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

GEORGE I. ATTA, FAICP
DIRECTOR

ARTHUR D. CHALLACOMBE
DEPUTY DIRECTOR

2014/ED-5(MS)

May 28, 2014

MAY 29 2014

Ms. Jessica Wooley
Office of Environmental Quality Control
Department of Health, State of Hawaii
235 South Beretania Street, Room 702
Honolulu, Hawaii 96813

Dear Ms. Wooley:

SUBJECT: Special Management Area Ordinance
Chapter 25, Revised Ordinances of Honolulu
Draft Environmental Assessment

Project: Kahe Photovoltaic Facility Project
Applicant: Hawaiian Electric Company, Inc.
Agent: Planning Solutions, Inc.
Location: 92-200 Farrington Highway – Kahe Point
Tax Map Key: 9-2-49: 6
Proposal: Special Management Area-Major (SMA) Permit to allow the installation of and operation of a utility installation, Type B, consisting of an 11.5 megawatt (MW) ground-mounted photovoltaic (PV) system which connects with the existing substation at Kahe Generating Station.

We respectfully request publication of the project summary of the Draft Environmental Assessment (DEA) in the next edition of The Environmental Notice on **June 8, 2014**. Enclosed are two hard copies and one electronic copy of the DEA and the Publication Form. The Publication Form, including project summary, was also sent via electronic mail to your office.

Should you have any questions, please contact Malynne Simeon at 768-8023 or via email at msimeon@honolulu.gov.

Very truly yours,

for George I. Atta, FAICP
Director

Enclosure: DEA, two hard copies and one disk
One copy of OEQC Publication Form

OEQC,

Please publish notice of the availability of the Chapter 25, Revised Ordinances of Honolulu, environmental assessment for a photovoltaic project, as noted in the attachment, in the June 8, 2014 Environmental Notice. This will establish the beginning of the 30 day public comment period.

Thank you,

Ardis Shaw-Kim
Department of Planning and Permitting
City and County of Honolulu

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PETER B. CARLISLE
MAYOR

DAVID K. TANOUE
ACTING DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

(JP)

October 28, 2010

MEMORANDUM

TO: LAND USE PERMITS DIVISION
SITE DEVELOPMENT DIVISION
PLANNING DIVISION
BUILDING DIVISION
CUSTOMER SERVICE OFFICE

FROM: DAVID K. TANOUE, ACTING DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

SUBJECT: INTERPRETATION NO. 2010/INT-3, RELATING TO MULTIPLE DWELLING UNITS ON A SINGLE COUNTRY OR RESIDENTIAL ZONING LOT IN THE SPECIAL MANAGEMENT AREA (SMA)

Attached for your information is an interpretation which clarifies that more than two dwelling units on a single subdivision lot shall continue to be considered "part of a larger development" for purposes of Chapter 25, Revised Ordinances of Honolulu, the SMA Ordinance, even though more than two dwellings may be permitted by-right, pursuant to the new provisions of Land Use Ordinance Section 21-8.20A.

DKT:cs

Attachment

INTERPRETATION WRITE-UP

Date: October 28, 2010
Interp. No. 2010/INT-3

ROH Section:	25-1.3(2)(A), Revised Ordinances of Honolulu (ROH), relating to exemptions from the Special Management Area (SMA) Ordinance.
Problem Statement:	ROH Section 25-1.3(2)(A) states that construction of a "single-family residence that is not part of a larger development" is not "development" for purposes of the SMA Ordinance. With the September 2, 2010 enactment of Land Use Ordinance (LUO) Section 21-8.20A (via Ordinance No. 10-19), up to eight dwellings may now be constructed by-right on a single residential or country district zoning lot of sufficient size. Therefore, how many dwellings may be constructed on a single zoning lot within the SMA, before an SMA permit is required?
Interpretation:	Only two dwellings units. Any proposal for more than two dwelling units ("residences") on a single zoning lot shall require an SMA permit.
Justification:	It has been a long-standing interpretation by the Department of Planning and Permitting (DPP) that the construction of more than two dwellings on a single zoning lot triggers the SMA permit requirement; albeit, this practice has never previously been documented through a formal Interpretation. This Interpretation was based on the provisions of former LUO Section 21-8.20(a), which allowed a maximum of two single-family dwellings by-right on a single residential, country, or agricultural zoning lot, provided the lot met the minimum lot size requirements (twice the underlying minimum lot size). A two-family dwelling was also allowed without triggering SMA requirements, provided the lot met the minimum lot size requirement for a two-family dwelling or ohana dwellings, as applicable. The construction of more than two dwellings (either two single-family dwellings or a two-family dwelling) required either a cluster, site development plan, planned development-housing, or formal subdivision action. That is, whenever more than two dwelling units were proposed on a single lot, they were

considered "part of a larger development," and thus were subject to SMA permit requirements.

With the recent establishment of LUO Section 21-8.20A, up to eight dwellings may now be constructed "by-right" on a single residential or country zoning lot of sufficient size. This LUO amendment was intended to facilitate the development of in-fill housing. However, it does not supersede current SMA Ordinance provisions, interpretations, or practices. This issue was specifically discussed with the City Council during its consideration of this particular LUO amendment. We explained that the DPP position was unchanged; i.e., only two dwelling units would be permitted without an SMA permit, as expressed in this Interpretation. Accordingly, if more than two dwelling units are proposed on a single zoning lot, the dwellings will be considered "part of a larger development" for purposes of the SMA Ordinance. This Interpretation is consistent with associated LUO provisions relating to Cluster and Existing Use permit requirements for three or more dwelling units on a single zoning lot, which are unchanged by the amendments enacted through Ordinance No. 10-19.

David K. Tanoue, Acting Director
Department of Planning and Permitting

Draft Environmental Assessment
KAHE UTILITY-SCALE PHOTOVOLTAIC PROJECT

KAHE VALLEY, O'AHU, HAWAI'I

PREPARED FOR:

Hawaiian Electric Company, Inc.

PREPARED BY:

PLANNING SOLUTIONS

MAY 2014

PROJECT SUMMARY

Project:	**Kahe Utility-Scale Photovoltaic Project**
Applicant:	Hawaiian Electric Company, Inc. P.O. Box 2750 Honolulu, Hawai‘i 96840-0001 Contact: Robert Isler (808-543-7206)
Approving Agency:	Department of Planning and Permitting City and County of Honolulu 650 South King Street Honolulu, HI 96813
Location:	Kahe Generating Station, 92-200 Farrington Highway, Kapolei, HI, 96792
Proposed Action:	Installation of a ~11.5 MW (AC) photovoltaic facility including interconnections with the existing substation at the Kahe Generating Station and the island-wide electrical grid.
Associated Actions Requiring Environmental Assessment:	Construction within the Special Management Area as required by Chapter 25-3.3(e), Revised Ordinances of Honolulu.
Tax Map Key:	(1) 9-2-049:006
Parcel Area:	454.4 acres
Project Area:	41 acres
Judicial District:	‘Ewa
Development Plan Designation:	Public Facility
State Land Use District:	Urban
County Zoning:	I-2 Intensive Industrial
Required Permits & Approvals:	• PUC Authorization to Commit Funds • Chapter 25, ROH Environmental Assessment • Special Management Area Use Permit (Major) • National Pollutant Discharge Elimination System – Notice of Intent [Construction] (NPDES-NOI[C]) • Modification to Existing Conditional Use Permit • Noise Permit and/or Noise Variance • Grubbing, Grading, and Stockpiling Permit • Building Permits
Anticipated Determination:	Finding of No Significant Impact
Parties Consulted:	See Chapter 9
Consultant:	Planning Solutions, Inc. 210 Ward Avenue, Suite 330 Honolulu, HI 96814 Contact: Perry White (808-550-4483)

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List of Acronyms

Acronym	*Phrase*
AIS	Archaeological Inventory Survey
AC	Alternating Current
BESS	Battery Energy Storage System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CIA	Cultural Impact Assessment
CIP	Campbell Industrial Park
EA	Environmental Assessment
EIS	Environmental Impact Statement
EISPN	Environmental Impact Statement Preparation Notice
HAR	Hawaiʻi Administrative Rules
HRS	Hawaiʻi Revised Statutes
IPP	Independent Power Provider
kV	Kilovolt
MW	Megawatt
MWh	Megawatt Hour
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
PPA	Power Purchase Agreement
PUC	Public Utilities Commission
PV	Photovoltaic
RFP	Request For Proposals
RPS	Renewable Portfolio Standards
SCADA	Supervisory Control and Data Acquisition
TMK	Tax Map Key
VMP	Vegetation Management Plan

1. PROJECT OVERVIEW

1.1 INTRODUCTION AND OVERVIEW

This Environmental Assessment (EA) evaluates the potential environmental effects of Hawaiian Electric Co., Inc. (henceforth "Hawaiian Electric" or "the Company") constructing and operating an 11.5 megawatt (AC)[1] photovoltaic (PV) electric power project on approximately 41 acres of Company-owned land in Kahe Valley immediately north of its existing Kahe Generating Station (KGS). KGS occupies only one-tenth of the 454.4-acre parcel [TMK No. (1) 9-2-003:027]; the remainder of the parcel is vacant (see Figure 1.1, Figure 1.2, and Figure 1.3).

All of Hawaiian Electric's Kahe property is in the State Urban District and has been zoned for heavy industrial use (I-2) by the City and County of Honolulu (see Figure 1.4). It is also entirely within the Special Management Area (SMA). KGS' six oil-fired generating units have a combined capacity of approximately 650 MW; this is slightly more than half of Hawaiian Electric's total company-owned generating capacity. In addition to the electrical generating units themselves, the Company also maintains and operates extensive support facilities within KGS. These facilities include welding and repair bays, fuel and water storage tanks, water treatment facilities, cooling water intakes and discharge facilities, electrical substation equipment, offices, and warehouses.

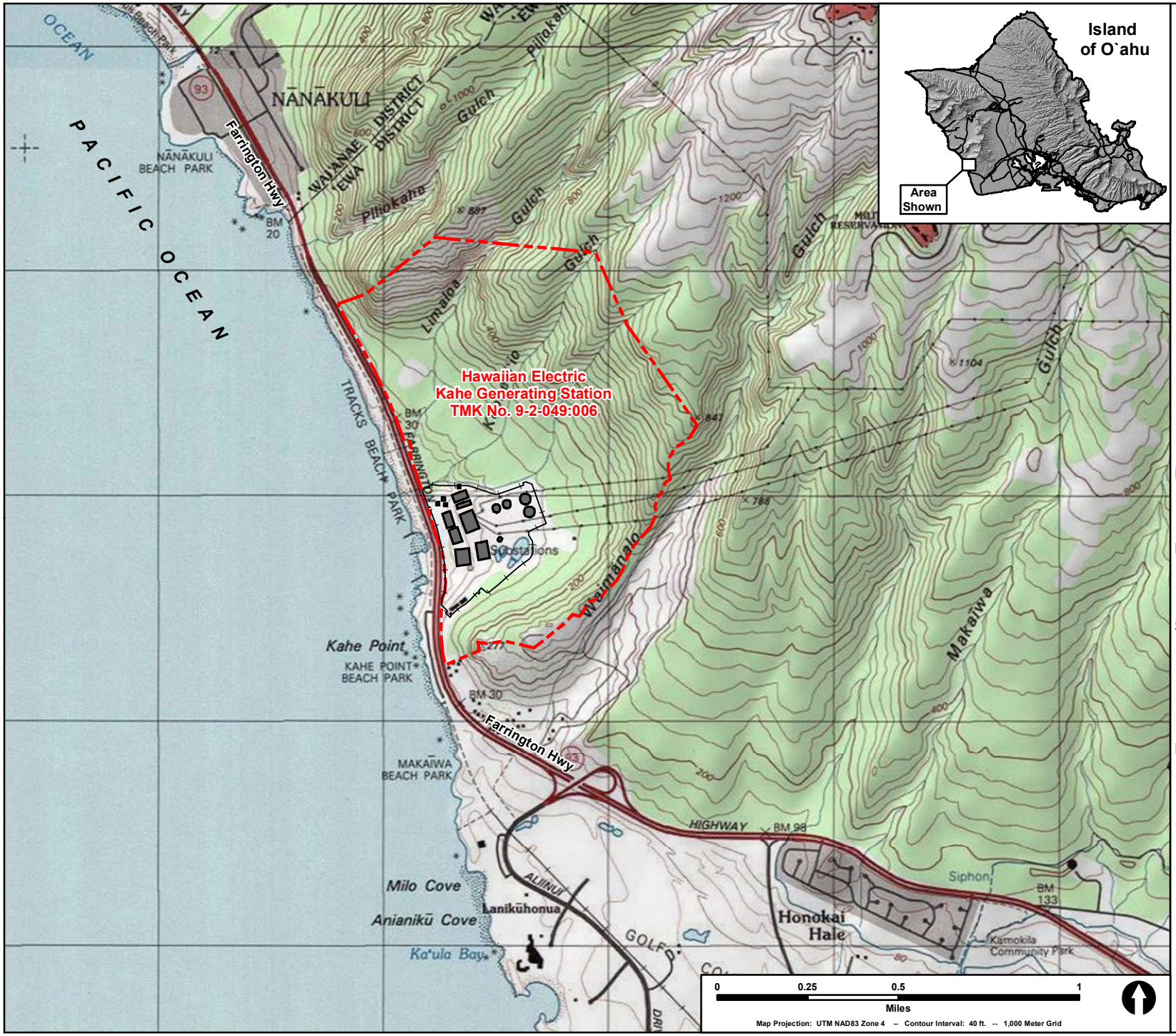
The proposed Kahe Utility-Scale Photovoltaic Project (KUSPP) includes the PV panels themselves; the inverters, transformers, conduits, and other equipment needed to connect them to a new substation that would be constructed as part of the project; and the 46kV power line needed to deliver the power to the company's islandwide electrical power grid through the existing Kahe Generating Station Substation/Switchyard. The photovoltaic array is expected to produce an average of 23 gigawatt hours (GWh) of electricity per year. This production represents approximately 0.5 percent of Hawaiian Electric's total electrical generation in 2012.[2]

This EA was prepared to fulfill the requirements of Chapter 25 of the Revised Ordinances of Honolulu (ROH) governing the issuance of permits for development within the Special Management Area (SMA). Section 25-3.3(c)(1) stipulates that any proposed development requiring an SMA use permit is subject to an assessment by the agency in accordance with the procedural steps set forth in Chapter 343 of the Hawai'i Revised Statutes (the State environmental impact statement [EIS] law) even if it does not involve one of the official Chapter 343 "triggers". Section 25-4.2 requires that in processing an EA or EIS being used in support of an SMA Permit application, the director adhere to the procedures set forth in HRS Chapter 343 and its implementing regulations (HAR 11-200).[3]

[1] The electrical output from an individual PV panel is in the form of direct electrical current (DC). The electrical utility transmits and distributes electricity to its customers in the form of alternating current (AC). Thus, it is possible to report the size of a system as either DC or AC. The "AC" rating is used throughout this report.

[2] Total consolidated sales across all Hawaiian Electric Industries (HEI) power plants were ~9,070 GWh.

[3] Section 25-3.3(c)(2) exempts actions for which a finding of no significant impact has been filed or a required EIS has been accepted from the need to prepare a new assessment.



Legend:

Kahe Fence Line

TMK 9-2-049:006 Boundary

Prepared for:

Hawaiian Electric Co., Inc.

Prepared by:

PLANNING SOLUTIONS

Sources:

-C & C Honolulu GIS
-Hawaiian Electric Energy Services Dept.
-USGS Quadrangle Maps:
-ESRI

Figure 1.1:

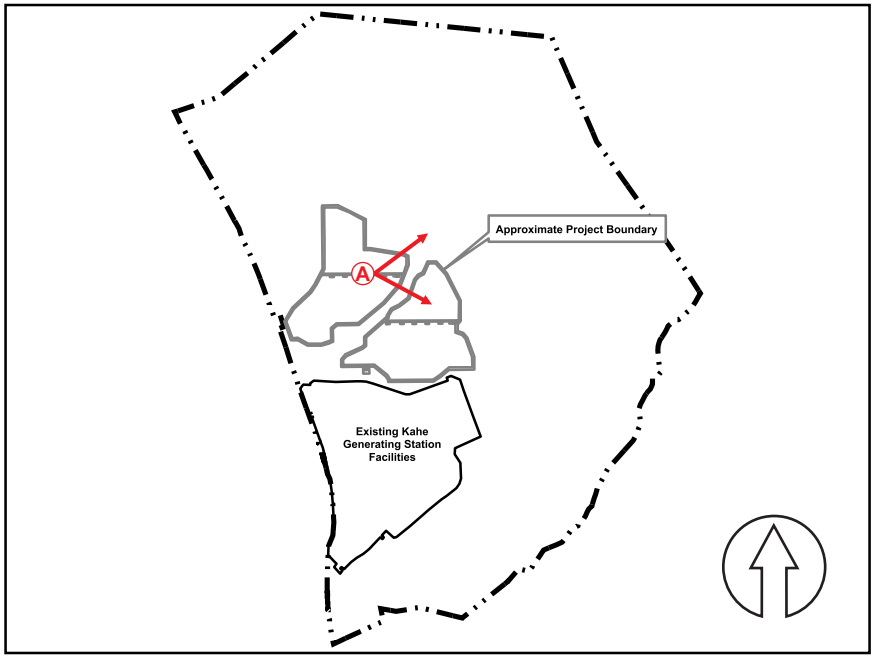
Location Map

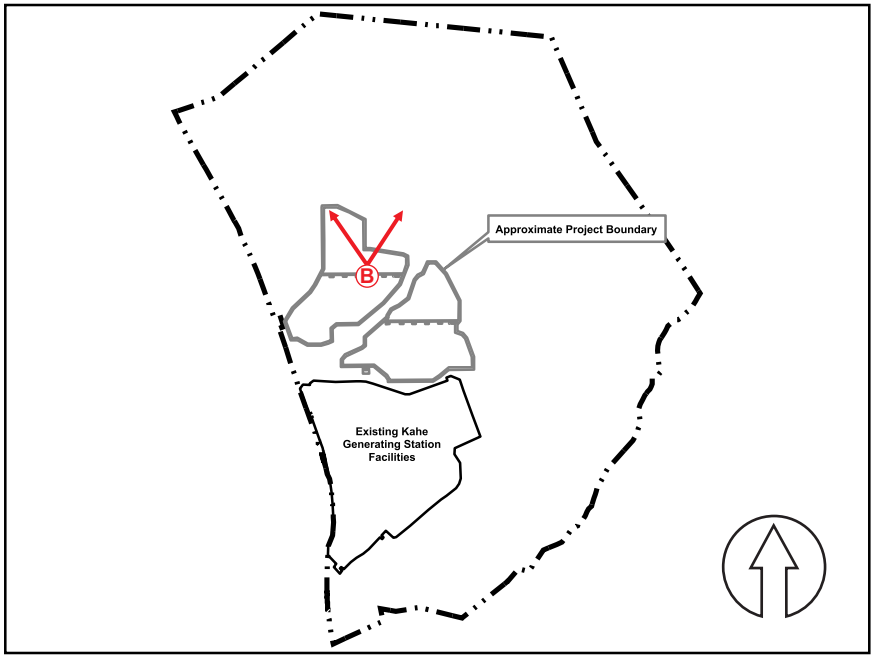
Kahe Utility-Scale Photovoltaic Project

Figure 1-1 Location Map 2014-02-25.mxd

Prepared for:	Prepared by:	Sources:	Project:	Figure 1.2:
Hawaiian Electric	PLANNING SOLUTIONS	-Hawaiian Electric -SolarCity -ESRI	Kahe Utility-Scale Photovoltaic Project	**Vicinity Map**

