.K. Derrickson, AICP at 587-3921.

Sincerely,

Daniel E. Orodenker
Executive Officer

cc: Nick Molinari, AES Distributed Energy
Kathy Sokugawa, C&C DPP
Rodney Funakoshi, OP

DAVID Y. IGE
GOVERNOR

CURT T. OTAGURO
COMPTROLLER

AUDREY HIDANO
DEPUTY COMPTROLLER

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810-0119

(P)19.183

SEP 9 2019

Ms. Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Ms. Kettley:

Subject: AES West Oahu Solar Plus Storage Project
Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment
Ewa District, Oahu; TMK: 9-2-002:007

Thank you for the opportunity to provide comments for the subject project. We have no comments to offer at this time, as the subject project does not appear to directly impact any of the Department of Accounting and General Services' managed facilities. However, we do intend to monitor this project as it develops, given the relative proximity of certain State facilities that are located within Kapolei.

If you have any questions, your staff may call Mr. Dennis Chen of the Planning Branch at 586-0491

DYKC:mo

Sincerely,

CHRISTINE L. KINIMAKA
Public Works Administrator

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone (808) 768-8480 • Fax (808) 768-4567
Web site www.honolulu.gov

KIRK CALDWELL
MAYOR

ROBERT J. KRONING P E
DIRECTOR

MARK YONAMINE P E
DEPUTY DIRECTOR

September 10, 2019

AES Distributed Energy
c/o Tetra Tech
ATTN: Nick Molinari
737 Bishop St., Suite 2340
Honolulu, Hawaii 96813

Dear Mr. Molinari,

Subject: AES West Oahu Solar Plus Storage Project, Ewa District, Oahu; TMK 9-2-002:007 Pre=Assessment Consultation for HRS Chapter 343 Environmental Assessment

Thank you for the opportunity to review and comment. The Department of Design and Construction does not have any comments at this time.

Should you have any further questions, please contact me at 768-8480.

Sincerely,

Robert J. Kroning, P.E.
Director

RJK:ms(784539)

DAVID Y. IGE
GOVERNOR
STATE OF HAWAII

JOSH GREEN
LT. GOVERNOR
STATE OF HAWAII

WILLIAM J. AILA, JR
CHAIRMAN
HAWAIIAN HOMES COMMISSION

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS

P. O. BOX 1879
HONOLULU, HAWAII 96805

September 11, 2019

In reply refer to: PO-19-194

Ms. Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawai'i 96813

Dear Ms. Kettley:

Subject: Chapter 343 Environmental Assessment Pre-Assessment Consultation for AES West O'ahu Solar Plus Storage Project, 'Ewa District, O'ahu TMK: 9-2-002:007

The Department of Hawaiian Home Lands acknowledges receiving the request for comments on the above-cited project. After reviewing the materials submitted, the project is located mauka of DHHL's 'Ewa Moku land holdings, identified as Honouliuli Ahupua'a- Kapolei in the O'ahu Island Plan. DHHL offers the follow comments:

The inclusion of energy storage capacity in the proposal is commendable. However, the use of lithium-ion battery storage increases the risk of potentially hazardous situations. The EA should include a detailed description of the proposed safety controls, contingency plans, as well as end-of-lifecycle treatment of the battery storage system. While lithium-ion battery is a reasonable energy storage method, the draft EA should include a review of other options including other batteries, compressed air, hydroelectric, and cryogenic energy storage systems.

The proposed project is located within the State Land Use Commission's Agriculture District. The type of mounting system proposed could provide opportunities for other agriculture uses within the same foot-print. The elevation of the panels could allow the land to still be utilized for farming, or other uses. Additional details regarding the proposed mix-use of the project area should be included in the draft EA.

The proposed project is located less than three miles from six Hawaiian Homestead communities with 1,195 active DHHL lessee households. DHHL recommends considering this community when short and/or long-term job opportunities arise from this project.

The proposed project has the potential to impact DHHL's beneficiaries in 'Ewa Moku. We highly encourage you to consult with Hawaiian Homestead community associations and

other (N)native Hawaiian organizations when preparing the draft EA (and associated documents assessing cultural impact, and historic resources) and to better assess potential impacts to cultural and natural resources, access and other rights of Native Hawaiians. A list of some of DHHL beneficiary homestead associations may be found at https://dhhl.hawaii.gov/homestead-associations/.

Mahalo for the opportunity to provide comments. If you have any questions, please call Malia Cox, at 620-9485 or contact via email at malia.m.cox@hawaii.gov.

Aloha,

William J. Aila Jr., Chairman
Hawaiian Homes Commission

C: Kapolei Community Development Corporation- via email
Kānehili Hawaiian Homestead Association-via email
Kaupeʻa Homestead Association- via email
Maluʻōhai Residents Association- via email

HONOLULU FIRE DEPARTMENT

CITY AND COUNTY OF HONOLULU

636 South Street
Honolulu, Hawaii 96813-5007
Phone: 808-723-7139 Fax: 808-723-7111 Internet: www.honolulu.gov/hfd

KIRK CALDWELL
MAYOR

MANUEL P. NEVES
FIRE CHIEF

LIONEL CAMARA JR.
DEPUTY FIRE CHIEF

September 12, 2019

Mr. Nick Molinari
AES Distributed Energy
c/o Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Mr. Molinari:

Subject: Preassessment Consultation for Hawaii Revised Statute Chapter 343 Environmental Assessment
AES West Oahu Solar Plus Storage Project
Ewa District, Hawaii
Tax Map Key: 9-2-002: 007

In response to your letter dated August 23, 2019, regarding the abovementioned subject, the Honolulu Fire Department (HFD) reviewed the material provided and requires that the following be complied with:

1. Fire department access roads shall be provided such that any portion of the facility or any portion of an exterior wall of the first story of the building is located not more than 150 feet (46 meters) from fire department access roads as measured by an approved route around the exterior of the building or facility. (National Fire Protection Association [NFPA] 1; 2012 Edition, Sections 18.2.3.2.2 and 18.2.3.2.2.1.)

   A fire department access road shall extend to within 50 feet (15 meters) of at least one exterior door that can be opened from the outside and that provides access to the interior of the building. (NFPA 1; 2012 Edition, Section 18.2.3.2.1.)

2. A water supply approved by the county, capable of supplying the required fire flow for fire protection, shall be provided to all premises upon which facilities or buildings, or portions thereof, are hereafter constructed, or moved into or within the county. When any portion of the facility or building is in excess of 150 feet (45,720 millimeters) from a water supply on a fire apparatus access road, as measured by an approved route around the exterior of the facility or building, on-site fire hydrants and mains capable of supplying the required fire flow shall be provided when required by the AHJ [Authority Having Jurisdiction]. (NFPA 1; 2012 Edition, Section 18.3.1, as amended.)

3. The unobstructed width and unobstructed vertical clearance of a fire apparatus access road shall meet county requirements. (NFPA 1; 2012 Edition, Sections 18.2.3.4.1.1 and 18.2.3.4.1.2, as amended.)

4. The project shall comply with all fire code requirements for photovoltaic systems (NFPA 1; 2012 Edition, Section 11.12.)

5. The project shall comply with all fire code requirements for battery storage systems (NFPA 1; 2012 Edition, Chapter 52.)

6. Submit civil drawings to the HFD for review and approval.

Should you have questions, please contact Battalion Chief Wayne Masuda of our Fire Prevention Bureau at 723-7151 or wmasuda@honolulu.gov.

Sincerely,

SOCRATES D. BRATAKOS
Assistant Chief

SDB/TC:gl

DAVID Y. IGE
GOVERNOR

DR. CHRISTINA M. KISHIMOTO
SUPERINTENDENT

STATE OF HAWAI'I
DEPARTMENT OF EDUCATION
P.O. BOX 2360
HONOLULU, HAWAI'I 96804

OFFICE OF FACILITIES AND OPERATIONS

September 12, 2019

Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Re: Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment for AES West Oahu Solar Plus Storage Project, Tax Map Key 9-2-002:007, Ewa District, Oahu

Dear Ms. Kettley:

The Hawaii State Department of Education (HIDOE) has the following comments for the proposed AES West Oahu Solar Plus Storage Project (Project). According to the information provided, the Project consists of a ground mounted solar PV system, battery energy storage, and associated facilities on approximately 80 acres of land located at Ewa, Island of Oahu, TMK 9-2-002:007.

The proposed Project will not impact any HIDOE schools or facilities.

Thank you for the opportunity to comment. Should you have questions, please contact Robyn Loudermilk, School Lands and Facilities Specialist of the Facilities Development Branch, Planning Section at 784-5093 or via email at robyn.loudermilk@k12.hi.us.

Respectfully,

Kenneth G. Masden II
Public Works Manager
Planning Section

KGM:rll

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843
www.boardofwatersupply.com

September 23, 2019

Ms. Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Ms. Kettley:

Subject: Mr. Nick Molinari's Letter Dated August 23, 2019 Requesting Water Availability to the Proposed AES West Oahu Solar Plus Storage Project
Tax Map Key: 9-2-002: 007

Thank you for the opportunity to comment on the proposed solar power storage facility and the compatible agricultural activities.

The existing water system is adequate to accommodate the proposed solar power storage facility. However, please be advised that this information is based upon current data, and therefore, the Board of Water Supply (BWS) reserves the right to change any position or information stated herein up until the final approval of the building permit application. The final decision on the availability of water will be confirmed when the building permit application is submitted for approval.

Proposed water connection designs for the solar storage facility shall be submitted for our review and approval. The construction schedule shall be coordinated with the BWS to minimize impacts to our water system.

If water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission and daily storage.

The BWS cannot sufficiently determine the water availability adequacy for the proposed compatible agriculture activities because no information regarding domestic and irrigation demands were provided.

The developer should investigate the feasibility of using non-potable water for irrigation of the proposed agricultural activities. If non-potable water is unavailable and/or infeasible, a report of the investigation including proposed irrigation demands should be submitted to us before we will consider the use of potable water for irrigation demands.

The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.

If you have any questions, please contact Robert Chun, Project Review Branch of our Water Resources Division at 748-5443.

Very truly yours,

ERNEST Y. W. LAU, P.E.
Manager and Chief Engineer

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 3RD FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8305 • Fax: (808) 768-4730 • Internet: www.honolulu.gov

KIRK CALDWELL
MAYOR

WES FRYSZTACKI
DIRECTOR

JON Y. NOUCHI
DEPUTY DIRECTOR

TP8/19-784814R

September 23, 2019

Ms. Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Ms. Kettley:

SUBJECT: Pre-Consultation Draft Environmental Assessment for AES West Oahu Solar Plus Storage Project, Ewa District, Island of Oahu,TMK: 9-2-002: 007

In response to your letter dated August 23, 2019, we have the following comments:

1. **Traffic Management Plan (TMP).** A TMP should be prepared for this project that is jointly reviewed and accepted by the Department of Transportation Services (DTS) and the Department of Planning and Permitting. The TMP shall include the following:

   a. A discussion of the traffic impacts that the project may have on any surrounding City roadways and facilities, including short-term impacts during construction with corresponding measures to mitigate these impacts by applying Complete Streets principles.

   b. Construction materials and equipment should be transferred to and from the project site during off-peak traffic hours (8:30 a.m. to 3:30 p.m.) to minimize any possible disruption to traffic on the local streets.