Figure 1-2 Vicinity Map 2014-05-21.mxd





Prepared For:
Hawaiian Electric

Prepared By:
PLANNING SOLUTIONS

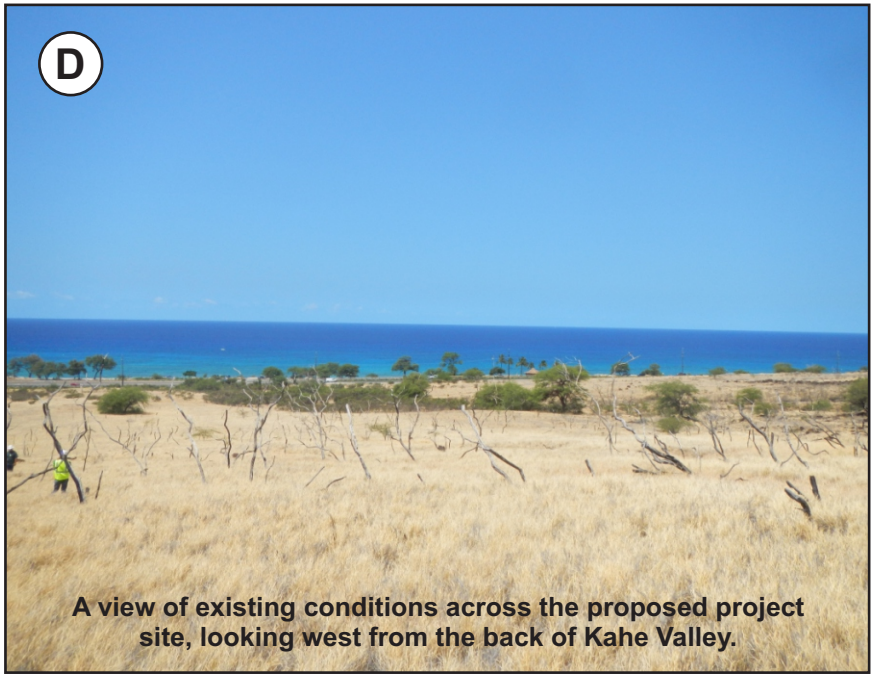
Source:
PSI

Project:
Kahe Utility-Scale Photovoltaic Project

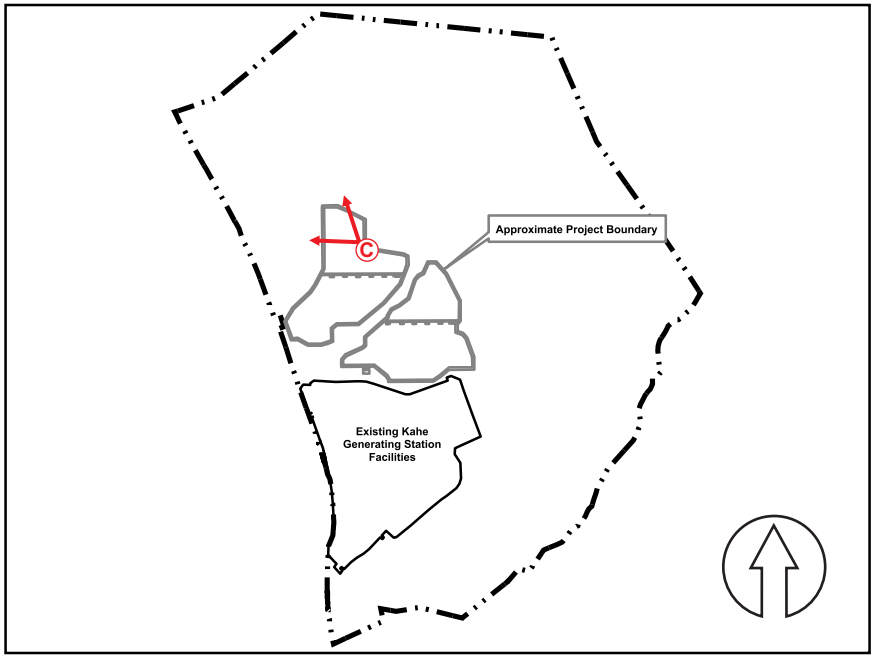
Figure 1.3A:
Existing Conditions at the Project Site

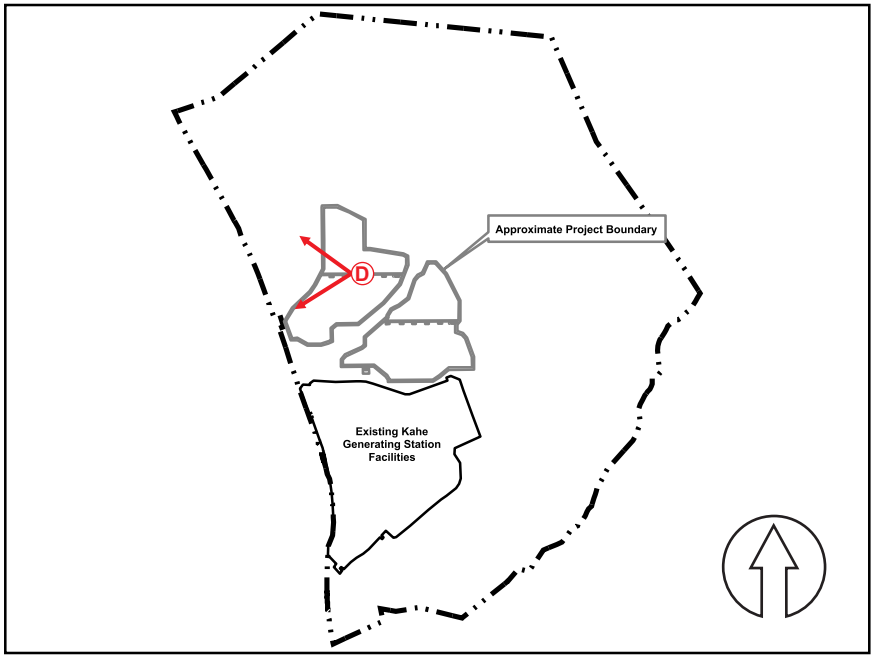
Figure 1-3A Existing Conditions on the Project Site 2014-05-21.cdr

A view looking northwest, across the proposed project site.



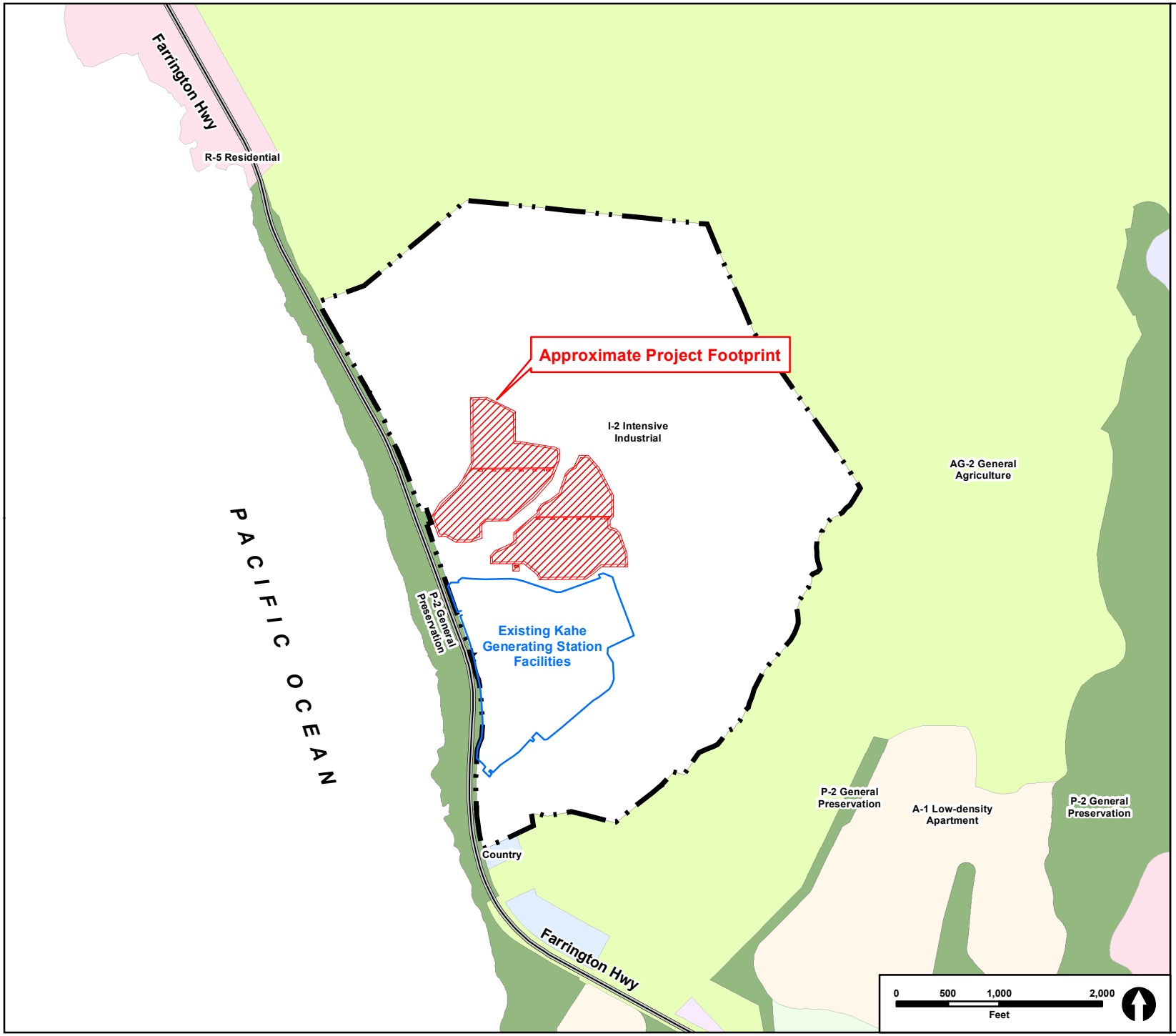
A view of existing conditions across the proposed project site, looking west from the back of Kahe Valley.





Prepared For:	Prepared By:	Source:	Project:	Figure 1.3B:
Hawaiian Electric	PLANNING SOLUTIONS	PSI	Kahe Utility-Scale Photovoltaic Project	**Existing Conditions at the Project Site**

Figure 1-3B Existing Conditions on the Project Site 2014-05-21.ctr



Prepared for:

Hawaiian Electric

Prepared by:

PLANNING SOLUTIONS

Sources:

-Hawaiian Electric
-City & County of Honolulu GIS

Figure 1.4:

Zoning

Kahe Utility-Scale Photovoltaic Project

Figure 1-4 Zoning Map 2014-05-22.mxd

1.2 OVERVIEW OF WORK WITHIN THE SMA

Hawaiian Electric proposes to undertake the following activities within the SMA as part of this project (see Figure 1.5 for the approximate locations).

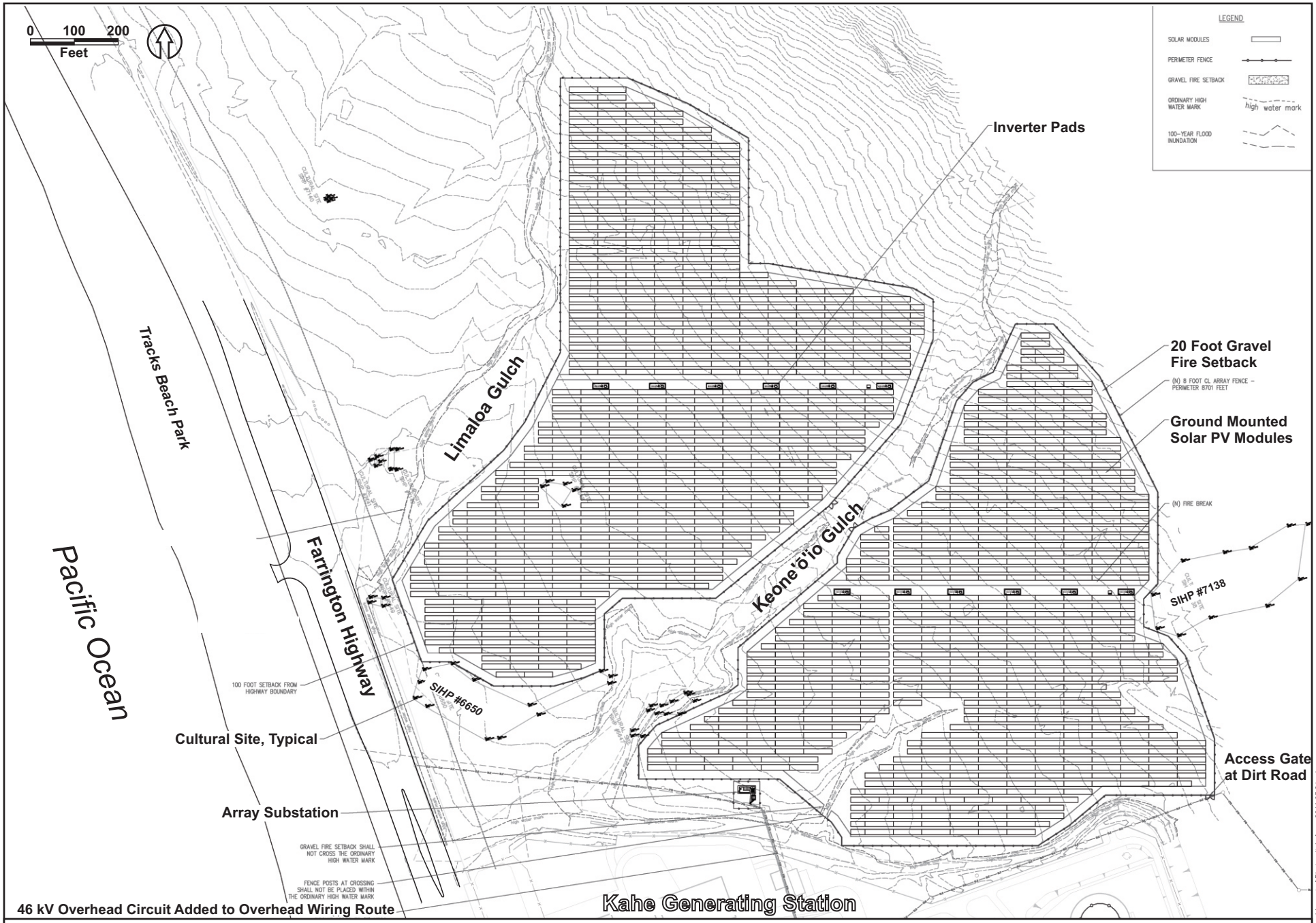
- Install nearly 47,000 photovoltaic panels mounted on approximately 5,000 support posts. These panels would have a total surface area of approximately 22.4 acres and would be capable of supplying up to 11.5 MW (AC) of electricity to Hawaiian Electric's islandwide electrical grid.
- Construct 12 electrical equipment pads, each equipped with one (1) inverter and one (1) transformer.
- Install underground conduits and wiring linking the strings of photovoltaic modules to the electrical equipment pads.
- Connect the foregoing to new equipment installed within the existing KGS Substation.

These components are integral to the construction, operation, and maintenance of the photovoltaic electrical generation facility.

1.3 ORGANIZATION OF THE REPORT

The remainder of this report is organized as follows:

- Chapter 2 describes the proposed facility in detail, including its location, design, construction, cost, and mode of operation.
- Chapter 3 discusses the purpose and need for the proposed photovoltaic facility.
- Chapter 4 outlines the alternatives analyzed in this DEA, as well as several other alternatives that were considered and rejected by Hawaiian Electric in earlier phases of the planning process.
- Chapter 5 provides descriptions of the existing environment and analyzes the ways in which the proposed action could impact environmental, cultural, and socioeconomic resources. It also outlines strategies for minimizing adverse effects and mitigating unavoidable adverse impacts.
- Chapter 6 discusses the consistency of the proposed project with applicable county and state plans, policies, and controls.
- Chapter 7 states the anticipated determination that the proposed project will not have a significant adverse effect on the environment.
- Chapters 8 and 9 identify parties consulted and references cited during preparation of this DEA.



Prepared For:	Prepared By:	Source:	Project:	Figure 1.5:
Hawaiian Electric	PLANNING SOLUTIONS	SolarCity 05/21/2013	Kahe Utility-Scale Photovoltaic Project	**Conceptual Layout of Photovoltaic Array**

Figure 1-5 Conceptual Layout of Photovoltaic Array 2014-05-21.cdr

2. DESCRIPTION OF THE PROPOSED PROJECT

The overall location and configuration of the various project elements within Hawaiian Electric's Kahe property are depicted in Figure 1.5 This chapter provides more detailed information about the design of the proposed facilities. It also describes the procedures that will be used in its construction, operation and maintenance, the materials that will be used, the estimated costs, and the anticipated project development schedule.

2.1 PROPOSED NEW FACILITIES

The proposed project involves the construction, installation, and operation of an approximately 11.5 MW (AC) renewable photovoltaic electrical generation system located on an undeveloped portion of Hawaiian Electric's existing property at Kahe Generating Station. The project, which will be tied to the Hawaiian Electric's island-wide electrical grid, will provide as-available, low-cost renewable electrical energy and reduce the overall use of fossil fuel on O'ahu.

2.1.1 PV MODULES

The project will include approximately 47,000 320-watt fixed-tilt/ground-mounted photovoltaic panels ("modules").[4] The modules will be installed on ground-mounted racking systems, which will have almost 5,000 posts or piles driven into the ground to an approximate depth of 8 feet, consistent with building code wind-loading criteria. To maximize energy output, the panels will be set at a 20-degree tilt to the sun and will be oriented facing south. Figure 2.1 contains a photograph of the type of module that would be used. Figure 2.2 depicts the dimensions and specifications of an individual panel.

2.1.2 ELECTRICAL EQUIPMENT PADS

The modules will be divided into twelve distinct sub-systems. Groups of modules will be connected to pad-mounted inverters. The inverters will convert the DC power produced by the panels into the AC current that is used in Hawaiian Electric's system. Each inverter will have its own 800 V-12.47 kV transformer. Eleven of these transformers will be sized 1.0 MW (AC) and the remaining inverter will be sized at 0.5 MW (AC) for the 11.5 MW AC total discussed throughout this report. The 12.47 kV power from each of these twelve groups will be carried through electrical cables in underground conduits to the new substation (see Section 2.1.3) and then the combined output of these twelve transformers will be delivered to the proposed Kahe PV Substation.

2.1.3 46 KV KAHE PV SUBSTATION

The combined output from the twelve equipment pads will be delivered to a single 12.47 kV-46 kV transformer in a new 46 kV substation that Hawaiian Electric would construct adjacent to Farrington Highway at the southern end of the PV arrays. Access to the substation would be via Kahe Generating Station and the new 20-foot wide fire setback.

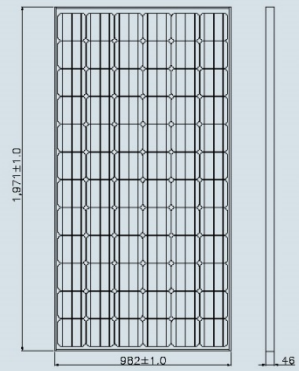
[4] This output estimate is under Standard Test Conditions (STC) which are 1,000 watts per square meter solar irradiance, 25 degrees Celsius cell temperature, air mass equal to 1.5, and American Society for Testing and Materials (ASTM) G173-03 standard spectrum.