2. **Roadway, Sidewalk and Crosswalk Closures.** If there are any roadway, sidewalk or crosswalk closures, alternate routes should be provided for vehicles, pedestrians, and bicyclists that are safe and clearly marked.

3. **Vehicle/Pedestrian Crossing**. Any existing pedestrian, bicycle and vehicle access/crossing shall be maintained with the highest safety measures during construction.

4. **Best Management Practice (BMP) Controls**. BMP controls should be included at the construction site to prevent trailing of dirt and debris onto adjacent roadways.

5. **Roadway Damage**. Any damage to the existing roadway and sidewalk area caused by the project should be repaired to current City standards as well as meet Americans with Disabilities Act requirements.

6. **Neighborhood Impacts**. The area representatives, neighborhood board, as well as the area residents, businesses, emergency personnel (fire, ambulance, and police), Oahu Transit Services, Inc. (TheBus and TheHandi-Van), etc., should be kept apprised of the details and status throughout the project and the impacts that the project may have on the adjoining local street area network.

7. **Street Usage Permit**. A street usage permit from the DTS should be obtained for any construction-related work that may require the temporary closure of any traffic lane on a City street.

Thank you for the opportunity to review this matter. Should you have any questions, please contact Virginia Sosh, of my staff, at 768-5461.

Very truly yours,

Wes Frysztacki
Director

DAVID Y. IGE
GOVERNOR

JADE T. BUTAY
DIRECTOR

Deputy Directors
LYNN A.S. ARAKI-REGAN
DEREK J. CHOW
ROSS M. HIGASHI
EDWIN H. SNIFFEN

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO:
DIR 0886
STP 8.2753

September 25, 2019

Ms. Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Ms. Kettley:

Subject: AES Distributed Energy, Inc. (AES) West Oahu Solar Plus Storage Project
Pre-Assessment Consultation
Kapolei, Oahu, Hawaii
TMK: (1) 9-2-002:007

The State Department of Transportation (DOT) understands AES is proposing to construct and operate a solar photovoltaic (PV) and battery energy storage project on approximately 80 acres of land owned by the University of Hawaii. The project would consist of an approximately 12.5-megawatt (MW) ground-mounted solar PV system, coupled with a 50 MW-hour battery energy storage system and related interconnection and ancillary facilities. The site will be accessed from Kualakai Parkway (Hawaii Route 8930) at an existing gated entry located north of the Kualakai Parkway intersection with H-1. Both roadways are under the DOT, Highway Division jurisdiction.

Our comments on the subject project are as follows:

<u>Airports Division (DOT-AIR)</u>

1. The proposed project is approximately 3.64 miles from Kalaeloa Airport (JRF). All projects within five miles from Hawaii State airports are advised to read the Technical Assistance Memorandum (TAM) for guidance with development and activities that may require further assessments and permits. The TAM can be viewed at this link: http://files.hawaii.gov/dbedt/op/docs/TAM-FAA-DOT-Airports_08-01-2016.pdf.

2. We recommend that you submit a Federal Aviation Administration (FAA) Form 7460-1, Notice of Proposed Construction or Alteration for the site of the proposed solar PV system. Note that you will need latitude, longitude, ground elevation, and the above ground elevation data for the installation site in order to fully complete this form. The form and

criteria for submittal can be found at the following website: https://oeaaa.faa.gov/oeaaa/external/portal.jsp.

3. A glint and glare analysis must be attached to your submittal of FAA Form 7460-1. The following website may assist you with preparation of a glint and glare analysis: www.sandia.gov/glare. When you have received the FAA determination from your submittal of FAA Form 7460-1, please provide DOT-AIR with a copy for our files.

4. The proposed installation of solar PV system located in or near the approach path of aircrafts into JRF can create a hazardous condition for pilots due to possible glint and glare reflected from the PV array. If glint or glare from the PV array creates a hazardous condition for pilots, the owner of the PV system shall be prepared to immediately mitigate the hazard upon notification by DOT-AIR and/or FAA.

5. PV systems have also been known to emit radio frequency interference (RFI) to aviation-dedicated radio signals, disrupting the reliability of air-to-ground communications. An owner must ensure that an operating PV installation will not create any RFI that interferes with any aviation communication frequency. If the proposed project creates an RFI situation, the owner of the PV system shall be prepared to immediately mitigate the RFI hazard upon notification by DOT-AIR and/or FAA.

Highways Division

With respect to State highways, the Draft Environmental Assessment should include:

1. A traffic impact assessment that addresses:
   a. Trip generation during construction and operations;
   b. Additional site access points that may be utilized during construction;
   c. Potential construction phase impacts to nearby DOT roadways (e.g., Kualakai Parkway and H-1) and intersections, proposed mitigation measures.

2. A discussion of the existing and proposed overhead and underground linear utility alignments (e.g. powerlines) and the potential for new alignments to impact DOT roadways.

If there are any questions, please contact Mr. Blayne Nikaido of the DOT Statewide Transportation Planning Office at (808) 831-7979 or via email at blayne.h.nikaido@hawaii.gov.