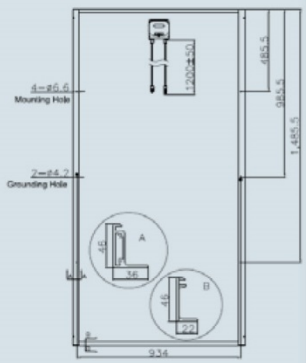
Figure 2.1 Photographs of Proposed PV Modules

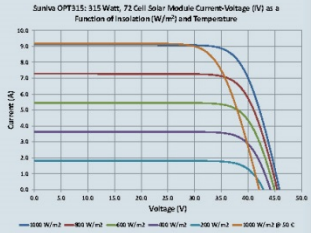



Source: Suniva (2014)

Figure 2.2 Typical Solar Array Dimensions and Specifications







PLEASE RECYCLE

APRIL 14, 2014 (REV. 18) [SAMD_0018]

OPTIMUS SERIES: OPT 72 CELL MODULES

ELECTRICAL DATA (NOMINAL)

The rated power may only vary by -0/+3% and all other electrical parameters by ± 5%

Model Number	OPT 310-72-4-100	OPT 315-72-4-100	OPT 320-72-4-100	OPT 325-72-4-100
Power Classification (Pmax)	310 W	315 W	320 W	325 W
Module Efficiency (%)	16.02%	16.27%	16.53%	16.79%
Voltage at Max. Power Point (Vmp)	36.2 V	36.5 V	36.8 V	37.0 V
Current at Max. Power Point (Imp)	8.56 A	8.62 A	8.69 A	8.77 A
Open Circuit Voltage (Voc)	45.7 V	45.9 V	46.1 V	46.3 V
Short Circuit Current (Isc)	9.06 A	9.10 A	9.20 A	9.27 A

The electrical data apply to standard test conditions (STC): Irradiance of 1000 W/m² with AM 1.5 spectra at 25°C.

CHARACTERISTIC DATA

Type of Solar Cell	High-efficiency ARTisun Select cells of 156 x 156mm (6 in.)
Frame	Silver anodized aluminum alloy
Glass	Tempered (low-iron), anti-reflective coating
Junction Box	NEMA IP67 rated; 3 internal bypass diodes
Cable & Connectors	12 AWG (4 mm²) PV Wire cable with with multiple connector options available; cable length 1200 mm

MECHANICALS

Cells / Module	72 (6 x 12)
Module Dimensions	1971 x 982 mm (77.6 x 38.7 in.)
Module Thickness (Depth)	46 mm (1.80 in.)
Approximate Weight	23 kg (50.70 lbs.)

TEMPERATURE COEFFICIENTS

Voltage	ß, Voc (%/°C)	-0.335
Current	α, Isc (%/°C)	+0.047
Power	γ, Pmax (%/°C)	-0.420
NOCT Avg	(+/- 2 °C)	46.0

LIMITS

Max. System Voltage	1000 VDC for IEC, 1000 VDC for UL
Max Series Fuse Rating	15 Amps
Operating Module Temperature	-40°C to +85°C (-40°F to +185°F)
Storm Resistance/Static Load	Tested to IEC 61215 for loads of 2400 Pa (50 psf); hail and wind resistant

Suniva® reserves the right to change the data at any time. View manual at suniva.com.
[1]UV 90 kWh, TC 400, DH 2000. [2]Tests were conducted on module type OPT 60 silver frame.

Please read installation manual before installing or working with module.

Product	Modules per pallet	Pallets per Container	Total Modules
OPT - 72 cell	22	24	528

HEADQUARTERS
5765 Peachtree Industrial Blvd.,
Norcross, Georgia 30092 USA
Tel: +1 404 477 2700
www.suniva.com

Suniva®
The Brilliance of Solar Made Sensible®

Source: Suniva (2014)

The proposed Kahe Utility-Scale Photovoltaic Project substation would have several different types of equipment including switchgear, one standard oil-filled ANSI/IEEE transformer, and other electrical components.[5] The transformers' purpose is to raise the voltage of the electrical power from the 12.47 kV voltage delivered from the twelve equipment pads to 46 kV that will feed into Hawaiian Electric's existing switch yard at the Kahe Generating Station. The transformer would service two incoming (from the equipment pads) 12.47 kV circuits. The conceptual plan for the substation provides a 10-foot long by 8-foot wide by 10-foot high pre-fabricated SCADA and switch gear building. This small structure would house the relaying and protective controls, station control batteries, communications equipment, and other necessary monitoring and control equipment, tools, and maintenance supplies.

The 46 kV output from the transformer at the KUSPP Substation would be delivered to the existing 46 kV bus in the Kahe Generating Station switchyard via a power line situated entirely within the KGS site. This 46 kV line would consist of four segments:

- Segment 1 is approximately 100 feet of 46 kV underground line. This segment will be underground in order to traverse below the existing overhead 46 kV line identified as the *Permanente* line.
- Segment 2 is approximately 500 feet of 46 kV overhead line; this segment will consist of two new 45-foot high wooden poles, one on either end of the line segment.
- Segment 3 is approximately 185 feet of 46 kV underground line. Segment 3 is required to be underground to traverse below the existing overhead 46 kV lines.[6]
- Segment 4 would begin with a 45-foot pole at the terminus of Segment 3 and carry the 46 kV line overhead to an extension of the dead-end structure in the existing Kahe switchyard.

2.2 CONSTRUCTION ACTIVITIES

2.2.1 SOLAR ARRAYS AND RELATED ELECTRICAL EQUIPMENT

2.2.1.1 Construction Personnel and Equipment

Construction of the solar arrays and related equipment would require the use of heavy, combustion-engine powered equipment including heavy and light utility vehicles, pick-up trucks, pile drivers, all terrain forklifts, and excavators. The work would require the services of managers, heavy equipment operators, licensed journeymen electricians, and laborers working on-site. Construction activities for the PV array and ancillary facilities are described below. This equipment would be transported to the site as needed and staged there for as long as it is needed. The storage, maintenance, and fueling of these pieces of equipment would be in compliance with all applicable NPDES regulations and best management practices (BMPs).

2.2.1.2 Initial Site Preparation

The contractor would begin by constructing a ford crossing over the existing drainage ditch that runs along the north side of the developed portion of Hawaiian Electric's Kahe Generating Station. This crossing will provide Hawaiian Electric access to the project site from the existing KGS facility. Throughout the construction and operation of the KUSPP, workers, equipment, and material would

[5] American National Standards Institute (ANSI) is a private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States. The Institute of Electrical and Electronics Engineers (IEEE) is a non-profit professional association which propagates standards for the electrical and electronics industries.

[6] These are *Mikilua*, *Standard Oil 2*, *Permanente*, and *Standard Oil 1*.

access the site via the existing main entrance to KGS, and then travel the remaining distance to/from the site via existing system of internal roads and this new crossing. Once access to the site is established, the areas for the two "blocks" into which the photovoltaic arrays are divided would be staked out and all trees and bushes inside these blocks would be removed using hand tools, including chainsaws; this vegetation would then be mulched on site and eventually used for maintenance of the plantings in Hawaiian Electric's adjacent Farrington Highway Landscaping Project[7]. The KUSPP will not require any mass grading or grubbing, but there will be some leveling at selected sites to achieve the 15 percent maximum slope required for panel installation.

Next, a 20-foot wide fire setback would be created around each of the two array blocks. This would require a bulldozer or grader to remove all large rocks and cut to a depth of approximately 6″ in order to create a flat surface.[8] Once the work in the setback area is done, the contractor would erect an 8-foot high chain-link security fence around each of the two blocks of the photovoltaic array; no fencing would be installed within the ordinary high-water mark of any drainageway. Drainage infrastructure designed to prevent any increase in storm water runoff leaving the site would be installed at this time as well.

2.2.1.3 Underground Electrical Power Line Installation

The contractor would excavate four-foot (minimum) deep trenches in which it would place the conduits that would carry the electrical cables interconnecting the individual photovoltaic modules and the larger electrical system. Low-voltage, entrenched lines would also traverse the four blocks of the photovoltaic array. The excavated soil would then be backfilled into the trench and the soil tamped back to the appropriate level of compaction. All low-voltage electric lines (i.e., lines carrying power at less than 12.47 kV) installed in underground trenches would be placed within PVC conduits. Medium-voltage electric lines (i.e., lines carrying power at 12.47 kV) would be placed in concrete-lined trenches, below grade. Overhead medium-voltage electrical wiring would be installed at all vehicle-crossing areas, as well as at the unnamed drainage channel along the northern edge of the existing facilities at the Kahe Generating Station. The excavation work for the conduits and wiring would be conducted using an excavator or mini-excavator, followed by the appropriate compaction equipment. No construction would occur within, or north of, Limaloa Gulch.

2.2.1.4 Electrical Equipment Pad Construction

Twelve reinforced concrete pads would be constructed to support electrical equipment. The approximate locations of the pads are shown on Figure 1.5. Figure 2.3 contains conceptual plans (layout and elevation) for a typical pad. As shown on the plan, each pad would hold one 1000 kW inverter, each capable of converting the DC power from the modules into 3-phase, 60 Hz AC power. In addition to the inverter, each pad would also hold a single mineral oil-filled 800 V to 12.46 kV step-up transformer housed in a green (or similar earth-tone) enclosure. Each pad may, as necessary, have a small associated swale and drainage structures adjacent to the pad to capture the small quantities of runoff from hardened areas. Once the pads and conduits are built, a truck and crane would be used to install the transformer and inverter on each pad.

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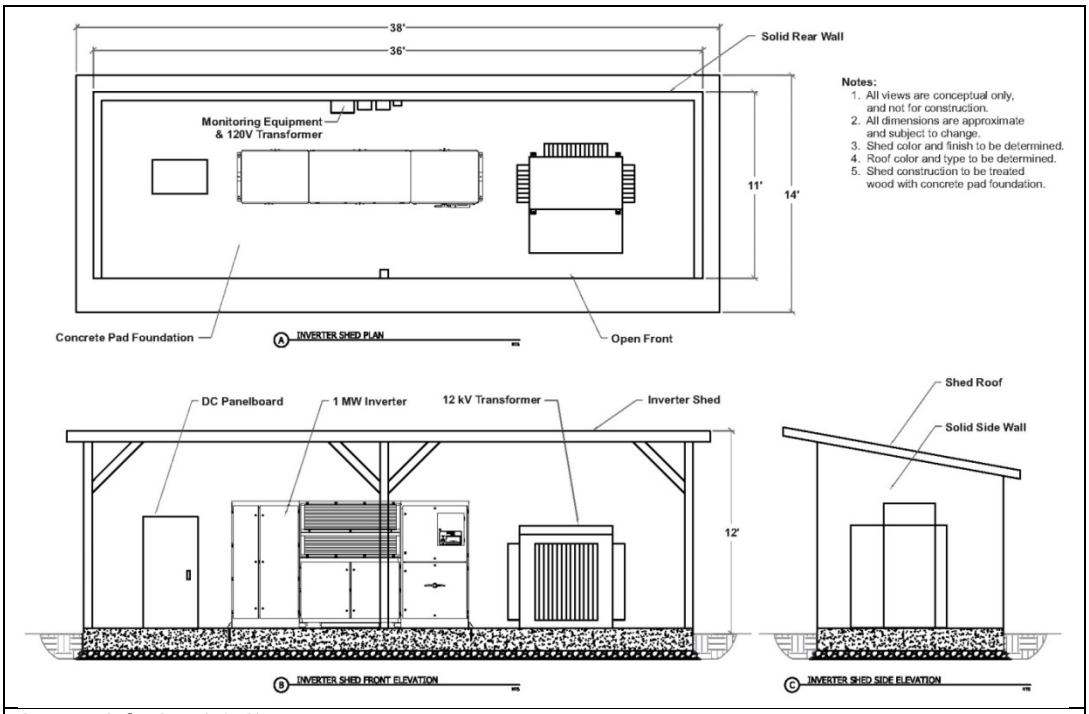
[7] The Farrington Highway Landscaping Project is not related to, and will be completed prior to commencement of, the Kahe Utility-Scale Photovoltaic Project however the effect this landscaping will have on the project's visibility will be discussed in Section 5.9 of this report. The purpose of the project is to install native Hawaiian landscaping on Hawaiian Electric's property fronting Farrington Highway.

[8] The access road crossing of Keone'ō'io gulch will be done without earthmoving or gravel emplacement below the ordinary high water mark that marks the limits of Department of the Army jurisdiction.

Figure 2.3 Conceptual Layout of Equipment of Each Equipment Pad



Source: SolarCity (2013)

2.2.1.5 Photovoltaic Modules and Racking Mount Installation

The contractor would use a small pile-driver to install the galvanized steel posts which support the photovoltaic modules (see Figure 2.4 for illustration). The pile-driver would access the site from the east, proceeding west along each row, driving posts as it goes. The likely installation device is a Pauselli 900 track-mounted pile driver, an impact-style machine. In cases where a post cannot be driven to its scheduled depth, the machine operator would test the post to determine if the embedment achieved meets the required strength. If it does, the post would be cut off to the correct height, and the pile-driver would continue to the next post location. If it does not, another post would be driven nearby, an excavator would remove the obstruction, or the structural engineer would oversee implementation of an alternate solution (e.g., install a small poured concrete footing).

Once the posts are in place, trucks would transport the racking and module components to the array blocks where work crews would mechanically assemble the mounts and photovoltaic modules; no additional welding, painting, or other field finish is required for this process. Galvanized metal pipe-and-rail mounting frames would be bolted onto the posts, and then the photovoltaic modules would be affixed to them at an approximately 20-degree tilt, facing south to capture maximum sunlight.

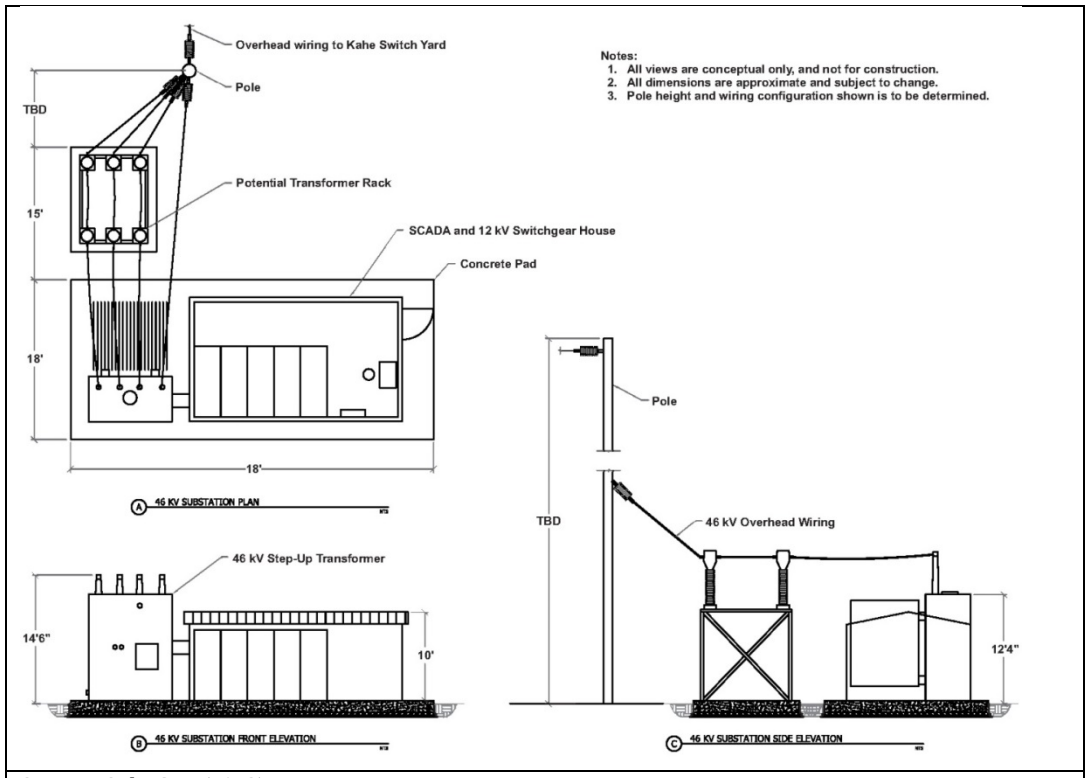
Figure 2.4 Illustration of Solar Array Construction Process

	
(a) Site preparation work, including creation of site access and laydown areas.	*(b) Site preparation is complete; pile driver has begun driving the ground mount piles into the earth.*
	
(c) The horizontal racking mounts are installed on the vertical foundations and PV panels are bolted onto them.	*(d) A view of the photovoltaic modules mounted on the horizontal rails.*
	
(e) Trenches are dug from the photovoltaic arrays to the inverter equipment pad location and conduits are laid.	*(f) The inverter and transformer pads are laid out, and the concrete foundation is poured and leveled.*
	
(g) The inverters, transformers, and other electrical equipment are placed on the pads.	*(h) The array is connected to the electrical grid and construction is complete.*
Source: SolarCity (2013)	

2.2.2 KUSPP SUBSTATION CONSTRUCTION

The KUSPP substation site would be grubbed and graded, then lined with coarse gravel to create a porous substrate, preventing storm water from pooling near the electrical equipment. Within this footprint, several small concrete pads would be poured, to serve as foundations for the 46 kV step-up transformer, switchgear, outdoor metering equipment, and SCADA enclosure (see Figure 2.5). A drainage swale and small dry well would be built adjacent to the concrete pads, to capture any runoff from these impermeable surfaces. It would be enclosed by an 8-foot high security fence before equipment is installed. The substation equipment would be brought to the site via a truck travelling along the firebreak and then lifted into place using a crane. A backhoe with auger would be used to drill a hole for a utility pole which would be set inside the substation site, which would carry the 46 kV overhead cables which would leave the substation and cross over the existing drainage ditch and into the KGS switchyard.

Figure 2.5 Conceptual Layout of Substation



Source: SolarCity (2013)

2.2.3 VEGETATION MANAGEMENT

Vegetation that interferes with solar access, maintenance and emergency repairs must: (*i*) be removed during original project construction and (*ii*) controlled over the life of the facility to prevent it from reestablishing itself sufficiently to interfere with site operations. Undesirable species (also referred to as "target vegetation") include all tree, shrub, and grass species that grow to heights in excess of 18 inches and climbing vines. Examples of these target species include, but are not limited to Guinea grass, arboreal *kiawe*, and *koa haole*. One of the best ways of minimizing the growth of these undesirable species is to encourage the growth of herbaceous growth (e.g., buffelgrass and '*ilima*) that matures at less than 18" in height.

Hawaiian Electric has developed the Vegetation Management Plan reproduced in Appendix B with the ultimate goal of eliminating tall growing grasses, woody trees and shrubs and other noxious weed species such as climbing vines, and allowing desirable vegetation to remain. A combination of hand cutting, mowing, string trimming, selective pruning, selective foliar treatment, low volume basal treatments, mulching, stump removal and cut stump treatments will be the primary methods of vegetation control. Treatment methods used will vary depending on the target species composition and density, site access, and topography. Vegetation management will be executed in two phases.

- *Construction Phase.* In the first phase, target species will be removed within the immediate construction zone. Tall (>18") native plants may be transplanted to the landscaping buffer along Farrington Highway prior to start of construction. Target Species over 1" in diameter will be removed and chipped, and their stumps and basal clumps will be removed. Herbicide will be applied locally to remaining target species as required (foliar basal and stump treatment). Cleared areas under arrays will be treated with a pre-emergent to prevent sudden plant germination caused by topsoil disturbance during the construction process.
- *Operational Phase.* In the second (post-construction) phase, the site will be mowed on a semi-annual basis or as required to maintain vegetation at a height no greater than 18". A combination of mowing, hand cutting, string trimming, and selective use of herbicides will be used to control vegetation. The timing and frequency of maintenance will be adjusted as needed.

2.3 OPERATION AND MAINTENANCE

Photovoltaic Panel Cleaning. Under typical circumstances, the photovoltaic modules do not require regular maintenance. Under some circumstances, however, if enough dust and dirt accumulates on the panel surfaces, a periodic cleaning may be desirable. This cleaning would involve washing the surfaces using water containing no cleaners, chemicals, or other additives and would be done as often as conditions require. Hawaiian Electric work crews would obtain demineralized water from Kahe Generating Station's ample supply and truck it up to the site via the firebreak. There, crews would clean the dust and dirt which may accumulate on the module surfaces with hand tools or a pressure nozzle. As noted above, the frequency of these cleanings would be very intermittent, if at all, and would depend on the frequency and intensity of rainfall on the project site. The wash water would drain off and into the ground.

Equipment Maintenance. Periodic maintenance on the electrical equipment would involve replacing air filters within the inverters as needed; testing connections with thermal imaging cameras and addressing any issues discovered; and sampling the mineral oil within the transformers. Once the solar array has been constructed, Hawaiian Electric personnel would use the firebreak when servicing and maintaining the electrical equipment.

Vegetation Management. Vegetation would be maintained and controlled throughout the life of the solar array as discussed in Section 2.2.3 above. The complete Vegetation Management Plan is reproduced in Appendix B of this document.

2.4 DECOMMISSIONING

The performance of the solar panels is under warrantee for a period of 25 years. It is likely that they will continue to perform adequately for a longer period of time. Regardless of the exact service life of the project, there will come a time when the panels, inverters, and other equipment will need to be replaced depending on system needs and the technology available at the time. In the event that the project is eventually decommissioned, the site would be put to another, as yet undetermined use. It is important to note that some elements such as concrete pads and underground conduits would be left in place, and the site would not be restored to its "original" condition. Decommissioning the kind of photovoltaic system that Hawaiian Electric has proposed is not something that has been done on any

large scale. However, sufficient information is available to outline the activities that will have to be undertaken and the procedures that are most likely to be followed.[9]

The following facilities would be removed: (*i*) photovoltaic modules, panels, and wiring; (*ii*) racking systems and support structures; (*iii*) inverters, transformers, and generators; (*iv*) concrete foundations and underground infrastructure; (*v*) transformer and overhead/trenched electrical network; (*vi*) electrical poles; and (*vii*) safety fences. In accomplishing this, Hawaiian Electric would observe the following dismantling, demolishing, and disposal procedures for the above-ground structures:

- Disconnect the solar array system from the substation by first turning off the breaker switches and then severing the electrical cable.
- Disconnect the individual photovoltaic modules from the site electrical network and remove them from the support racks to re-use, recycle, or safely dispose them offsite in accordance with applicable laws and regulations.
- Disconnect and remove the inverter and transformers and either send the components back to the manufacturer, re-use them, recycle them, or safely dispose of them offsite.
- Remove and demolish the transformer(s) and other electrical equipment in accordance with then-current standards and best practices.
- Cut the ends of the underground electrical lines on the site, retrieve as much of the material as possible to re-use or recycle, and bury the remaining conduits to approximately two feet below grade, leaving them in place.
- Remove underground infrastructure and protective electrical structures such as concrete electrical boxes and concrete pad foundations for inverters and transformers and backfill the area around them as necessary. Waste concrete would be recycled offsite by a concrete recycler.

The Company would comply with all applicable regulatory requirements during the decommissioning of the solar array, including those which govern the handling and disposal of the disassembled components, some of which may require disposal according to toxic waste regulations (e.g., Resource and Conservation Recovery Act) unless they can be recycled.[10] Hawaiian Electric intends that its decommissioning procedures will return the site to a state suitable for other industrial use.

2.5 PROJECT SCHEDULE

The estimated construction start date and duration for the photovoltaic array and substation are presented in Table 2.1.

[9] Most of the materials in a solar power project are reusable or recyclable, and some equipment may have manufacturer take-back and/or recycling requirements. To the extent that these exist and are still in force, Hawaiian Electric would avail itself of all of the opportunities that they present.

[10] The Resource and Conservation Recovery Act constitutes the primary set of rules governing wastes containing Cd, Se, Pb, Cu or Ag provided that these wastes are considered to be discarded material and are not included in any specific exclusions.

Table 2.1 Preliminary Project Schedule

Task	*Estimated Start Date*	*Estimated Completion Date*
Regulatory Process	10/2013*	9/2014
Interconnection Study	11/2013*	10/2014
Environmental Review	11/2013*	8/2014
SMA Permit	5/2014	2/2015
Grubbing, Grading, and Building Permits	5/2014	9/2014
Material Acquisition and Delivery	1/2015	7/2015
Construction	1/2015	10/2015
Facility in Operation	11/2015	n/a
Note: Items marked with an asterisk (*) have already occurred.		
Source: Hawaiian Electric Company, Inc. (2014)		

2.6 PROJECT COSTS

Hawaiian Electric has prepared preliminary construction cost estimates based on the facility concepts presented above. These estimates are summarized in Table 2.2.

Table 2.2 Estimated Project Costs

Component	*Cost ($)*
Engineering, Procurement, and Control Contract	31,900,000
Allocation for Change Orders	4,800,000
Switchyard	2,300,000
Construction Period Allowance	2,300,000
Project Management	400,000
General Services	200,000
Permits and Approvals	500,000
Total	**42,400,000**
Source: Hawaiian Electric Company, Inc. PUC Docket No. 2013-0360.	

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3. PURPOSE & NEED

3.1 NEED FOR PHOTOVOLTAIC ARRAY AND SUBSTATION

Hawaiian Electric's Public Utility Commission application for the proposed project (PUC Docket No. 2013-0360) outlines several factors which contribute to the need for the proposed projects: (*i*) to provide low-cost, clean, and renewable energy to the people of O'ahu as called for under the Hawai'i Clean Energy Initiative; (*ii*) to fulfill its commitment as a publicly-regulated utility to meet or exceed the requirements of the State of Hawaii's Renewable Portfolio Standards (RPS) law; and (*iii*) to take advantage of available federal and state tax credits.[11] Each of these is discussed below.

3.1.1 LOW-COST, CLEAN, AND RENEWABLE ENERGY

3.1.1.1 Source of Low-Cost Electrical Power

Based on Hawaiian Electric's analysis, the proposed project is anticipated to produce electrical power for 30 years at a levelized cost of approximately 16.1 cents per kilowatt-hour (kWh). The Company assumes that this project will provide its customers with an estimated net savings of approximately $64,000,000 over its anticipated lifetime, based on October 2013 fuel oil prices. The levelized cost analysis assumes a 30 percent federal investment tax credit but does not include a State of Hawai'i refundable tax credit.[12] To the extent that additional state tax credits are available to Hawaiian Electric, the entire credit will be passed on to its customers.

The project's projected 16.1 cents per kWh constitutes a substantially lower levelized cost, with tax credits, when compared to that of the other recent renewable energy PPAs approved on O'ahu:

- 21.8 cents per kWh for Kalaeloa Solar 2 (Docket No. 2011-0051);
- 22.9 cents per KWh for Kahuku Wind (Docket No. 2009-0176);
- 22.9 cents per kWh for Kawailoa Wind (Docket No. 2011-0224); and
- 23.6 cents per kWh FIT Tier Photovoltaic (Docket No. 2008-0273).

In addition, the project's 16.1 cent per kWh is 29 percent lower than the Company's current on-peak avoided costs of 22.697 cents per kWh.[13] Thus, Hawaiian Electric believes that this project will serve the public interest by allowing it to meet its objective of providing timely, clean, renewable energy at low cost to its customers.

3.1.1.2 Clean Renewable Energy

In January, 2008 the State of Hawai'i and the United States Department of Energy began the Hawai'i Clean Energy Initiative (HCEI). This initiative is a comprehensive program intended to move the State of Hawai'i away from dependence on imported fossil fuels for electricity, and towards indigenously-produced, renewable energy. On October 20, 2008 the Governor of the State of Hawai'i, the Hawai'i State Department of Business, Economic Development, and Tourism (DBEDT), the Hawai'i Consumer Advocate, and the Hawaiian Electric Company signed the Energy Agreement. The agreement is a commitment on the part of the State and Hawaiian Electric to accelerate the

[11] PUC Docket No. 2013-0360 *Hawaiian Electric Application and Verification Exhibits, and Certificate of Service* in the matter of the application of Hawaiian Electric Company, Inc. for the Approval of Waiver from the Framework for Competitive Bidding and Approval to Commit Funds in Excess of $2,500,000 for the Purchase and Installation of Item PO002929, Kahe Utility-Scale PV Project. This document was submitted to the PUC on October 22, 2013.

[12] The federal investment tax credit of 30 percent applies to projects that are in service by the end of 2016. To date, this tax credit has not been extended beyond 2016.

[13] The on-peak avoided energy cost rate for October 2013.

addition of new, renewably-resourced clean energy production capacity and to transition the Company away from a model that encourages increased electricity usage. The HCEI covered a wide range of initiatives, including:[14]

- A requirement that 40 percent of electric power sales come from renewable resources by 2030. This goal reiterates the Renewable Portfolio Standard passed by the State of Hawai‘i’s Legislature in 2009.
- A commitment to reduce the use of fossil fuels for transportation by becoming an early adopter of plug-in hybrids and electric vehicles for Hawaiian Electric’s fleet and by helping to promote the hybrid and electric vehicle market.
- Encouraging increased distributed solar electricity production through a Photovoltaic Host program to make it easier to install photovoltaic panels on O‘ahu rooftops.
- An agreement by Hawaiian Electric to conduct comprehensive generation and transmission analyses every three years, taking into consideration RPS standards, federal and state greenhouse gas emissions limits, and impacts to local natural resources, the local economy, and the Company’s ratepayers.

This last point, regarding maintaining and updating the island-wide electrical system, is essential to improving the efficiency, reliability, and safety of the system and enhancing the integration and use of intermittent renewable energy (e.g., photovoltaic power) and other advanced technologies. Towards this end, the Public Utility Commission ordered that capital expenditure applications should include an assessment of the reasonability of future capital improvement projects in the light of the HCEI and the State’s movement towards energy self-sufficiency. Hawaiian Electric has concluded that the proposed project is reasonable in view of the strategic objectives of the HCEI and that the project will supply clean, renewable energy, while displacing approximately 1.8 million gallons of imported, non-renewable, fossil fuel per year. The PUC application is discussed further in Section 3.1 of this report.

Also, included in the agreement is a commitment by Hawaiian Electric to implement feed-in tariffs to promote the development of new alternative energy projects and thus dramatically accelerate the addition of renewable energy to the island-wide electrical grid. A feed-in tariff is a set of standardized published purchased power rates, including terms and conditions, which the utility will pay for each type of renewable-energy resource based on the size of the project and the amount of power it will supply to the grid. The KUSPP will further this objective, and thus the development of additional renewable energy projects, by helping Hawaiian Electric establish benchmarks for the predictability, reliability, and cost-per-watt requirements for future renewable energy projects by Independent Power Producers (IPPs).

3.1.1.3 State of Hawai‘i Renewable Portfolio Standards

Hawaiian Electric’s need, as noted above, for the proposed facilities stems in part from its obligation to meet the requirements of the State of Hawai‘i’s Renewable Portfolio Standards (RPS) law. The State of Hawai‘i RPS law, Hawai‘i Revised Statutes §269-91, sets minimum requirements for the use of renewable sources of energy for electrical generation such as wind, solar, and biofuels. The law requires that 40 percent of generation be met by renewable resources by 2030, with several interim goals to be met prior to that date. The schedule for compliance with RPS standards is summarized in Table 3.1 below. In addition, Act 234 of the Session of Laws for 2007 establishes a framework for reducing greenhouse emissions to the levels emitted in 1990 by the year 2020. Thus, there is a growing legal mandate for the exploration of clean, renewable energy generation in the State of Hawai‘i.

[14] Hawaiian Electric Company, Inc. (2008) *Corporate Sustainability Report*.

Table 3.1 Renewable Portfolio Standards Dates and Targets

Year	*Target as a Minimum % of Total Sales*	*Energy Savings Included*
2010	10%	Sale of electricity plus energy savings via efficiency programs and solar water heaters included.
2015	15%	Through sales of electricity only.
2020	25%	Through sales of electricity only.
2030	40%	Through sales of electricity only.
Source: Hawai‘i Revised Statutes § 269-92		

The KUSPP is expected to produce an average of 23 GWh per year of renewably-sourced electrical energy for over 30 years. At this anticipated rate of output, the project would result in an estimated savings to customers of approximately $64,000,000 over the lifetime of the facility when compared with oil-fired generation, based on October 2013 fuel oil prices. This cost savings assumes a 30 percent investment tax credit, and does not include the State of Hawai‘i refundable tax credit. To the extent that additional State of Hawai‘i tax credits are available to Hawaiian Electric, the entire credit would be passed on to the Company’s customers, providing even greater savings to company customers over the project’s lifetime. The 30-year levelized cost for this project, based on the assumptions and analysis shown in Appendix D is estimated to be 16.1 cents per kilowatt hour (kWh). This is nearly 30 percent lower than the Company’s 2013 on-peak avoided cost of 22.697 cents per kWh.

3.1.2 AVAILABLE STATE AND FEDERAL TAX INCENTIVES

Through the provisions of §1603 of the American Recovery and Reinvestment Act of 2009 (the “ARRA”), a 30 percent Federal Investment Tax Credit is available for capital investments made in eligible renewable energy projects, provided that the project enters service prior to January 1, 2017. The KUSPP is considered eligible for this tax credit and the fiscal repercussions are reflected in the Company’s revenue requirement calculations.

A 35 percent State Renewable Energy Technologies Income Tax Credit (RETITC) is currently available for photovoltaic projects with a cap of $500,000.00 per system. Based on rules promulgated by the State of Hawai‘i, the KUSPP will consist of twelve (12) systems. Due to a level of uncertainty as to whether these state tax credits will be available at the time the project goes into service, no RETITC credits were assumed in the financial analysis. However, to the extent that State of Hawai‘i tax credits are available to Hawaiian Electric, their full value would be passed on to customers.

3.2 OBJECTIVES & PURPOSE OF THE PROPOSED PROJECT

Table 3.2 lists Hawaiian Electric's specific objectives for the proposed photovoltaic project.

Table 3.2 Project Objectives

Objective	*Definition*
1	Take advantage of existing Company resources to provide 11.5 MW (AC) of clean, environmentally responsible, renewable energy.
2	Obtain power that costs substantially less than that from other comparable sources.
3	Gain corporate experience developing and operating utility-scale PV systems.
4	Help the Company meet the State of Hawai'i's RPS standards for coming years.
5	Help the Company take advantage of available federal and state tax credits to lower customer costs.
6	Avoid or minimize adverse environmental effects.
Source: Hawaiian Electric Co., Inc. (2014)	

4. ALTERNATIVES EVALUATED

Title 11, Chapter 200 of the Hawaii Administrative Rules (HAR §11-200) contains the Department of Health's environmental impact rules. Section §11-200-9 defines the assessment process for "applicant actions" such as the one that Hawaiian Electric is proposing. Among other things, it requires the approving agency to analyze alternatives to the proposed action in the environmental assessment. In accordance with those State requirements and as part of its continuing review of its operations and facility needs, Hawaiian Electric considered various alternatives before choosing the proposed project as the appropriate course of action. This process consisted of defining the objectives of the project (see Table 3.2), identifying possible alternatives (including those specifically mandated by HRS Chapter 343), and evaluating each alternative with respect to the project's objectives. This Chapter briefly describes the process that it followed and the alternatives it determined are appropriate to address in the environmental assessment. It begins with a brief review of the State of Hawai‘i Public Utilities Commission framework within which decision-making occurs. This is followed by a discussion of the project objectives that were most influential in determining the alternatives to consider.

4.1 INTRODUCTION

4.1.1 PUC FRAMEWORK

Hawaiian Electric's decision-making is guided by the Public Utilities Commission regulations within which it operates. An important part of those regulations consists of the "Framework for Competitive Bidding" which governs the manner in which the utility acquires or builds new energy generation.[15] Section II.A.3 of the framework stipulates that unless the Commission finds it to be unsuitable or that it qualifies for one of the specific exemptions that the PUC has approved, the utility is required to use competitive bidding when acquiring or developing new generation resources unless certain conditions and possible exceptions apply.

Section II.A.3 of the Framework provides for the following exceptions to competitive bidding.

> *II.A.3.b. Under certain circumstances, to be considered by the Commission in the context of an electric utility's request for waiver under Part II.A.4, below, competitive bidding may not be appropriate. These circumstances include: (i) when competitive bidding will unduly hinder the ability to add needed generation in a timely fashion; (ii) when the utility and its customers will benefit more if the generation resource is owned by the utility rather than by a third-party (for example, when reliability will be jeopardized by the utilization of a third-party resource); (iii) when more cost-effective or better performing generation resources are more likely to be acquired more efficiently through different procurement processes; or (iv) when competitive bidding will impede or create a disincentive for the achievement of IRP goals, renewable energy portfolio standards or other government objectives and policies, or conflict with requirements of other controlling laws, rules, or regulations.*
>
> *II.A.3.d. Furthermore, the Commission may waive this Framework or any part thereof upon a showing that the waiver will likely result in a lower cost supply of electricity to the utility's general body of ratepayers, increase the reliable supply of electricity to the utility's general body of ratepayers, or is otherwise in the public interest.*

[15] The "Framework for Competitive Bidding is contained in Appendix A of PUC Decision and Order No. 23121 (adopted under PUC Docket No. 03-372) and is dated December 8, 2006.

After considering all of the factors of which it is aware, Hawaiian Electric has concluded that the proposed project has characteristics which make it extremely beneficial for its customers and which qualify it for an exemption under the Framework. Accordingly, it has applied to the Commission (PUC Docket No. 2013-0360) for a waiver from its "Framework for Competitive Bidding" pursuant to Parts II.A.3.b.(iii) and II.A.3.d of the Framework.[16] The same filing also requests a determination that it is appropriate to construct the related 46 kV sub-transmission line above and below the surface of the ground, pursuant to HRS § 269-27.6(a). The PUC is now considering the petition.

As explained in detail in the aforementioned PUC waiver application, Hawaiian Electric anticipates that the project would produce electricity for 30 years at a levelized cost of approximately 16.1 cents per kilowatt-hour (kWh). Its calculations indicate that the cost of power from the proposed project would be substantially lower than both the renewable energy costs it has been able to negotiate (and which the PUC has approved) under recent Power Purchase Agreements (PPA) and the Company's October, 2013, on-peak avoided cost of 22.697 cents per kWh. The Company is unaware of any factors that would lead competitive bidding to result in an equivalent or lower cost to its customers, and so has requested the Commission to approve its waiver request.

4.1.2 OTHER IMPORTANT CONSIDERATIONS

4.1.2.1 PV Facilities

In addition to the economic factors discussed in the preceding section, Hawaiian Electric was guided by the project objectives listed in Table 3.2 in determining the range of alternatives to evaluate in this environmental assessment. It has reached a number of conclusions in this regard that reinforce its belief that the proposed project would be advantageous with respect to achievement of the objectives listed in Table 3.2.