Sincerely,

for JADE T. BUTAY
Director of Transportation

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 27, 2019

LD 1572

Tetra Tech
ATTN: Lisa Kettley
737 Bishop Street, Suite 2340
Honolulu, HI 96813

Via email: lisa.kettley@tetratech.com

Dear Sirs:

SUBJECT: **AES West Oahu Solar Plus Storage Project, Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment,** ānoa, 'Ewa District, Island of Oahu; TMK: (1) 9-2-002:007

Thank you for the opportunity to review and comment on the above subject matter. Information on the subject project was distributed to selected divisions of the department for their review and comment.

Enclosed are responses from the a) Engineering Division, b) Division of Forestry and Wildlife, c) Commission on Water Resource Management, and d) Land Division—Oahu District. Should you have any questions, please feel free to contact Barbara Lee at (808) 587-0453 or via email at barbara.j.lee@hawaii.gov. Thank you.

Sincerely,

Russell Y. Tsuji
Land Administrator

Enclosure(s)
cc: Central Files

LD 1572

RECEIVED
LAND DIVISION

2019 AUG 27 AM 10: 30

DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

August 23, 2019

Subject: AES West O'ahu Solar Plus Storage Project, 'Ewa District, O'ahu; TMK 9-2-002:007
Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment

Dear Interested Party,

AES Distributed Energy, Inc. (AES) is proposing to construct and operate a solar photovoltaic and battery energy storage project on land owned by the University of Hawai'i (UH) approximately three miles northeast of Kapolei on the island of O'ahu. The project area encompasses a total of approximately 80 acres in an area commonly referred to as the UH West O'ahu Mauka Property and is within tax map key (TMK) 9-2-002:007. As the land is owned by UH, the project would involve use of State-owned land, thus requiring compliance with Hawaii Revised Statutes (HRS) Chapter 343. Pursuant to the requirements of HRS Chapter 343 and Hawaii Administrative Rules (HAR) §11-200, AES is preparing an environmental assessment (EA) to evaluate the potential environmental effects of the project.

As part of the environmental review process, pre-assessment consultation is being conducted to obtain input on the scope of issues to be considered in the Draft EA. An overview of the project and a location map are attached. We are requesting input regarding the project, including concerns related to particular environmental resources, as well as relevant information that should be considered in the evaluation.

Please provide comments regarding the scope of the EA in writing via U.S. postal mail or e-mail to Lisa Kettley at Tetra Tech (737 Bishop Street, Suite 2340, Honolulu, Hawaii 96813 or lisa.kettley@tetratech.com). Comments must be postmarked by September 30, 2019 to be considered in the Draft EA.

Thank you for your participation in the environmental review process for the proposed project.

RECEIVED
2019 AUG 26 AM 10: 15
DEPT. OF LAND
& NATURAL RESOURCES
STATE OF HAWAII

Sincerely,

Nick Molinari
AES Distributed Energy

Attachments: Project Overview
Location Map

AES West Oahu Solar Plus Storage Project

AES Distributed Energy (AES) is proposing to construct and operate the West Oahu Solar Plus Storage Project (Project) on land owned by University of Hawaii (UH) approximately 3 miles northeast of Kapolei, on the southwest side of O'ahu. The Project area encompasses approximately 80 acres in an area commonly referred to as the UH West O'ahu Mauka Property and is within tax map key (TMK) 9-2-002:007. The Project area is shown in the attached figure.

The concept for a renewable energy facility on the UH West O'ahu Mauka Property was originally identified by UH as part of their 2014 Land Master Plan. In coordination with UH, AES developed a preliminary layout for a solar plus storage facility and submitted a proposal to Hawaiian Electric Company (Hawaiian Electric) in response to their *Request for Proposals for Variable Renewable Dispatchable Generation for the Island of O'ahu*, issued in February 2018. This competitive procurement process for renewable energy projects specifically targeted projects that would satisfy the resource needs identified in Hawaiian Electric's 2016 Power Supply Improvement Plan as part of the effort to meet Hawaii's goal of generating 100 percent of its energy needs from renewable sources by 2045. The Project is one of three selected by Hawaiian Electric for the island of O'ahu.

The Project would consist of an approximately 12.5-megawatt (MW) ground-mounted solar PV system, coupled with a 50 MW-hour battery energy storage system and related interconnection and ancillary facilities. The major components of the Project would include:

- **Solar Panels:** The solar PV system would include a series of panels arranged into arrays consisting of evenly-spaced rows. The panels would be mounted on a racking system installed on posts.
- **Battery Energy Storage System:** The battery energy storage system would include containerized lithium-ion battery units (each approximately the size of a shipping container) distributed across the Project area. The battery units would incorporate several layers of protection to avoid failures and to contain potential hazardous substances, including integrated monitoring and circuit protection, a self-contained heating ventilation air cooling system, and a fire detection and suppression system.
- **Electrical Conduit:** The solar panels and battery units would connect with a Project substation via underground electrical conduit. The conduit would be installed in trenches located at the terminus of each solar panel array.
- **Substation and Interconnection Facilities:** The substation would be constructed adjacent to an existing Hawaiian Electric 46kV transmission line that traverses the Project area and would facilitate interconnection with the electrical grid; an overhead electrical connection between the substation and existing transmission line may be required for interconnection.
- **Access and Site Work:** The Project would be accessed via the existing gated entry off Kualakai Parkway (near the intersection with Interstate H-1) and would utilize a network of existing and new onsite access roads. Some road improvements may be needed to facilitate access within the Project area. In addition, some site grading would be needed to accommodate the Project facilities and to comply with stormwater and civil engineering requirements.
- **Agricultural Activities:** The Project would be located within the State agricultural district with soils that are classified by the Land Study Bureau as Class B, D and E. Pursuant to Hawai'i Revised Statutes (HRS) Chapter 205, the Project area would also be made available for compatible agricultural activities.