- The project site is the only company-owned property on which a utility-scale photovoltaic system could be constructed without new land acquisition. The desire to take full advantage of existing Company resources led it to exclude alternatives that would require the acquisition of property it does not already own.
- Developing it as a corporate project, rather than contracting it out to an IPP, is the best means for Hawaiian Electric to develop in-house corporate experience and expertise with the types of photovoltaic systems that appear likely to play an increasingly important role in providing electrical power to O'ahu's people and businesses. Hawaiian Electric believes that the knowledge and experience it gains will allow it to serve its customers more efficiently and reliably over the long term than if it continued to rely entirely on IPPs for power from PV sources. This is true whether it leads the Company to pursue subsequent PV projects or merely provides a knowledge base that will allow it to negotiate and interact with IPPs using such technology more efficiently and knowledgeably.
- When it originally acquired the land that it now owns in Kahe Valley the company anticipated that it would continue to develop additional generating units in that location. Because of that, and to avoid the land use conflicts that it had experienced as other development occurred around its then-existing generating stations (e.g., Honolulu Power Plant, Waiau Generating Station), Hawaiian Electric purchased considerably more land than was needed immediately. It has now concluded

[16] The Framework provides that under certain circumstances competitive bidding may not be appropriate, particularly when more cost-effective or better performing generation resources are more likely to be acquired more efficiently through different procurement processes or when the waiver will likely result in a lower cost supply of electricity to the utility's ratepayers, increase the reliable supply of electricity to the utility's general body of ratepayers, or is otherwise in the public interest.

that the renewable generation such as the proposed KUSPP is the appropriate type of generation for installation on the northern side of the valley floor.

4.1.2.2 Substation

Because a substation is required to step up the generated energy to the voltage needed to feed into the existing island-wide electrical grid, Hawaiian Electric determined that the photovoltaic array and the substation were inextricably linked components of a single project. Locating the substation elsewhere would increase the cost of installing the connection. Therefore, all discussion of alternative siting considers the photovoltaic array and substation as a single undertaking.

4.2 PROJECT ALTERNATIVES CONSIDERED AND ELIMINATED

4.2.1 ALTERNATE LOCATIONS

Hawaiian Electric briefly considered the possibility of locating the proposed photovoltaic project at locations other than Kahe Valley. However, for reasons discussed above it concluded that none had the potential to meet the project objectives. The following factors (some of which overlap points made previously) are among those that led it to conclude that other locations do not have the potential to meet the project objectives nearly as well as the Kahe Valley site that it has proposed:

- The Company's long experience with the Kahe site provided a high degree of confidence that other factors, such as unsuitable site-conditions, industrial waste, or cultural remains would not become obstacles to project development.
- The cost of investigating and purchasing a new site meant that an alternate location could reasonably be expected to drive up the time required for, and cost of, project development.
- Alternate sites would almost certainly have a greater interconnection cost, given the Kahe site's proximity to the existing Kahe Generating Station switch yard and transmission systems.
- The Kahe site's proximity to existing Hawaiian Electric infrastructure and staff reduced the projected time and cost of project operations and maintenance.
- The Company's investigations indicated that there were no other major obstacles to project development.

Based on the foregoing, Hawaiian Electric determined that alternate locations were not viable alternatives to that which it has proposed.

4.2.2 ALTERNATE SIZES

Hawaiian Electric's proposed KUSPP is sized at 11.5 MW in order to take advantage of economy of scale, which requires as large a photovoltaic facility as possible.[17] To create a smaller project would have led to higher per-megawatt costs for the transmission interconnection (i.e., for the substation). Because Hawaiian Electric's analysis indicated that the 11.5 MW facility could be accommodated by its existing system, there was no clear advantage to pursuing a reduced-scale alternative. The proposed size of the substation is scaled to match the proposed 11.5 MW output from the photovoltaic facility. Any reduction in its size would leave it too small to perform well in its intended function housing the required electrical switching and transformer equipment needed to link the proposed project with the existing switch yard at Kahe Generating Station. Any larger size would leave it with excess capacity.

[17] Economies of scale are the cost advantages that enterprises obtain due to size, throughput, or scale of operation, with cost per unit of output generally decreasing with increasing scale as fixed costs are spread out over more units of output.

4.2.3 ALTERNATE TIMING (DELAYED ACTION)

As previously discussed, the existing project schedule is a "fast-track" one designed to allow the Company to take best advantage of available tax credits and to meet or exceed the State's renewable energy goals. There were several compelling reasons why delayed action would not meet Hawaiian Electric's immediate project goals or its broader strategic objectives.

The most immediate concern is the effect that a delay would have on Hawaiian Electric's ability to capitalize on the opportunity presented by the American Recovery and Reinvestment Act of 2009 (the "ARRA"). Under the conditions imposed by this act, tax incentives are available at 30 percent of the total project cost. The ARRA Tax Credit has no volume cap, but it does impose deadlines which dictated the project's timeline to a substantial degree. In order to qualify for this ARRA Tax Credit incentive, the credit is equal to 30 percent of expenditures, with no maximum credit. Eligible solar energy property includes equipment that uses solar energy to generate electricity. A number of changes to this tax credit are scheduled to take effect for systems placed in service after December 31, 2016. The tax credit for equipment that uses solar energy to generate electricity will decrease from 30 percent to 10 percent. Hawaiian Electric will meet this requirement by March 1, 2016.

Delaying action past the point at which Hawaiian Electric made the tentative decision to proceed with the Kahe Utility-Scale Photovoltaic Project would have made it unable to take advantage of the currently-applicable tax incentives, which the Company estimated would increase the portion of the project's cost that Hawaiian Electric would need to recover from its customers rather than through savings related to the tax incentives by an estimated $12.7 million. This increase, without a commensurate increase in value, would substantially reduce the net benefit of the project, possibly even threatening its overall viability.

In addition to the financial pressures that a delay would impose, a delay would deprive Hawaiian Electric and its ratepayers the substantial benefits that substituting solar energy for fossil fuel has for the natural environment. The Company believes that the sooner that additional renewable energy sources are brought online and reduces the state's dependence on fossil fuels, the sooner the economic and environmental benefits described in this report can be realized.

4.3 NO ACTION

Under the "No Action" alternative, the proposed photovoltaic project would not be constructed. The project site would remain un-used. In addition to not meeting the project's objectives, were Hawaiian Electric to select the "No Action" alternative, the environmental and socio-economic impacts identified in Chapter 5 would not occur and conditions would remain as identified in the discussion of existing conditions.

Without this facility, Hawaiian Electric would be less able to: (*i*) meet the increasing demand for electricity on O‘ahu with renewably sourced energy; (*ii*) meet the RPS requirements established by the State of Hawai‘i; and (*iii*) fulfill its leadership role related to the Hawai‘i Clean Energy Initiative. It would continue to use existing and other planned power sources, the great majority of which will rely on fossil fuels, to a greater extent than would be the case if the project is approved.

Given the limits that the "No Action" alternative would place on Hawaiian Electric's ability to fulfill its legal and public-trust commitments, the Company has determined that it is not a feasible or desirable alternative and is included in this EA solely to satisfy the requirements of Hawai‘i Revised Statutes (HRS) Chapter 343, and its implementing regulations in Hawai‘i Administrative Rules (HAR) §11-200 and to provide a baseline against which to measure the impacts of the proposed project.

5. AFFECTED ENVIRONMENT, ENVIRONMENTAL IMPACTS, & MITIGATION MEASURES

This chapter describes the potential environmental effects of the proposed actions. It is organized by impact topic (e.g., air quality, noise, geology and soils, water quality, etc.). The discussion under each topic begins with an overview of existing conditions related to that topic. Where appropriate, this includes the larger environmental context (e.g., West Oʻahu); in other cases the focus is narrower (e.g., Kahe Generating Station). The discussion also distinguishes between short-term construction impacts and those that may result from the facilities' continuing long-term presence or operation. Where appropriate, the discussion includes the measures that Hawaiian Electric proposes to take to minimize or mitigate potential adverse effects.

5.1 TOPOGRAPHY, GEOLOGY, AND SOILS

5.1.1 EXISTING CONDITIONS: TOPOGRAPHY, GEOLOGY, AND SOILS

The proposed KUSPP is situated within Kahe Valley, one of a series of parallel-trending gulches that drain from the upper reaches of the southwest portion of the Waiʻanae Mountains, the remnant of the Waiʻanae Volcano, the older of the two large shield volcanoes that created most of the island of Oʻahu. The sloping valley floor on which it would be constructed ranges in elevation from 15 to 170 above mean sea level (msl). It is surrounded on three sides by hills that rise sharply to elevations of 600 to 800 feet above mean sea level (msl) at the property line (even higher further inland).

Takasaki (1971) observed that the shield of the Waiʻanae Volcano was built by eruptions that took place along three rift zones; the two principal ones trend northwestward and southeastward from the summit, while a lesser one trends northeastward. The parallel to sub-parallel fissures and line of cinder and spatter cones that are typical of such zones on younger volcanoes are absent in older, dormant volcanoes such as the Waianae volcano. In those, the rift zones are generally identified by erosion-exposed dike complexes. Near surface lava in Hawaiʻi typically contains high numbers of cooling joints, vesicle partings, flow-unit boundaries, rubble layers and other planes of weakness (Walker, 1987). Dikes cutting near surface flows can be highly irregular in shape. Dikes are common in the western and southwestern Waiʻanae Range, principally in the highly permeable, thin-bedded flows of the lower member of the series.

The Waiʻanae Volcano lavas are divided into lower, middle, and upper members. The member closest to the surface is a little more than 2,000 feet thick, and consists mostly massive *aʻa* flows that issued from large cinder cones. Dikes also locally intrude the upper member in the southwestern portion of the island, but fewer are present than in the lower two members. The valleys of the Waianae Range typically contain moderately thick deposits of alluvium and colluvium.

According to the Soil Survey Geographic database, the land on which most of the proposed KUSPP facility would be constructed is classified as either (rSY) "stony steep land" (the *makai* portion of the site) and (LPE) "Lualualei Extremely Stony Clay" (the more *mauka* section of the project site). The steep stony land is classified as highly erodible land, and the mauka Lualualei Extremely Stony Clay is classified as potentially highly erodible land. Because of the moderate slopes and stoniness in this area, it is not well suited for agricultural use (Foote et al. 1972:84) and is prone to erosion.

5.1.2 PROBABLE IMPACTS ON TOPOGRAPHY, GEOLOGY, AND SOILS: CONSTRUCTION PHASE

Construction of the Kahe Utility-Scale Photovoltaic Project would involve selective grubbing and vegetation removal and only very small amounts of earthmoving (see Table 5.1). Consequently, it would have little effect on the overall topography of the project site. [18] All of the soils and underlying rock that would be affected by the proposed project are suitable for construction of the proposed facility as they are designed.

Table 5.1 Estimated Earthmoving Volumes

Area	*Length of Access (ft.)*	*Width of Access (ft.)*	*Average Cut/Fill Depth (ft.)*	*Graded Area (sf)*	*Cut to Fill Ratio (%)*	*Estimated Cut (cy)*	*Estimated Fill (cy)*
Array 1 Road	4,145	20	2.00	82,900	50.0	3,070	3,070
Array 2 Road	4,300	20	2.00	86,000	50.0	3,185	3,185
Panel Leveling	N/A	N/A	2.00	53,800	50.0	1,993	1,993
Equipment Pads	N/A	N/A	N/A	4,200	50.0	78	78
Source: Belt Collins Hawaii LLC. (via email from Benjamin Liu to Planning Solutions dated January 24, 2014)							

Cut and fill will be balanced on the site. However, as not all of the material that is cut will be suitable for use as structural fill, the contractor may need to import up to 100 cubic yards of select material (such as gravel, rock, sand, etc.) capable of creating a strong and stable foundation for key project components. In areas where select fill will be required (e.g., roadbeds, foundations, etc.), the existing soil composition of the property will be altered, but none of these changes is such that they would discourage future use of the area for other likely uses of the property. Furthermore, the areas where these changes would occur represent less than 5 percent of the project site; most of the project area's soil composition and potential for alternate uses would remain unchanged. No significant geologic resources (i.e., gravel or sand) are present.

5.1.3 PROBABLE IMPACTS ON TOPOGRAPHY, GEOLOGY, AND SOILS: OPERATIONAL PHASE

With one possible exception, ongoing operation and maintenance of the facilities covered by this report do not involve activities or substances that have the potential to significantly affect topography, soils, or geologic resources. The possible exception is that maintenance of good ground cover and the use of appropriate vegetation management procedures are essential to preventing substantial soil loss over the long term. That, in turn, will maintain the soil stability and health, so that the area can, if deemed appropriate, be used for other industrial uses when the photovoltaic array is decommissioned. The Vegetation Management Plan that is included in Appendix B describes the method that will be used to maintain the protective cover in good health for the life of the project. Hawaiian Electric believes that these techniques are adequate to achieve that purpose. Moreover, it will carefully monitor conditions on the site once it assumes responsibility for the PV array and will take immediate corrective action should it be necessary.

5.1.4 PROBABLE IMPACTS ON TOPOGRAPHY, GEOLOGY, AND SOILS: DECOMMISSIONING

As indicated earlier in this report, the system is expected to remain in operation for a minimum of 30 years, and it is likely that it will continue to perform adequately for a much longer period of time.

[18] Grading will be required where the existing slope is greater than 10 percent and some depressions will need to be filled.

When the decision is made to decommission it, the work can be done without any substantial effect on the area's topography or soils, at which point the area could either be returned to much the same condition it is in at the present time or put to some other use.

Decommissioning will entail manually dismantling the panels and the associated racking mounts and removing the vertical piles using a backhoe and choker chain so as to cause minimal soil disturbance. Removing the buried conduits would involve slightly greater disturbance, including mixing of soil profiles—topsoil with subsoil—compaction, and rutting, but immediate backfilling and revegetation would prevent unnecessary soil erosion and loss. The potential for erosion would be reduced if the buried conduits were left in place, but doing so could constrain other potential uses of the site.

5.2 HYDROLOGY

5.2.1 EXISTING CONDITIONS: HYDROLOGY

5.2.1.1 Existing Conditions: Surface Water

There are no perennial streams or natural lakes within the KGS parcel. However, storm water flows intermittently in three named drainageways–Limaloa, Keone‘ō‘io, and Kahe Gulches–and one unnamed gulch that drain the northern and middle portions of the valley (see Figure 5.1 for the drainage basin boundaries). [19]

- Limaloa Gulch, which at 395 acres is the largest of the three, is located directly north of the project site and receives runoff from approximately 20 percent of the area on which PV panels would be constructed.
- Keone‘ō‘io Gulch bisects the project site and receives runoff from approximately 60 percent of the 41-acre site.
- Kahe Gulch runs along the southern boundary of the project site and it receives runoff from the remainder of the site, either directly or indirectly through water that runs first into a small unnamed gulch that joins it immediately *makai* of the existing tank farm.

These four non-perennial gulches all eventually merge into Kahe Stream, which is channelized along the boundary of the power plant and continues beneath the State Department of Transportation's (DOT) Farrington Highway before discharging into the Pacific Ocean. Under most circumstances a sand berm that forms across the mouth of the Limaloa/Keone‘ō‘io Gulch outlet separates the drainageway from the Pacific Ocean, but outflow from the drainage overtops and eventually breaches the berm during periods of substantial rainfall. Figure 5.2 shows the location of the Ordinary High Water Mark (OHWM) for each of the drainageways that has been identified by project engineers and submitted to the U.S. Army Corps of Engineers (COE) for approval.[20] The photograph reproduced in Figure 5.3, which illustrates the area around the Farrington Highway drainage crossing, shows the

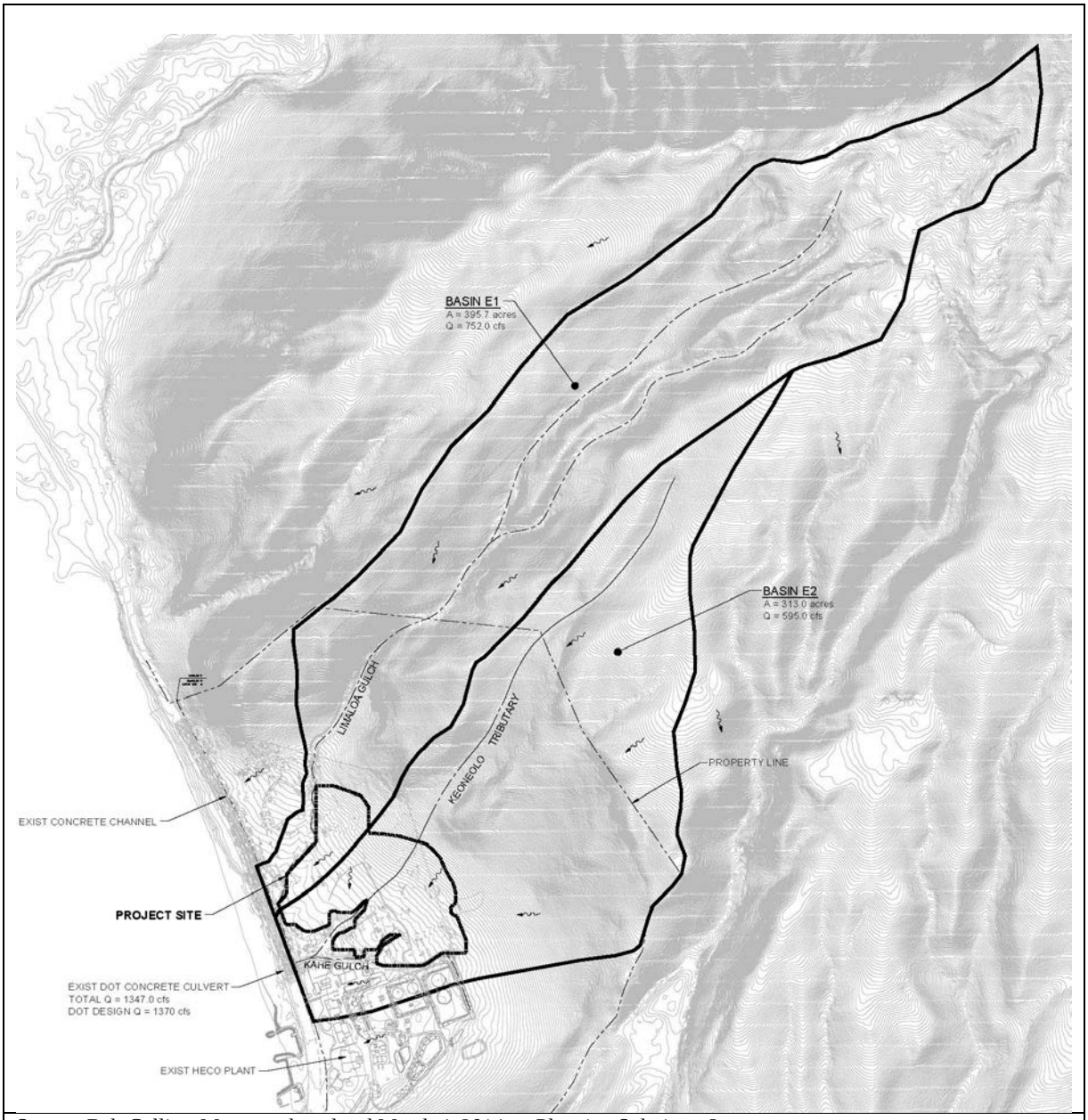
[19] An additional small unnamed basin is delineated within the southeastern corner of the project area but joins Kahe Stream several hundred feet inland of Farrington Highway.

[20] Corps regulations define the term "ordinary high water mark" for purposes of the CWA lateral jurisdiction at 33 CFR 328.3(e), which states:

> *"The term ordinary high water mark means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.*

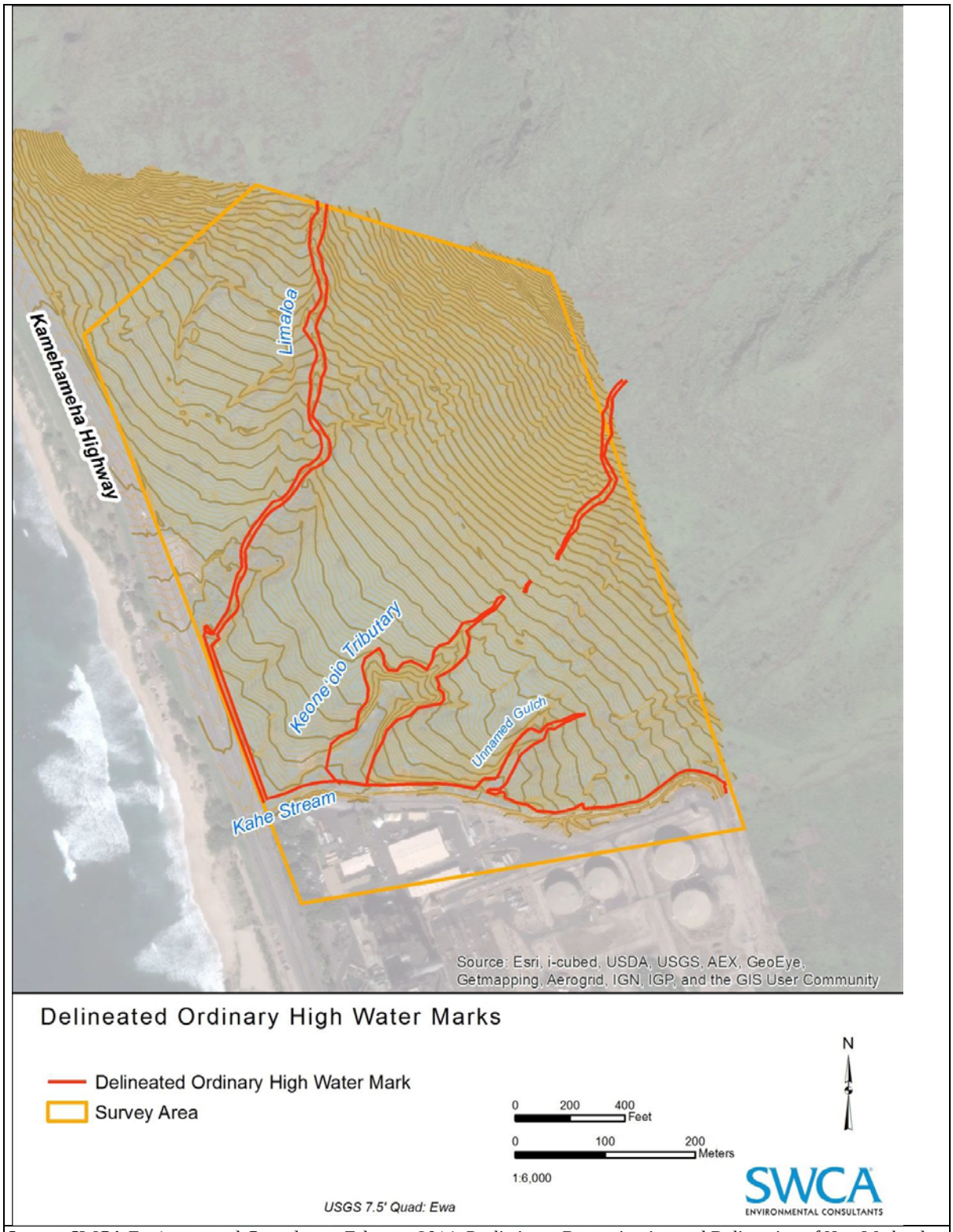
converging drainages and the culvert beneath the highway. As can be seen in Figure 5.2, the OHWM for Keone‘ō‘io was undetectable in certain areas.

Figure 5.1. Drainage Basin Boundaries



Source: Belt Collins, Memorandum dated March 4, 2014, to Planning Solutions, Inc.

Figure 5.2. SWCA Delineated Ordinary High Water Marks within the Survey Area



Source: SWCA Environmental Consultants, February 2014, *Preliminary Determination and Delineation of Non-Wetland Waters Of The U.S. For Kahe Utility Photovoltaics.* Prepared for Belt Collins Hawaii LLC.

Figure 5.3. Reach of Kahe Stream Immediately above Farrington Highway

Source: SWCA Environmental Consultants (February 18, 2014, Figure 6).

Belt Collins Hawaii LLC. (March 4, 2014) estimates of the existing peak discharge for the 720-acre drainage basin that is tributary to the culvert beneath Farrington Highway are as shown in Table 5.2. They indicate that the runoff resulting from a 1-hour/rainfall event with a recurrence interval of once in 100 years is 1,347 cubic feet per second under existing conditions and 1,349 cfs under developed conditions. The existing Department of Transportation culvert beneath Farrington Highway has a design capacity of 1,370 cfs.

5.2.1.2 Existing Conditions: Ocean Waters

Offshore waters in the Pacific Ocean to the west of the Kahe facility are classified Class "A" by the State Department of Health. According to HAR Title 11-54:

> *"It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. 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."*

As indicated above, presently surface water runoff from the project site enters the ocean only during substantial rainfall events. While the data needed to quantify this are unavailable, rainfall data from Barbers Point suggests that it probably occurs no more than a few times in any given month.[21]

Table 5.2. Estimated Peak Discharge (cfs) for 100-Year 1-Hour Design Storms

Drainage Basin	Area (sf)	Area (acres)	Runoff Coefficient, C: % Impervious [C=0.98]	Runoff Coefficient, C: % Vegetation [C=0.50]	Runoff C Weighted	Rainfall Intensity, I (in/hr)	Tc (min)	Corrected I' (in/hr)	Peak Flow Q (cfs)	Point of Discharge
Existing Condition										
E1	17,236,692	395.7	0.00%	100.00%	0.50	3.1	45.0	3.80	752.0	Limaloa Gulch to Exist DOT Culvert
E2	13,634,280	313.0	0.00%	100.00%	0.50	3.1	45.0	3.80	595.0	Kahe Gulch to Exist DOT Culvert
						Existing Total Stormwater Runoff =			**1347.0**	
Drainage Basin	**Area (sf)**	**Area (acres)**	**Runoff Coefficient, C: % Impervious [C=0.98]**	**Runoff Coefficient, C: % Vegetation [C=0.50]**	**Runoff C Weighted**	**Rainfall Intensity, I (in/hr)**	**Tc (min)**	**Corrected I' (in/hr)**	**Peak Flow Q (cfs)**	**Point of Discharge**
Developed Condition										
D1	17,236,692	395.7	0.06%	99.94%	0.50	3.1	45.0	3.80	753.0	
D2	13,634,280	313.0	0.07%	99.93%	0.50	3.1	45.0	3.80	596.0	
						Developed Total Stormwater Runoff =			**1349.0**	
						Minimum Runoff captured in drainage structures =			2.0	
						Developed Peak Flow Entering Exist DOT Culvert =			**1347.0**	Exist DOT Culvert
Totals								**Net Increase =**	**0.0**	
						DOT Drainage Map Calculated Runoff =			**1370.0**	**Existing DOT Culvert**

Notes:
1. C = runoff coefficient.
   C = 0.98 impervious areas
   C = 0.50 existing vegetation
2. T_c = time of concentration. DOT calculated T_c = 45 minutes.
3. I = rainfall intensity = 1-hour rainfall x CF. 1-hour rainfall is dependent on recurrence interval.
   Recurrence interval - Based on design for DOT drainage culvert capacity
   Interval: 100 years.
   1-hour rainfall (i):
   i = 3.1 See attached Figure 21 for 100-year, 1-hour rainfall.
   CF = correction factor - interpolated from Plate 4, DPP Drainage Standards.
4. Q = Runoff generated within the drainage basin = CIA.
5. Existing DOT culvert sizing criteria based on DOT Drainage Map for Project No. S-0900(3), dated June 1964.
   - Area = 720
   - Total Tc = 45 minutes
   - Runoff coefficient, "C", = 0.5
   - Calculated existing runoff = 1,370 cfs (rounded)
6. The calculated developed stormwater runoff quantity of 1,348 cfs is comparable to the DOT calculated existing runoff amount of 1,370 cfs.
7. Developed drainage basin layout based SolarCity's estimate of impervious area: (12'x32'x9') + (23'x11') + (25'x17') = 4134 sf, which includes 12 inverter substations spread across the site, a SCADA house, and 46 kV substation pad. Final design to be based on the final array layout, topographic survey, and soils report for the site.
8. Drainage structure to be used for runoff capture to be decided during final design, retention basins and/or seepage wells likely to be used; an Underground Injection Control (UIC) permit will be obtained for any structure requiring one under the Department of Health regulations.

Abbreviations:
cfs cubic feet per second
in/hr inches per hour
kV kilo-volts
min minute
SCADA supervisory control and data acquisition
sf square feet

Source: Table 2, Belt Collins, Memorandum dated March 4, 2014, to Planning Solutions, Inc.

5.2.1.3 Existing Conditions: Groundwater

The principal groundwater reservoir in the southeastern portion of the Wai‘anae Range is in the middle and lower members of the Waianae Volcanic Series. The volcanic aquifers are recharged by infiltration of rainfall and surface runoff originating in the Wai‘anae Mountains. Groundwater flows from inland areas outward toward the coastline. Flows of the upper member are largely above the water table and contain only a small perennial supply. Groundwater gradients in portions of the southern Waianae Range have been shown to be step-like rather than smooth due to the presence of dikes that act as barriers to groundwater flow (Takasaki, 1971; Hufen and others, 1980). The caprock that overlies this basal groundwater to the east is absent at Kahe.

[21] During the period January 1, 1949 through November 30, 2013 rainfall in excess of 0.09 inches occurred an average of only 6.5 percent of the time (an average of approximately two days per month). National Climate Data Center, http://www.ncdc.noaa.gov/cdo-web/) Met. Stations: Kalaeloa John Rogers Field (USW00022514, 1949-1998; USW00022551, 1999-2013); Honolulu Observatory 702.2 (USC00518806, 1960-8/1962; USC00511918, 9/1962-2013; Ewa MCAS (USW00022515, 1945-1949)

The project site is located within the Makaīwa Aquifer System (CWRM #30205). The CWRM has not assigned a sustainable yield to the system, and no wells are presently withdrawing water from it. Sustainable yields have been established for the Nānākuli Aquifer System immediately to the north (2 million gallons per day) and to the ‘Ewa-Kunia Aquifer System immediately to the South (16 million gallons per day).[22] Records maintained by the State of Hawai‘i and available on its GIS system show five wells in Kahe Valley near the project site. Wells Nos. 2107-03, 2107-04, and 2107-06 are on the property that would be used for the KUSPP. Wells Nos. 2107-02 and 2107-05 are located within the Kahe Generating Station complex less than a thousand feet to the south. Data from these test wells show that groundwater is a minimum of 25 feet below the ground surface at all locations; in most cases it is even further (see Table 5.3). The initial chloride readings from these show that the *makai* wells (2107-02 and 2107-03) have chlorides of 13,500 and 6,750 parts per million, respectively, and the two next lowest in ground elevation) have chlorides of 3,300 and 2,410. These are consistent with the location of the Underground Injection Control line location discussed elsewhere in this report.

Table 5.3. Selected Kahe Valley Groundwater Characteristics

Well No.	*Yr. Drilled*	*Ground Elev (in ft. above msl)*	*Well Depth (in ft. below ground)*	*Water Table (in ft. above msl)*	*Initial Chlorides (in PPM)*	*Aquifer Code*
2107-02	1956	22	204	2.1	13,500	30204
2107-03	1956	28	204	1.7	6,750	30204
2107-04	1956	62	127	5.8	362	30204
2107-05	1956	40	91	1.9	3,300	30204
2107-06	1956	58	125	2.1	2,410	30204
Note: Old well numbers were T128, T129, T130, T131, and T68.						
Source: State of Hawai‘i GIS, file name = allwells_n83, 1/22/2014.						

Approximately 60 percent of the area on which the proposed PV panels would be located is situated *makai* of the Underground Injection Control (UIC) line established by the State Department of Health and regulated under Hawai‘i Administrative Rules Title 11, Chapter 23 (HAR §11-23).[23] The remainder is inland of the line and is, therefore, subject to limitations.

5.2.2 PROBABLE IMPACTS: HYDROLOGY

5.2.2.1 Effects on Surface Water

As indicated in Table 5.2, the proposed project is being designed so that it will not alter the estimated peak discharge for 100-year 1-hour design storms. This condition is accomplished by grading only where required to prepare level pad elevations and access roads, minimizing the amount of impermeable ground cover, leaving most existing vegetation in place, and providing drainage infrastructure to capture and dispose of any increase in storm water runoff from the few areas where impermeable surfaces are needed.[24] None of the work will measurably alter the flow paths of the runoff.

[22] Values are as reported on Map ID: 1026 dated August 28, 2008, at http://www.state.hi.us/dlnr/cwrm/mapsillustrations/gwhu_oahu.pdf.

[23] *Makai* of the UIC line the total dissolved solids concentration of the groundwater is more than five thousand mg/L; this means that the aquifer is not an existing or potential source of drinking water.

[24] A total of approximately 5,000 square feet of impervious area will be added to the project site based on 12 inverter pads, a SCADA house, and the 46kV substation pad.

The project engineer has calculated that the slight increase in impermeable surface will increase the 100-year 1-hour runoff from the property by approximately 2 cubic feet per second (see Table 5.2). This increase in runoff, due to the added impervious area, will be captured and disposed of in drainage structures, such as retention basins and/or seepage or dry wells, before reaching the defined drainageways. Preliminary estimates suggest that between two and five seepage or dry wells will suffice, but this will not be known for certain until the results of geotechnical testing that will be conducted at the site are available. The project engineer has determined that the project will not generate any additional flow at DOT's culvert under the 100-year rainfall 24-hour storm event.

The proposed project has been designed so that Hawaiian Electric believes that all of the PV facilities are outside the ordinary high water mark (OHWM), and the Company has obtained a preliminary jurisdictional determination and "No Permit Required" letter from the Honolulu District of the U.S. Army Corps of Engineers under the condition that fill is not placed below the OHWM.

Preliminary plans indicate the security fence and the 20-foot wide perimeter fire setback will cross Keone‘ō‘io Gulch without any ground disturbance. This crossing will be accomplished by simply omitting the placement of gravel within the delineated area; the fence posts will be placed outside the OHWM as well. The fence fabric will be placed within the gulch but the security system will be designed to give way in the event of a very large storm so that the fencing would not increase the area subject to flooding should debris accumulate on the *mauka* side of the fence.

The proposed PV facilities do not involve any discharges that have the potential to affect water quality. As noted above, the project design minimizes the amount of ground disturbance during construction, seeks to maintain the existing vegetative cover, and includes the use of construction Best Management Practices (BMPs). Because of that, the project is not expected to lead to erosion that would adversely affect water quality. Nonetheless, because the area disturbed during construction of the perimeter fire access is likely to exceed one acre, the contractor must obtain an NPDES Construction permit (NPDES NOI-C) from the State Department of Health. Hawaiian Electric anticipates that it will accomplish this through the existing General Permit system and will file a NPDES NOI-C with the Department in accordance with the provisions of Hawai‘i Administrative Rules Chapter 11-55, Appendix C. That NPDES General Permit covers discharges composed entirely of storm water runoff associated with construction activities, including clearing, grading, and excavation that result in the disturbance of one (1) acre or more of total land area.

5.2.2.2 Effects on Groundwater

Groundwater Recharge. The area where the proposed facilities would be constructed has relatively low rainfall and high evapotranspiration rates. Because of this, very little of the precipitation that falls on the project site presently percolates to the water table and recharges the groundwater supply. Since the effect of the very small increase in impermeable surface that the project will create will be offset by increased percolation through the unlined retention basins and/or dry wells, no significant change in the amount of groundwater recharge is likely. The quality of the recharge water will remain unchanged as well.

Groundwater Withdrawals. Construction of the proposed facilities does not require significant water use and will not, therefore, affect groundwater withdrawals from anyplace on the island. The same is true with respect to operation and maintenance.

5.2.2.3 Sanitary Wastewater Disposal

Neither the PV arrays nor the substation will generate sanitary wastewater. Portable toilets will be used to meet the needs of construction workers on site during the construction period. The waste that is collected in these facilities will be taken to an approved sanitary wastewater treatment and disposal facility.

5.3 CLIMATE/MICRO-CLIMATE

5.3.1 EXISTING CONDITIONS: CLIMATE/MICRO-CLIMATE

5.3.1.1 Wind Patterns

The Hawaiian Island chain is situated in south of the large Eastern Pacific semi-permanent high-pressure cell, the dominant feature affecting air circulation in the region. Over the Hawaiian Islands, this high pressure cell produces very persistent winds called the northeast trade winds. During the winter months, cold fronts sweep across the north central Pacific Ocean, bringing rain to the Hawaiian Islands and intermittently modifying the trade wind regime.

As shown in Figure 5.4, northeasterly trade winds dominate in the project area. Trade winds are produced by the outflow of air from the Pacific Anticyclone, also known as the Pacific High. The center of this system is usually located well north and east of the Hawaiian chain and moves to the north and south seasonally. In the summer months the center moves to the north, causing the trade winds to be at their strongest from May through September. Average wind speeds (see Table 5.4) are moderate, ranging between 7 miles/hour (mph) in October and 8.1 mph in April. Average maximum gusts range between a little under 23 mph (Jan. and Nov.) and nearly 25 mph (July).

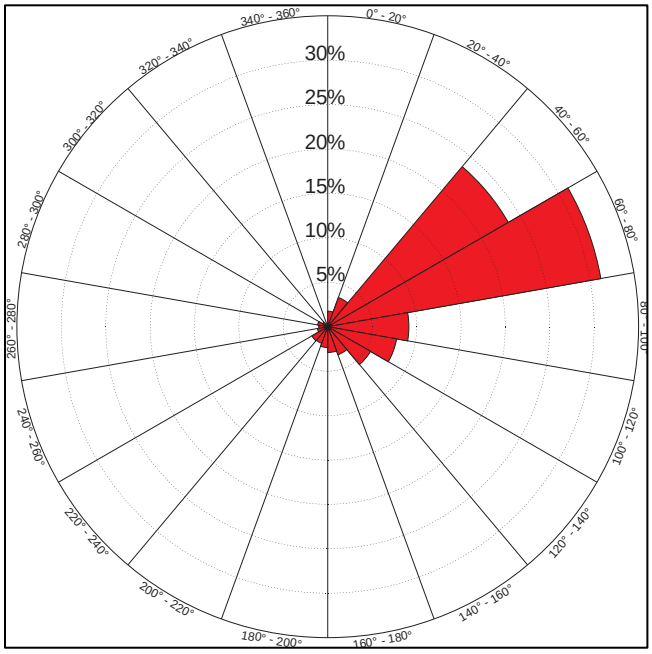
Table 5.4 Project Site Average Wind Speeds by Month

Month	*Wind Speed Monthly Averages (miles per hour)*			
	Average[1]	*Maximum 2-Minute Gust*[2]	*Maximum 5-Second Gust*[2]	*Maximum Recorded Gust*[3]
January	7.6	16.2	20.6	22.6
February	7.4	15.5	19.7	23.3
March	8.0	16.3	21.5	24.1
April	8.1	16.0	21.8	24.5
May	7.8	15.4	20.2	24.0
June	7.9	15.8	21.3	24.7
July	7.9	15.7	21.9	24.9
August	7.6	15.8	22.1	24.3
September	7.2	15.3	20.9	22.8
October	7.0	15.1	20.4	22.6
November	7.2	14.8	19.9	23.5
December	7.4	15.6	20.1	23.3
Overall	**7.6**	**15.6**	**20.8**	**23.7**

Notes: [1]1986 – 2011; [2]1999 – 2011; [3]1949 - 1998

Source: *Kalaeloa John Rogers Field* (National Climate Data Center, http://www.ncdc.noaa.gov/cdo-web/)

Figure 5.4 Wind Rose (John Rogers Field, 1999 – 2012)



Source: *Kalaeloa John Rogers Field* (National Climate Data Center, http://www.ncdc.noaa.gov/cdo-web/)

The principal exceptions to these mild wind conditions take place when hurricanes pass near to the Hawaiian Islands. The highest wind speed recorded at the John Rogers Field station was 70.2 mph, which occurred on November 23, 1982 as Hurricane ʻIwa (a Category Two storm) produced its maximum winds on the Island of Kauaʻi (sustained winds of 80 to 90 miles per hour). Hurricane Iniki, a Category 4 hurricane which passed directly over Kauaʻi on September 11, 1992, had sustained wind speeds of between 130 and 160 mph over that island but produced a maximum gust at John Rogers Field of 51.7 mph.