The Project area will be secured for use by AES through a long-term lease with UH. The Project would be constructed and operated by AES, and the power generated by the Project would be sold to Hawaiian Electric under a new 25-year power purchase agreement (PPA). The PPA was executed in February 2019 and is currently under review by the Public Utilities Commission (PUC). It is anticipated that construction would require approximately 12-15 months, with commercial operations commencing in 2021 or 2022. Once operational, the Project would provide the energy needed to power approximately 4,600 homes on O'ahu each year, offsetting approximately 545,794 barrels of fuel and approximately 244,394 tons of greenhouse gas emissions over the life of the Project.[1]

---

[1] Hawaiian Electric Company PUC filing

Figure 1

Oahu West Solar Project

AES Distributed Energy

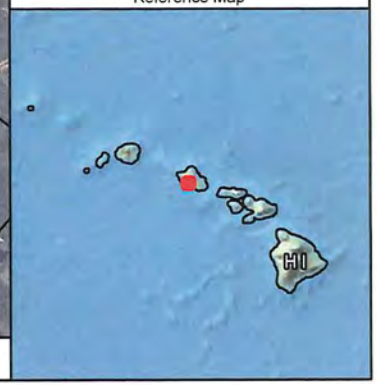
Project Vicinity

HONOLULU COUNTY, HI

- Project Area
- Property Boundary
- Interstate Highway
- Roadway
- City/Town

TETRA TECH

Reference Map



P:\GIS_PROJECTS\AES_Distributed_Energy\Oahu_West_Solar\MXDs\AES_OahuWestSolar_Figure1_ProjectVicinity_8pt5x11_20190822.mxd

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

RECEIVED LAND DIVISION 2019 SEP -6 PM 12:7 DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

LD 1572

August 13, 2019

MEMORANDUM

FROM

TO:

DLNR Agencies:
__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
__Office of Conservation & Coastal Lands
X Land Division – Oahu District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: **AES West Oahu Solar Plus Storage Project, Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment**
LOCATION: 'Ewa District, Island of Oahu; TMK: (1) 9-2-002:007
APPLICANT: AES Distributed Energy, Inc.

Transmitted for your review and comment is information on the above-referenced project. Additional information is also attached for reference.

Please submit any comments by **September 25, 2019.** 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 Barbara Lee at 587-0453 or by email at barbara.j.lee@hawaii.gov. Thank you.

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

Signed:
Print Name: Carty S. Chang, Chief Engineer
Date: 9/6/19

Attachments
cc: Central Files

DEPARTMENT OF LAND AND NATURAL RESOURCES
ENGINEERING DIVISION

LD/Russell Y. Tsuji
Ref: AES West Oahu Solar Plus Storage Project, Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment
TMK(s): (1) 9-2-002:007
Location: Ewa District, Island of Oahu
Applicant: AES Distributed Energy, Inc.

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 Special Flood Hazard Area (high risk areas). State projects are required to comply with 44CFR regulations as stipulated in Section 60.12. Be advised that 44CFR reflects the minimum standards as set forth by the NFIP. Local community flood ordinances may stipulate higher standards that can be more restrictive and would take precedence over the minimum NFIP standards.

The owner of the project property and/or their representative is responsible to research the Flood Hazard Zone designation for the project. Flood Hazard Zones are designated on FEMA's Flood Insurance Rate Maps (FIRM), which can be viewed on our Flood Hazard Assessment Tool (FHAT) (http://gis.hawaiinfip.org/FHAT).

If there are questions regarding the local flood ordinances, please contact the applicable County NFIP coordinating agency 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) 241-4896.

Signed: _____
CARTY S. CHANG, CHIEF ENGINEER

Date: 9/4/19

2166
ref. 19803

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

LD 1572

RECEIVED
LAND DIVISION
2019 SEP 23 AM 11:11
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

August 13, 2019

MEMORANDUM

TO: FROM

DLNR Agencies:
__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
__Office of Conservation & Coastal Lands
X Land Division – Oahu District
X Historic Preservation

FROM: TO: Russell Y. Tsuji, Land Administrator
SUBJECT: **AES West Oahu Solar Plus Storage Project, Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment**
LOCATION: 'Ewa District, Island of Oahu; TMK: (1) 9-2-002:007
APPLICANT: AES Distributed Energy, Inc.

Transmitted for your review and comment is information on the above-referenced project. Additional information is also attached for reference.

Please submit any comments by **September 25, 2019.** 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 Barbara Lee at 587-0453 or by email at barbara.j.lee@hawaii.gov. Thank you.

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

Comments was previously sent to AES 6/28/19 (See attached)

Signed: _____
Print Name: **DAVID G. SMITH, Administrator**
Date: _____

Attachments
cc: Central Files

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
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET, ROOM 325
HONOLULU, HAWAII 96813

JUN 28 2019

Log No. 19803

Mr. Nick Molinari
AES Distributed Energy, Inc.
4875 Pearl East Circle, Suite 200
Boulder, CO 80301

Dear Mr. Molinari:

The Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) has received your inquiry regarding Hawaii Revised Statutes Chapter 195D consultation for the proposed AES West O'ahu Solar Plus Storage Project near Kapolei in the 'Ewa District on the island of O'ahu, Hawai'i, TMK: (1) 9-2-002:007. Proposed work would include construction and operation of a 12.5 megawatt solar photovoltaic system on an approximately 80 acre parcel of land commonly known as the University of Hawai'i West O'ahu Mauka property.

We appreciate the inclusion of mitigation measures in the submitted Biological Report intended to avoid construction and operational impacts to State listed species. DOFAW provides the following additional comments on the potential of the proposed work to affect listed species in the vicinity of the project area in support of your request for information.

The State endangered Hawaiian Short-eared Owl or Pueo (*Asio flammeus sandwichensis*) is known to occur in the project site vicinity. Pueo are a crepuscular species, most active during dawn and dusk twilights. DOFAW recommends twilight pre-construction surveys by a qualified biologist prior to clearing vegetation. If Pueo nests are present, a buffer zone should be established in which no clearing occurs until nesting ceases, and DOFAW staff should be notified.

We note that artificial lighting can adversely impact seabirds that may pass through the area at night by causing disorientation. This disorientation can result in collision with manmade artifacts or grounding of birds. For nighttime lighting that might be required, DOFAW recommends that all lights be fully shielded and directed to avoid reflecting off the panels to minimize impacts. Solar panels may also reflect moonlight during moonlit nights that may attract and disorient seabirds; monitoring during moon phases should be considered to assess if impacts are occurring. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season from September 15 through December 15. This is the period when young seabirds take their maiden voyage to the open sea.

Studies have shown that solar power facilities on the mainland have been linked with avian mortality of a variety of bird species including waterbirds and raptors. As aforementioned, the project area is on open habitat where the Pueo may transit or reside near. In addition to pre-

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

LD 1572

August 13, 2019

MEMORANDUM

TO: **DLNR Agencies:**
__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
__Office of Conservation & Coastal Lands
X Land Division – Oahu District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: **AES West Oahu Solar Plus Storage Project, Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment**
LOCATION: 'Ewa District, Island of Oahu; TMK: (1) 9-2-002:007
APPLICANT: AES Distributed Energy, Inc.

Transmitted for your review and comment is information on the above-referenced project. Additional information is also attached for reference.

Please submit any comments by **September 25, 2019.** 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 Barbara Lee at 587-0453 or by email at barbara.j.lee@hawaii.gov. Thank you.

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

Signed: /s/ M. Kaleo Manuel
Print Name: Deputy Director
Date: September 10, 2019

Attachments
cc: Central Files

FILE ID: RFD.5228.3
DOC ID: 21827

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON

BRUCE S. ANDERSON, PH.D.
KAMANA BEAMER, PH.D.
MICHAEL G. BUCK
NEIL J. HANNAHS
WAYNE K. KATAYAMA
PAUL J. MEYER

M. KALEO MANUEL
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

September 10, 2019

REF: RFD.5228.3

TO: Mr. Russell Tsuji, Administrator
Land Division

FROM: M. Kaleo Manuel, Deputy Director
Commission on Water Resource Management

SUBJECT: AES West Oahu Solar Plus Storage Project, Pre-Assessment Coonsultation for HRS Chapter 343 Environmental Assessment

FILE NO.: RFD.5228.3
TMK NO.: (1) 9-2-002:007

Thank you for the opportunity to review the subject document. The Commission on Water Resource Management (CWRM) is the agency responsible for administering the State Water Code (Code). Under the Code, all waters of the State are held in trust for the benefit of the citizens of the State, therefore all water use is subject to legally protected water rights. CWRM strongly promotes the efficient use of Hawaii's water resources through conservation measures and appropriate resource management. For more information, please refer to the State Water Code, Chapter 174C, Hawaii Revised Statutes, and Hawaii Administrative Rules, Chapters 13-167 to 13-171. These documents are available via the Internet at http://dlnr.hawaii.gov/cwrm.

Our comments related to water resources are checked off below.

- [ ] 1. We recommend coordination with the county to incorporate this project into the county's Water Use and Development Plan. Please contact the respective Planning Department and/or Department of Water Supply for further information.
- [ ] 2. We recommend coordination with the Engineering Division of the State Department of Land and Natural Resources to incorporate this project into the State Water Projects Plan.
- [ ] 3. We recommend coordination with the Hawaii Department of Agriculture (HDOA) to incorporate the reclassification of agricultural zoned land and the redistribution of agricultural resources into the State's Agricultural Water Use and Development Plan (AWUDP). Please contact the HDOA for more information.
- [ ] 4. We recommend that water efficient fixtures be installed and water efficient practices implemented throughout the development to reduce the increased demand on the area's freshwater resources. Reducing the water usage of a home or building may earn credit towards Leadership in Energy and Environmental Design (LEED) certification. More information on LEED certification is available at http://www.usgbc.org/leed. A listing of fixtures certified by the EAP as having high water efficiency can be found at http://www.epa.gov/watersense.
- [X] 5. We recommend the use of best management practices (BMP) for stormwater management to minimize the impact of the project to the existing area's hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events. Stormwater management BMPs may earn credit toward LEED certification. More information on stormwater BMPs can be found at http://planning.hawaii.gov/czm/initiatives/low-impact-development/
- [ ] 6. We recommend the use of alternative water sources, wherever practicable.
- [ ] 7. We recommend participating in the Hawaii Green Business Program, that assists and recognizes businesses that strive to operate in an environmentally and socially responsible manner. The program description can be found online at http://energy.hawaii.gov/green-business-program.
- [X] 8. We recommend adopting landscape irrigation conservation best management practices endorsed by the Landscape Industry Council of Hawaii. These practices can be found online at

http://www.hawaiiscape.com/wp-content/uploads/2013/04/LICH_Irrigation_Conservation_BMPs.pdf.