5.3.1.2 Temperature

Due to the tempering influence of the Pacific Ocean and their low-latitude location, the Hawaiian Islands experience extremely small diurnal and seasonal variations in ambient temperature. The temperature and rainfall data from nearby stations are summarized in Table 5.5. The long-term trend for the annual temperature average shown in Figure 5.5 shows the average temperature peaking between 1985 and 1992 and decreasing slightly since then.

5.3.1.3 Rainfall and Humidity

The terrain on Oʻahu is influential in determining the amount of rainfall. While rainfall near the top of the Koʻolau Range on the windward side of Oʻahu averages nearly 250 inches per year, annual rainfall at the project site has averaged 18.3 inches per year (1947-2012), more than an order-of-magnitude less. As shown in Table 5.5, on average, more than 80 percent of the annual rainfall occurs between October and April; from May through September it averages less than 1 inch per month. As shown in Figure 5.6, the annual rainfall is highly variable. Between 1947 and 2012 it ranged from a maximum of 37.4 inches in 1965 to a minimum of 2.97 inches in 1998. The 5-year running average presented in this figure suggests that the average annual rainfall has been slowly decreasing during this 65-year period. The daytime humidity is usually from the mid-60s to the mid-70s.

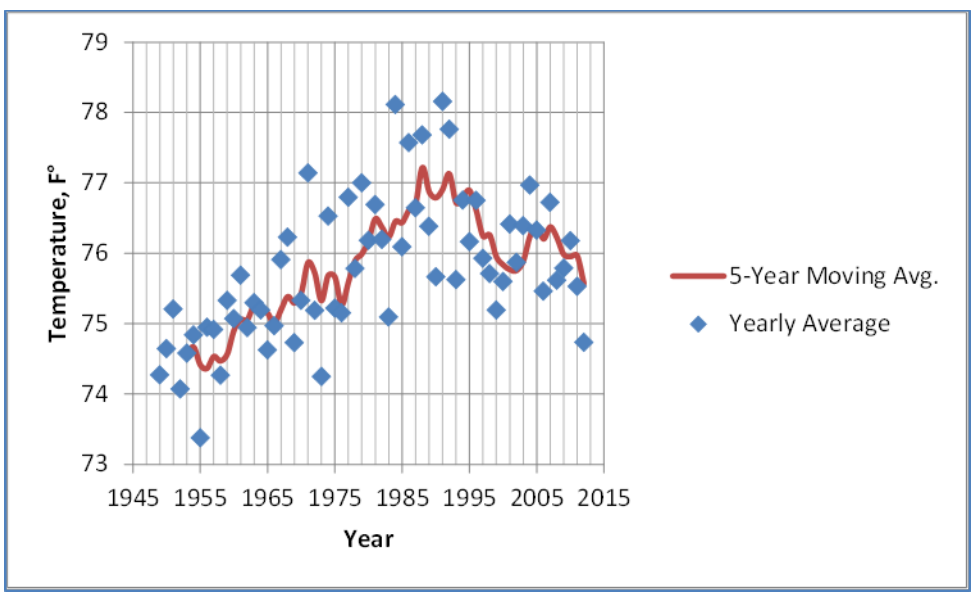
Table 5.5 Average Monthly Temperature, Rainfall, and Humidity

Month	*Air Temperatures, F° (Jan 1949-June 2013)*			*Monthly Rainfall, inches (April 1945-June, 2013)*			*Average Relative Humidity (%)*
	Minimum	*Average*	*Maximum*	*Minimum*	*Average*	*Maximum*	
January	50.0	72.3	89.1	0.09	3.14	14.22	71.7
February	52.0	72.2	89.1	0.00	2.19	10.06	69.1
March	52.0	73.0	91.9	0.03	2.11	17.42	67.9
April	55.9	74.2	91.9	0.01	1.07	12.13	67.5
May	59.0	75.7	91.9	0.00	0.89	8.52	65.5
June	61.0	77.7	96.1	0.00	0.31	2.09	62.6
July	62.1	78.7	98.7	0.00	0.35	2.57	62.0
August	64.9	79.2	96.1	0.00	0.40	2.96	61.8
September	64.0	79.0	93.9	0.02	0.49	2.72	63.8
October	54.0	77.8	93.9	0.00	1.65	13.57	70.6
November	55.9	75.8	96.8	0.01	2.24	22.43	69.4
December	55.0	73.6	91.9	0.00	2.80	12.30	70.8

Note: Temperatures calculated from hourly observations.

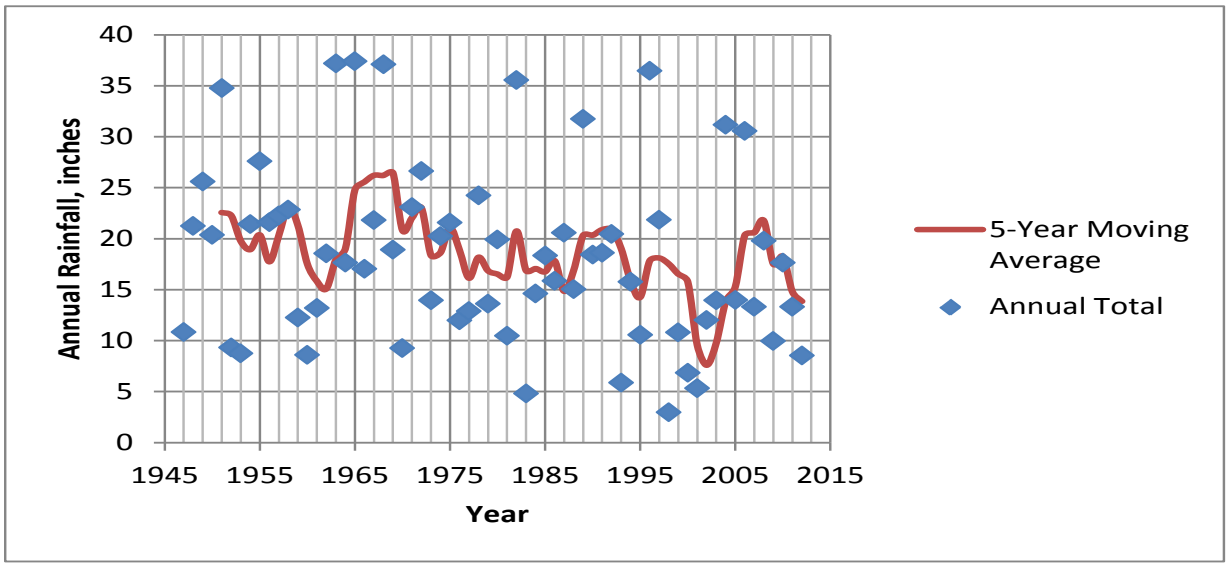
Source: National Climate Data Center, http://www.ncdc.noaa.gov/cdo-web/) Met. Stations:
Kalaeloa John Rogers Field (USW00022514, 1949-1998; USW00022551, 1999-2013)
Honolulu Observatory 702.2 (USC00518806, 1960-8/1962; USC00511918, 9/1962-2013
Ewa MCAS (USW00022515, 1945-1949)

Figure 5.5 Average Annual Temperature: Five-Year Moving Average



Source: See Table 5.5

Figure 5.6 Long-Term Annual Rainfall Trend (1947-2012)



Source: See Table 5.5

While average rainfall is relatively low, intense rainfall events do occur. During the first 15 days of November 1996, for example, record-breaking rainfall occurred along the leeward coast of the island. In Wai‘anae, 21 inches fell in an area where the average annual rainfall is 2 inches. At John Rogers Field during this period 20.2 inches of rain fell, with 7.48 inches falling during a single day (November 5, 1996). The maximum daily (24-hour) rainfall that occurred during this period was 10.51 inches, which fell on March 5, 1958.

5.3.2 EFFECTS ON CLIMATE

There is increasing agreement among atmospheric scientists that emissions of what have come to be known as “greenhouse gasses” from fossil fuel-fired power plants are contributing to a heating of the earth’s atmosphere.[25] Generally referred to as climate change, a continuation of this trend has the potential to alter atmospheric circulation, ocean circulation, and climate worldwide, with a host of consequences.

Other things being equal, the electricity produced by the proposed PV arrays will allow Hawaiian Electric to reduce the output and fuel combustion at its existing fossil fuel-fired generating facilities while still meeting the needs of its customers. Since burning oil at power plants produces carbon dioxide, methane, and other greenhouse gases, this will lower the Company’s emissions of those pollutants.

Hawaiian Electric estimates that the KUSPP will produce 23,000 megawatt-hours (MWh) of electricity per year. If emissions from Hawaiian Electric facilities were equivalent to the national average for oil-fired generation of 1,672 pounds of carbon dioxide per MWh and if power from the PV system could be substituted one-for-one for the power from Hawaiian Electric’s existing oil-fired

[25] Gases that trap heat in the atmosphere are called greenhouse gases. The primary greenhouse gases are carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Fluorinated gases. The first three are emitted when fossil fuels are burned to produce electricity (though there are many other sources of these gases as well).

facilities, the project would reduce CO_2 emissions by 19,228 tons per year.[26] This is far too small to have a measurable positive effect on global warming in and of itself. However, the initiative represents a positive step towards reducing the CO_2 emissions that result from the combustion of fossil fuels.

5.3.3 EFFECTS ON MICROCLIMATE

None of the activities or work required to construct the proposed project involve substantial heat or moisture emissions. Neither do they entail the erection of tall structures or re-grading of land that could alter wind-flow within the project site or surrounding areas to any measurable extent. None of the facilities are substantial structures that might serve as windbreaks or contain large masses of material that would serve as heat sinks. The facilities would, however, shade the ground under them and could affect soil moisture content in ways that have the potential to affect near-earth humidity and soil temperature. They also have the potential to affect reflectivity, but because sunlight that reflects off the surface of a solar panel cannot be used to produce electricity, manufacturers go to great lengths to minimize reflection and maximize the amount of solar energy that the panels absorb. [27] For reasons discussed below, the Kahe Utility-Scale Photovoltaic Project is not expected to cause a noticeable change in the microclimate beyond the boundaries of the project site.

5.3.3.1 Effect on Temperature

Residents living near some much larger solar farms on the Mainland have expressed concern that the presence of a large number of panels would alter air temperatures in and around the facility. Because of this, Hawaiian Electric has evaluated the extent to which the proposed Kahe Photovoltaic Project might increase air temperatures on and immediately around the project site.[28] In the course of these investigations it also reviewed evidence concerning possible effects on soil temperature and soil moisture content within the area where the PV arrays would be constructed. Both factors are relevant to long-term maintenance of vegetative groundcover in the area.

Many researchers argue that, in theory, PV panels are not likely to increase temperature in the area immediately around a solar installation such as the proposed project. Specifically, they note that:

- The amount of the sun's heat absorbed by a solar panel is similar to the amount of the sun's heat absorbed by the earth.
- Because solar panels are thin (the glass is approximately 0.12 inches thick), lightweight, and surrounded by airflow (because it's mounted above the ground), they store less heat than the solid earth. The same physical characteristics mean that PV panels dissipate heat more quickly than

[26] U.S. Environmental Protection Agency , http://www.epa.gov/cleanenergy/energy-and-you/affect/oil.html. Readers should note that the KUSPP, like any renewable energy source that does not provide firm power, is unlikely to reduce emissions to this extent. That is because the utility will need to keep some firm power capacity on standby to maintain system stability as PV output falls off in response to passing clouds and other short-term and not readily predictable events.

[27] The modules that would be used in the proposed project are constructed using a glass whose surface has an anti-reflective treatment so sunlight striking it is directed towards the silicon photovoltaic cell, limiting reflection. One measure of the reflectivity is albedo, the ratio of solar radiation across the visible and invisible light spectrum reflected by a surface. Albedo varies between 0, a surface that reflects no light, and 1, a mirror-like surface that reflects all incoming light. Solar panels with a single anti-reflective coating have a reflectivity of around 0.10 to 0.3. By comparison, sand has an albedo between .15 and .45 and agricultural vegetation has an albedo between .18 and .25. In other words, the solar panels have a lower reflectivity.

[28] Readers should note that PV project developers have a selfish reason to want to minimize reflectance off of the panels. The sunlight which is absorbed by the panels is either converted into electricity or raises the temperature of the panels. In order the maximize the efficiency of electricity production, photovoltaic manufacturers design their panels to minimize the latter, striving to keep panels from reaching temperatures greater than 20° Fahrenheit (F) above that of the surrounding air. By comparison, automobiles in the sun at a parking lot can reach temperatures more than 40° F. higher than that of the surrounding air.

solid earth does. This means that nighttime temperatures may be slightly lower where PV panels are present.

- The other equipment associated with the arrays (e.g., the inverters) do not generate a significant amount of "waste heat".

Computer Simulations

The results of several recent computer simulations of the phenomenon support the conclusion that project-related effects on temperatures will be insignificant.

Lawrence Berkley National Laboratory Modeling. Computer modeling by researchers at the Lawrence Berkley National Laboratory (Millstein and Menon, July 1, 2011) examined the extent to which modification to the surface albedo of the earth through the widespread deployment of cool roofs and pavements (reflective materials) and photovoltaic arrays (low reflection) have the potential to change radiative forcing, surface temperatures, and regional weather patterns.[29] The huge hypothetical solar arrays that were used in that part of the analysis produce about 8,000 times more power than the proposed Kahe Utility-Scale Photovoltaic Project. Even with such an exaggerated source, the modeled local afternoon temperature increases were less than three-quarters of a degree Fahrenheit. Based on these results, it is apparent that the size of the several orders of magnitude smaller array field proposed for Kahe Valley would have no discernible effect on ambient temperature. And would not affect winds in any measurable way.

Tokyo Simulation. Genchi et al. (2003) conducted a simulation of the effects of large-scaled PV panel deployment in the urban setting of Tokyo. They conclude that the impact of large-scale installation of PV panels on micro-climate—in particular the building canopy temperature—would be negligible. The much smaller installation that is proposed by Hawaiian Electric for the Kahe Generating Station has even less potential to cause such effects.

CVSR Solar Photovoltaic Project. Donovan (July 6, 2010) assessed the extent to which a large solar project in California's Central Valley (the CVSR Solar Photovoltaic Project) might change ambient temperature under, over, and around the solar field. The analysis, which was applicable to PV arrays between 1 and 300 acres in size, compared conditions with and without such an array. In addition to changes in the albedo, there are other factors which could result in heat impacts. Drawing on work done on urban heat islands, he discussed three factors that could lead to an effect from large-scale PV arrays: (*i*) use of materials which absorb more solar radiation; (*ii*) use of massive materials which store more heat and dissipate heat slowly; and (*iii*) waste heat from energy usage, such as appliances, engines, and HVAC, which run on electricity, natural gas, and oil. He reached the following conclusions:

- With regards to factor (*i*), he concluded that while the PV array's slightly lower (relative to natural conditions) albedo (reflectivity) will cause it absorb slightly more heat than a field with no PV, PV panels dissipate heat more quickly than the earth. The fact that this increased heat is being absorbed by the PV panels and not the earth means that there will be no net gain in heat caused by the albedo change.
- With regards to second factor, the amount of heat released during periods when solar insolation is low (e.g., at night) is related to the mass of those materials and the amount of heat absorbed when the sun is shining on them. While PV modules can reach relatively high operating temperatures, they are thin and lightweight (rather than massive) and therefore do not store a large amount of

[29] The analysis used the Weather Research and Forecasting (WRF) model (a fully coupled regional climate model) to investigate feedbacks between surface albedo changes, surface temperature, precipitation and average cloud cover.

heat. Because of this, they cool to ambient air temperature shortly after the sun sets and do not affect air temperatures thereafter.

- With regards to the third factor, the only heat that would be emitted by equipment at the proposed project would be from the inverters that are scattered throughout the PV arrays. Even for the Central Valley PV system that Donovan studied (which included tracking motors and other heat-releasing equipment that would not be present at Kahe), the waste heat was less than 0.21 MWh/acre/day, or about 1 percent of total solar energy impacting the plant within a day.[30] To put this in perspective, this is about 250 times less per acre than the energy loads imposed by a large urban area and suggests that waste heat from energy loads would not have a significant temperature effect.

Center for Life Cycle Analysis.[31] Vasilis Fthenakis and Yuanhao Yu have completed a computer analysis of the potential for a heat island effect in 50 MW to 500 MW solar farms, i.e., facilities much larger than is contemplated at Kahe. They are developing computational fluid dynamics (CFD) simulation capabilities for modeling the air velocity, turbulence, and energy flow fields induced by large solar PV farms to answer questions pertaining to potential impacts of solar farms on local microclimate, and have conducted detailed 3-D simulations of a 1 MW section of a solar farm in North America and compared the results with recorded wind and temperature field data from the whole solar farm.

Both the field data and the simulations show that the annual average of air temperatures in the center of PV field can reach up to 1.9° C. above the ambient temperature. However, this thermal energy appears to completely dissipate to the environment at heights of 5 to 18 m above ground. The data also show a prompt dissipation of thermal energy with distance from the solar farm, with the air temperatures approaching (within 0.3° C) the ambient at about 300 m away of the perimeter of the solar farm. Analysis of 18 months of detailed data showed that in most days, the solar array was completely cooled at night, and, thus, it is unlikely that a heat island effect could occur.

In summary, while it is not possible to scale the results of the theoretical modeling and calculations that have been done elsewhere—in linear fashion—to the situation in Kahe Valley, together the theoretical analyses indicate that the 11.5 MW (AC) array that is planned would not have a measurable effect on the microclimate.

Field Research

The preceding discussion is based largely on theory. Some field research has been conducted as well. While the data are still limited, in order to address concerns about the possible temperature changes associated with large PV arrays, meteorologists working on the Sarnia Solar Power Plant in Ontario, Canada, obtained detailed air temperature data in and around the first (approximately 100-acre) phase of that project. The results of their measurements provide empirical evidence that PV arrays do not have a significant effect on the ambient temperatures in nearby areas.

Temperature data at the Sarnia facility was gathered using nine automated weather stations recording 30-minute averages of air temperature, relative humidity, global horizontal insolation[32], wind speed and direction, and barometric pressure. Six of the stations were installed around the Sarnia project

[30] In comparison, a study of the Urban Heat Island effect in New York City [1] showed that waste heat from energy usage in that city is about 250% of solar energy throughout the year.