[X] 9. There may be the potential for ground or surface water degradation/contamination and recommend that approvals for this project be conditioned upon a review by the State Department of Health and the developer's acceptance of any resulting requirements related to water quality.

[ ] 10. The proposed water supply source for the project is located in a designated water management area, and a Water Use Permit is required prior to use of water. The Water Use Permit may be conditioned on the requirement to use dual line water supply systems for new industrial and commercial developments.

[ ] 11. A Well Construction Permit(s) is (are) are required before the commencement of any well construction work.

[ ] 12. A Pump Installation Permit(s) is (are) required before ground water is developed as a source of supply for the project.

[ ] 13. There is (are) well(s) located on or adjacent to this project. If wells are not planned to be used and will be affected by any new construction, they must be properly abandoned and sealed. A permit for well abandonment must be obtained.

[ ] 14. Ground-water withdrawals from this project may affect streamflows, which may require an instream flow standard amendment.

[ ] 15. A Stream Channel Alteration Permit(s) is (are) required before any alteration can be made to the bed and/or banks of a steam channel.

[ ] 16. A Stream Diversion Works Permit(s) is (are) required before any stream diversion works is constructed or altered.

[ ] 17. A Petition to Amend the Interim Instream Flow Standard is required for any new or expanded diversion(s) of surface water.

[ ] 18. The planned source of water for this project has not been identified in this report. Therefore, we cannot determine what permits or petitions are required from our office, or whether there are potential impacts to water resources.

[ ] OTHER:

If you have any questions, please contact Lenore Ohye of the Commission staff at 587-0216.

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

LD 1572

August 13, 2019

MEMORANDUM

TO: **DLNR Agencies:**
__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
__Office of Conservation & Coastal Lands
X Land Division – Oahu District
X Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: **AES West Oahu Solar Plus Storage Project, Pre-Assessment Consultation for HRS Chapter 343 Environmental Assessment**
LOCATION: 'Ewa District, Island of Oahu; TMK: (1) 9-2-002:007
APPLICANT: AES Distributed Energy, Inc.

Transmitted for your review and comment is information on the above-referenced project. Additional information is also attached for reference.

Please submit any comments by **September 25, 2019.** 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 Barbara Lee at 587-0453 or by email at barbara.j.lee@hawaii.gov. Thank you.

( ) We have no objections.
(X) We have no comments at this time.
( ) Comments are attached.

Signed: Patti E. Miyashiro
Print Name: Patti E. Miyashiro
Date: September 4, 2019

Attachments
cc: Central Files

OFFICE OF PLANNING
STATE OF HAWAII

DAVID Y. IGE
GOVERNOR

MARY ALICE EVANS
DIRECTOR
OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824
Web: http://planning.hawaii.gov/

DTS 201909261040MA

October 1, 2019

Ms. Lisa Kettley
Project Manager
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Ms. Kettley:

Subject: AES West Oahu Solar Plus Storage Project, Pre-Assessment Consultation, Ewa District, Oahu
TMK: (1) 9-2-002: 007

Thank you for the opportunity to provide comments on the pre-assessment consultation for the preparation of a Draft Environmental Assessment (Draft EA) for a solar plus storage project near Kapolei, Oahu which was transmitted to us on August 23, 2019.

AES Distributed Energy, Inc. (AES), is proposing to construct and operate solar energy farm/storage facility on land owned by the University of Hawaii. The solar energy storage project will consist of a 12.5-megawatt (MW) ground-mounted solar photovoltaic system, coupled with a 50 MW-hour battery storage system and ancillary facilities.

The Office of Planning (OP) has reviewed the transmitted material and offers the following comments:

1. Special Permit: According to the Land Study Bureau ratings map, the project area has soils designated as B, D and E. In accordance with Hawaii Revised Statutes (HRS) § 205-4.5 (21), a Special Permit is required, and must meet the requirements for agricultural uses and decommissioning among other requirements. The Draft EA should address the special permit guidelines relative to determining the "unusual and reasonable" use of lands for the proposed solar facility.

   Also, OP notes that since the project is over 15 acres, the State Land Use Commission would be issuing the final decision on the Special Permit for the proposed facility.

2. <u>The Hawaii State Planning Act</u>
   Pursuant to Hawaii Administrative Rules (HAR) § 11-200-10(4) – general description of the action's technical, economic, social, and environmental characteristics, this project must demonstrate that it is consistent with state environmental, social, economic goals, and policies.

HRS Chapter 226, the Hawaii State Planning Act, provides goals, objectives, policies, planning coordination and implementation, and priority guidelines for growth, development, and the allocation of resources throughout the state.

The Draft EA should include a discussion on the project and its consistency with all three parts of HRS Chapter 226. We note that the proposed solar farm and storage facility is consistent with the principles of sustainability as a renewable energy production facility. This is applicable to HRS § 226-108 – sustainability priority guidelines. The Draft EA should include, but not be limited to, this provision in its analysis on HRS Chapter 226.

3. Hawaii Coastal Zone Management (CZM) Program
The CZM area is defined as "all lands of the State and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the U.S. territorial sea" (HRS § 205A-1).

Pursuant to HRS § 205A-4, in implementing the objectives of the CZM program, agencies shall consider ecological, cultural, historic, esthetic, recreational, scenic, open space values, coastal hazards, and economic development. As this project will require the approval of a government agency, the Draft EA should include analysis on the project's consistency with the objectives and supporting policies of the Hawaii CZM Program, as listed in HRS § 205A-2. Compliance with HRS § 205A-2 is an important component for satisfying the requirements of HRS Chapter 343.

4. Stormwater Runoff, Erosion, and Water Resources
Pursuant to HAR § 11-200-10(6) – identification and summary of impacts and alternatives considered; to ensure that the surface water and nearshore marine resources near the coastal area of the West Oahu remain protected, the negative effects of stormwater inundation from this cesspool closure and wastewater system construction action should be evaluated in the Draft EA.

As this project will involve lands classified in the State Land Use Agricultural District, and involve activities that create impermeable surface areas, the effects of stormwater runoff emanating from the project area should be evaluated in the Draft EA. The evaluation on stormwater runoff, erosion control, and any benefits on water quality should involve steps taken during the construction phase, as well as during the operational life of the proposed solar energy facility.

Issues that may be examined include, but are not limited to, project site characteristics in relation to flood and erosion prone areas, potential vulnerability of water resources, soil absorption characteristics of the area, and examining the amount of permeable versus impervious surfaces in the area. Developing mitigation measures for the protection for surface water resources and the coastal ecosystem should take this into account, pursuant to HAR § 11-200-10(7).

If you should have any questions, please contact Lorene Maki of our Land Use Division at (808) 587-2888 or Joshua Hekekia of our CZM program at (808) 587-2845.

Mahalo,

Mary Alice Evans

Mary Alice Evans
Director

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE (808) 768-8000 • FAX (808) 768-6041
DEPT WEB SITE www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

KIRK CALDWELL
MAYOR

KATHY K SOKUGAWA
ACTING DIRECTOR

TIMOTHY F T HIU
DEPUTY DIRECTOR

EUGENE H TAKAHASHI
DEPUTY DIRECTOR

October 10, 2019

2019/ELOG-1657 (FH)
1758671

Ms. Lisa Kettley
Tetra Tech
737 Bishop Street, Suite 2340
Honolulu, Hawaii 96813

Dear Ms. Kettley:

SUBJECT: Request for Comments on Pre-Assessment Consultation for Hawaii Revised Statutes, Chapter 343, Environmental Assessment for AES West Oahu Solar Plus Storage Project
Ewa District, Oahu, Tax Map Key 9-2-002: 007 (Portion)

This is in response to your letter received August 27, 2019, seeking pre-assessment consultation to obtain input on the scope of issues to be considered in the Draft Environmental Assessment (DEA) for the construction and operation of a solar photovoltaic and battery energy storage system (BESS Project). The BESS Project is proposed on land located three miles northeast of Kapolei, on approximately 80 acres within Tax Map Key 9-2-002: 007. The land is owned by the University of Hawaii (UH) in an area commonly referred to as the UH West Oahu Mauka property.

We offer the following comments:

1. According to the Land Study Bureau (LSB) classification maps, the Department of Planning and Permitting (DPP) estimates the proposed BESS Project is primarily on soils with productivity ratings of B, D, and E. However, to accurately determine what LSB soils the proposed BESS Project is on, a metes and bounds survey of the proposed BESS Project area, overlaid on a LSB map, is necessary to determine compliance with Chapter 205-4.5(21), Hawaii Revised Statutes (HRS). The site plan should include the proposed BESS Project area, the layout of the proposed BESS Project components, roadways, and any related support uses and structures.

2. Once compliance with Sections 205-4.5(20) and 205-4(21), HRS, is verified, you may apply for a Special Use Permit. Since the proposed BESS Project involves more than 15 acres, it is subject to approval by the State Land Use Commission, per Section 205-6(d), HRS.

3. The DEA should address how the proposed BESS Project conforms to the vision, policies, and guidelines of the Ewa Development Plan. In addition, the DEA should address the proposed BESS Project's consistency with each of the applicable Objectives and Policies of the Oahu General Plan.

4. Although the DPP gave preliminary confirmation in a July 17, 2019 letter that the BESS Project is considered a Type B Utility Installation, the DEA should include detailed information to determine the use of the site as either a Type A or Type B Utility Installation. If it is considered a Type B Utility Installation, then a Minor Conditional Use Permit will be necessary.

   There is not enough information to determine if the Project will meet all development standards of the AG-1 Restricted Agricultural District. If the Project does not comply with all the development standards, then a Zoning Waiver will be necessary.

5. The DEA should include an analysis of the visual impacts associated with the proposed BESS Project.

6. The DEA shall include a narrative describing how the proposed BESS Project's post-construction storm water quality strategic plan complies with the Rules Relating to Water Quality (Rules), City and County of Honolulu Administrative Rules, Title 20, DPP, Chapter 3. The strategic plan shall include a written description of the proposed development, expected activities and pollutants that will be generated by such activities at the site, low impact development site design strategies that will be used to comply with the Rules, and an anticipated development schedule. The DEA should also disclose how the proposed BESS Project shall comply with the City and County's prevailing Storm Drainage Standards.

7. The DPP recommends consultation with the Federal Aviation Administration and the Hawaii State Department of Transportation-Airports, as the location of the proposed BESS Project will be within five miles of the Kalaeloa Airport. Refer to the Technical Assistance Memorandum (TAM-2016-1) for guidance with the development and activities that may require further permits. The TAM-2016-1 can be viewed at:

   http://files.hawaii.gov/dbedt/op/docs/TAM-FAA-DOT-Airports_08-01-2016.pdf

8. The DEA should list all federal, state, and city permits required for the proposed BESS Project.

Should you have any questions, please contact Frank Hall, of our staff, at 768-8862 or frank.hall@honolulu.gov.

Very truly yours,

Kathy K. Sokugawa
Acting Director

KKS:ah

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