[31] "Analysis of the Potential for a Heat Island Effect in Large Solar Farms". Vasilis Fthenakis and Yuanhao Yu. Center for Life Cycle Analysis, Department of Earth and Environmental Engineering, Columbia University, New York, NY, and PV Environmental Research Center, Brookhaven National Laboratory, Upton, NY http://www.clca.columbia.edu/13_39th%20IEEE%20PVSC_%20VMF_YY_Heat%20Island%20Effect.pdf

[32] Solar radiation is usually measured with an instrument mounted horizontally, so that it sees the whole sky (direct plus diffuse) and such data is termed "global horizontal insolation" (GHI).

property and three stations were installed in nearby corn fields as controls. The sensors were positioned approximately 8 feet above ground, and are accurate to about ±0.5°C (sensor) and ±1 °C (in the data-logger system). One of the stations (SH #2) was approximately 100 feet from the western edge of Block #2 of the operating solar panels. All of the other monitoring stations are located at least 0.6 mile from the nearest operating or installed portion of the power plant.

The influence of module heating was measured by observing time-point by time-point (30 minute average) temperature differences between the various weather stations. The analysis focused on differences between the suspected "hot" station, SH #2 and nearby short-term controls (SH #7, #3, #9) and on differences between the controls themselves (#7, #3, #4, #9). The temperature differences, binned by hour over the period of record, between SH #2 and its two nearest undisturbed neighbors, or controls (SH#3, 0.81 mile to the North and SH#7 1.2 mile to the South) are shown in Table 5.6.

Table 5.6 Air Temperature Difference Measurements Associated With Large PV Arrays

	Hawks #2 - #7	***Hawks #2 - #3***	***Hawks #3 - #7***
Mean Difference ± 1 std (all hours of day)	- 0.02 ± 0.5 °C	+ 0.04 ± 0.5 °C	- 0.05 ± 0.6 °C
Maximum Mean Difference (night)	+ 0.26 °C @ 23:00	+ 0.26 °C @ 24:00	+ 0.03 °C@ 10:00
Maximum Mean Difference (day)	- 0.34 °C @ 15:00	- 0.22 °C @ 11:00	- 0.18 °C @ 14:00

Source: *Topaz Solar Farm Final Environmental Impact Report*, Appendix 8B, Sarnia Air Temperature Analysis, Interim Results, March 15, 2010.

In summary, analysis of the data collected during the first eleven months of operation (April 1, 2009 through February 28, 2010) of the first 20 MW of the first solar installation (Blocks #1 and #2) showed the following:

- There is no statistically significant mean temperature difference between the monitoring stations.
- Hint of an average diurnal variation of about 0.6 °C between the controls and the single station adjacent to the array, a value within the measurement error of the sensors.
- Only winter measurements available for comparing center-of-array to outside-of array measurements; more data needed to analyze long term trends.
- No measurable effect of wind.

While the interim report notes that additional data are needed to confirm these preliminary results, the preliminary findings provide strong evidence that the presence of large PV arrays does not have a significant effect on air temperature.

5.3.3.2 Effect on Soil Temperature and Soil Moisture Content

While not, strictly speaking, a "microclimatic effect", changes in soil temperature and soil moisture content are so closely tied to microclimate that they are discussed here. The broad surfaces of the photovoltaic modules will create substantial shade over a significant portion of the project site. This would lower daytime soil temperatures relative to un-shaded conditions (e.g., in a ploughed field), but it is not clear whether this difference would be: (*i*) similar or different from that caused by the presence of shading vegetation; or (*ii*) sufficient to affect the soil microenvironment in any substantial

way. A search of the literature failed to uncover substantive research on this topic.[33] While periodic washing of the photovoltaic modules will briefly increase surface moisture in localized areas, this will only occur when rainfall is scarce and would not measurably alter the climate or regional microclimate.

5.4 AIR QUALITY

5.4.1 EXISTING CONDITIONS: AIR QUALITY

The U.S. Environmental Protection Agency (EPA) has set national ambient air quality standards (NAAQS) for ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, 2.5-micron and 10-micron particulate matter ($PM_{2.5}$ and PM_{10}), and airborne lead. These ambient air quality standards establish the maximum concentrations of pollution considered acceptable, with an adequate margin of safety, to protect the public health and welfare. The State of Hawai‘i Department of Health (DOH) has also set ambient air quality standards for some pollutants; in some cases, these are more stringent than the Federal standards. At present, the State has set standards for five of the six criteria pollutants (the State does not have a standard for $PM_{2.5}$) in addition to hydrogen sulfide (DOH 2005). Hawai‘i Administrative Rules (HAR), Title 11, Chapter 59 *Ambient Air Quality Standards* and Chapter 60 *Air Pollution Control* establish these standards. Table 5.7 presents the state and national ambient air quality standards for selected pollutants.

Both State and national air quality standards consist of two parts: (*i*) an allowable concentration of a pollutant and (*ii*) an averaging time over which the concentration is measured. The allowable concentrations are based on the results of studies of the effects of the pollutants on human health, crops, and vegetation, and, in some cases, damage to paint and other materials. The averaging times are based on whether the damage caused by the pollutant is more likely to occur during exposure to a high concentration for a short time (one hour, for instance), or to a lower average concentration over a longer period (e.g., 8 hours, 24 hours, or a year). For some pollutants there is more than one air quality standard, reflecting both its short-term and long-term effects.

Air quality data collected at the Kapolei, Pearl City, and Honolulu monitoring stations (ordered in proximity to the project site) during the year 2011 are presented in Table 5.8. As shown by these data, air quality in the area never exceeded the short-term or long-term state or national standards for particulate matter (PM_{10}) or carbon monoxide (the two pollutants that could be released during construction of the proposed project).

[33] However, soil temperature is one of the factors on which the Brookhaven National Laboratory is planning on collecting data (http://www.bnl.gov/energy/files/nserc/BNL_Solar_Research_Overview_and_ NSERC_ Plans_with_Input.pdf).

Table 5.7 State and National Ambient Air Quality Standards

Pollutant	Unit	Averaging Period	NAAQS	SAAQS
CO	ppm	1-hour	35[b]	9
		8-hour	9[b]	4.4
Pb	µg/m^3	Quarterly	1.5[h]	1.5
NO_2	ppb	1-hour	100	None
	ppm	Annual	0.053[c]	0.04
H_2S	ppm	1-hour	None	0.025
PM_{10}	µg/m^3	24-hour	150[d]	150
		Annual	None [e]	50
$PM_{2.5}$	µg/m^3	24-hour block avg.	35	None
		Annual	15[f]	None
O_3	ppm	8-hour rolling avg.	0.075[g]	0.08
SO_2	ppm	3-hour	0.5[a]	0.5
		24-hour	0.14[b]	0.14
		Annual	0.03[c]	0.03

Notes:
a. Federal Secondary Standard.
b. Not to be exceeded more than once per year.
c. Average of all 1-hour values in the year may not exceed the level of the standard.
d. May not be exceeded more than one day per year.
e. EPA revoked the annual PM_{10} standard effective December 17, 2006 due to a lack of evidence linking health problems to long-term exposure. The State still has an annual standard.
f. The 3-year average of 24-hour values must not exceed the level of the standard.
g. The 3-year average of the fourth highest daily maximum value must not exceed the level of the standard.
h. Average of all 24-hour values in any calendar quarter may not exceed the level of the standard.

Source: State of Hawai‘i Department of Health, *Air Quality Data Book* (2010)

Table 5.8 Air Quality at Specified Locations: 2012

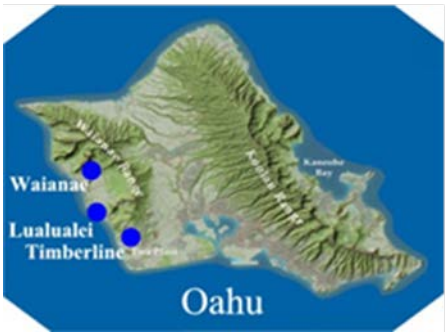
Parameter	*Strictest Standard*	*Kapolei*		*Pearl City*		*Downtown Honolulu*	
		Highest	*2nd Highest*	*Highest*	*2nd Highest*	*Highest*	*2nd Highest*
PM_{10} 24-hour (µg/m^3) [1]	***150 µg/m^3***	40	36	37	33	32	28
$PM_{2.5}$ 24-hour (µg/m^3) [1]	***35 µg/m^3***	23.5	14.8	20.1	13.4	16.9	12.8
8-Hour O_3 Average (ppm)	***0.075 ppm***	0.045	0.044	---	---	---	---
1-Hour NO_2 Average	***0.1 ppm***	0.027	0.023	---	---	---	---
Annual Mean NO_2	***0.053 ppm***[c]	0.003		---	---	---	---
1-Hour CO Average	***35 ppm***	1.5	1.3	---	---	1.0	1.0
8-Hour CO Average	***9 ppm***	1.1	1.1	---	---	0.7	0.7
Annual Mean CO	---	0.7		---	---	---	
1-Hour SO_2 Average	***0.075 ppm***	0.012	0.009	---	---	.031	.028
3-Hour SO_2 Average	***0.5 ppm***	0.007	0.006	---	---	0.026	0.021
24-Hour SO_2 Average	***0.140 ppm***	0.004	0.004	---	---	0.009	0.005
Annual SO_2 Average	***0.03 ppm***	0.002		---		0.001	

Notes: (X) = Not applicable.
1 = Particulate matter up to 10 microns in diameter. The State and Federal Ambient Air Standard for 24-hour PM_{10} is 150 µg/m^3.
2 = The State Ambient Air Standard for 24-hr. SO_2 is 0.14 ppm. Federal standard for SO_2 is now a 1-hour average not to exceed 75 ppb (0.075 ppm).

Note: The Hawai'i State Department of Health is required to notify the public whenever the National Ambient Air Quality Standards (NAAQS) are exceeded. The lists for 2012 and 2013 do not show any exceedances on O'ahu during those years.

Source: Hawaii State Department of Health, Environmental Management Division, Clean Air Branch records as reported in *The State of Hawaii Data Book 2012*. The list of exceedances are at http://health.hawaii.gov/cab/files/2014/01/exceedances_2013.pdf and http://health.hawaii.gov/cab/files/2013/05/exceedances_2012.pdf

In addition to these data, detailed air quality information is also available from three ambient air quality monitoring stations located on the Waianae Coast, as shown on the map to the right.[34] The monitoring stations were placed into operation in April 2009 as part of a commitment made by Hawaiian Electric to the communities of West O'ahu. The monitoring stations are one of six commitments made by Hawaiian Electric in conjunction with the development of a new power generating station at Campbell Industrial Park. The data are updated hourly at about 15 minutes after the hour. Air quality at all of these stations has been good since monitoring began.



[34] The Waianae, Lualualei, and Timberline monitoring stations each measure the concentrations of sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO_2), particulate matter (PM), and nitrogen dioxide (NO_2).

5.4.2 PROBABLE AIR QUALITY IMPACTS

5.4.2.1 Construction Period

The heavy construction equipment that will be used for this work (e.g., bulldozers, dump trucks, pile drivers, etc.) will be powered by internal combustion engines that emit a variety of air pollutants, all in small quantities and over a relatively limited period of time (i.e., several months).[35] None of these equipment emissions will add substantially to existing area sources of these pollutants, which consists principally of generation-related emissions from the Kahe power plant and vehicles traveling on Farrington Highway (the area's principal roadway).

Grubbing and grading necessarily involves the use of large, diesel-fueled construction equipment. However, in the case of the proposed KUSPP, the number of pieces of equipment operating at any one time is too low, and their distance from sensitive receptors too great, for combustion emissions such as NO_X and diesel particulate matter (diesel PM), from this equipment to have a significant effect on air quality.

Consequently, the soil disturbance caused by grubbing and grading work generates fugitive dust which can have a more substantial (albeit temporary) effect on air quality than emissions from the engines themselves.[36] The potential for adverse effect continues until the replacement vegetation has become established or material is placed over the exposed ground. To minimize this potential, Hawaiian Electric plans to limit the amount of grubbing, grading, and vegetation removal to the smallest amount possible. As discussed in Section 5.1.2 and shown in Table 5.1, it expects to grade and grub only those areas where fire setbacks, accessways and equipment pads are located, a total of less than 6 acres, or less than 15 percent of the total site. The remainder will be left with its existing ground cover.

Over the long-term, changes in ground cover that lead to the emergence of bare soil areas can lead to an increase in Aeolian soil erosion and airborne particulate matter. The Vegetation Management Plan (reproduced in Appendix B) is intended to ensure that good ground cover is maintained, thereby minimizing the potential for such an occurrence.

Specific information regarding the construction equipment that will be used will not be available until a construction contractor is selected. Consequently, overall construction emissions were estimated using screening emission rates and procedures recommended in the most recent edition of the *Air Quality Handbook: A Guide for Assessing the Air Quality Impacts for Projects Subject to CEQA Review* (San Louis Obispo Air Quality Control District, December 2009). The results of the calculation are shown in Table 5.9.

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[35] Construction equipment emissions result from the following sources and activities: (*i*) construction equipment engine exhaust; (*ii*) motor vehicle exhaust, brake, and tire wear; (*iii*) entrained dust from material delivery trucks; (*iv*) entrained dust from roadways; (*v*) entrained dust from construction worker vehicles; (*vi*) fugitive dust from bulldozing, grading, and scraping, and from the handling of excavated material, such as depositing material into haul trucks; and (*vii*) fugitive dust from wind erosion of disturbed areas

[36] The piles are installed using hydraulic pile-driving equipment that minimizes earth disturbance and, therefore, the potential for construction dust. The pile-driving equipment and the vehicles delivering the piles, panels, and other materials used to erect the arrays travel slowly and tend not to disturb the soil and produce substantial quantities of airborne particulates.

Table 5.9 California Guideline Screening Emission Rates for Construction Operations

Pollutant	*grams/Yds^3 of Material Moved*	*Lbs/ Yds^3 of Material Moved*	*Yds^3 of Material Moved*	*Emissions (in pounds/ year)*
Diesel PM	2.2	0.0049	4,342	21.3
Carbon Monoxide (CO)	138.0	0.304	4,342	1,320
Reactive Organic Gases (ROG)	9.2	0.0203	4,342	88
Oxides of Nitrogen (NO_x)	42.4	0.0935	4,342	406
Sulfur Oxides (SO_x)	4.6	0.010	4,342	43
Fugitive Dust (PM10)	0.75 tons/acre-mo. of Constr. activity		54 acre-months	12 tons
Note: These rates assume an average of 0.27 gallons of diesel fuel is burned for each cubic yard of earth moved.				
Sources: *CEQA Air Quality Handbook, A Guide for Assessing the Air Quality Impacts for Projects Subject to CEQA Review*, December 2009 - April 1996, and EPA-AP 42.				

The emission estimates from Table 5.9 were then used together with the fuel use estimate presented above to assess whether or not mitigation might be appropriate.[37] Table 5.10 shows the approximate level of construction activity that would require mitigation for each pollutant of concern if the project were in California (the location with the most stringent limits) and compares these with the estimated emission from the proposed project. The results indicate that special mitigation is not appropriate.

Table 5.10 Level of Construction Activity Where Mitigation May be Appropriate (CA)

Pollutant of Concern	*Thresholds ([1])*		*Amount of Material Moved*		*Threshold Exceeded?*
	Tons/Qtr	*Lbs/Day*	*Cu. Yds/Qtr*	*Cu. Yds/Day*	
Reactive Organic Gases	2.5	185	247,000	9,100	No
	6.0	185	593,000	9,100	No
NO_x	2.5	185	53,500	2,000	No
	6.0	185	129,000	2,000	No
PM_{10}	2.5	n/a	Any project with a grading area greater than 4.0 acres of continuously worked area will exceed the 2.5 ton PM10 quarterly threshold.		No
Note: Thresholds were approximated using the screening level emission rates from Table 5.9. Daily emission thresholds are based upon the level of daily emissions that may result in a short-term exceedance of the ozone standard.					
Source: Compiled by Planning Solutions, Inc. (2013)					

Minimization Measures. Hawaiian Electric will require its contractor to implement the following standard minimization measures, as well as whatever additional measures may be required by the grubbing and grading permits that the contractor must obtain from the City and County of Honolulu.

[37].Because it is a "non-attainment area" with respect to national and State ambient air-quality standards, the emission limits in San Luis Obispo, California are quite restrictive and, therefore, provide a conservative benchmark against which to judge the Kahe Utility-Scale Photovoltaic Project.

- Maintain all construction equipment in proper tune according to manufacturer's specifications.
- Fuel all off-road and portable diesel powered equipment, including but not limited to bulldozers, graders, cranes, loaders, scrapers, backhoes, generator sets, compressors, auxiliary power units, with motor vehicle diesel fuel.
- Maximize to the extent feasible, the use of diesel construction equipment meeting the latest certification standard for off-road heavy-duty diesel engines.
- Minimize the extent of disturbed area where possible.
- Use water trucks if needed to minimize the amount of airborne dust leaving the site.
- Cover or continuously wet dirt stockpile areas containing more than 100 cubic yards of material.
- Implement permanent dust control measures identified in the project plans as soon as possible following completion of any soil disturbing activities.
- Limit vehicle speed for all construction vehicles moving on any unpaved surface at the construction site to 15 mph or less.
- Cover all trucks hauling dirt, sand, soil, or other loose materials.

5.4.2.2 Operation and Maintenance Activities

None of the equipment associated with operation of the PV arrays and ancillary equipment (e.g., inverters, control equipment, transformers, switches, etc.) emit air pollutants of any kind. Consequently, once the PV facilities and other necessary equipment have been installed, very little would occur that has the potential to affect air quality so long as the land in and around the PV array is maintained in accordance with the Vegetation Management Plan (reproduced in Appendix B).

Some emissions will result from vehicles traveling to and from these facilities for occasional maintenance; similar to other facilities at Kahe Generating Station, but these will be over very short distances and relatively brief periods of time. In summary, when looked at cumulatively and over the long term, operations and maintenance of this project does not have the potential to harm air quality in the area.

At the same time, the proposed project's beneficial effect will extend well beyond the immediate project area. The electricity that the photovoltaic arrays would produce will allow Hawaiian Electric to reduce the amount of electricity that it must generate using fossil fuels. This reduction will allow a nearly proportionate decrease in the amount of pollutants emitted as a result of the combustion of fossil fuels at Hawaiian Electric's facilities on the island.

Table 5.11 shows the amounts of each regulated pollutant that were emitted for each kilowatt-hour (KWh) of power that was generated at Hawaiian Electric's four generating stations in 2012. Table 5.12 shows the anticipated emissions reductions as a result of the KUSPP project. Present estimates are that the Kahe Utility-Scale Photovoltaic project will produce an average of 23,000 megawatt hours (MWh) of power per year. This means that if fossil-fuel-fired generation was decreased by the same proportion at all the existing generation units, the proposed project would reduce the company's annual CO_2 emissions by 38,456,000 lbs. per year. If the replacement could be slanted disproportionately towards replacing power generated at older facilities, the reduction in emissions would be proportionately larger.

Table 5.11. Annual Air Pollutant Emissions in Pounds per Kilowatt Hour in 2012

Unit	*Power Generated (KWh)*	*Emissions in Lbs./KWh*					
		PM^{10}	*SO_2*	*CO*	*NO_x*	*VOC*	*CO_2*
CIP	21,259,482	1.7	0.3	79.6	27.9	1.3	33,435
Honolulu	46,435,800	9	159.9	0.2	216.6	0.1	59,166
Kahe	3,011,846,000	627.9	6,654.50	384.1	8,256.10	59.6	2,653,282
Waiau	1,041,325,278	193.6	2,571	99.6	2,619.40	15.8	951,044
TOTAL	***4,120,866,560***	***832.2***	***9,385.70***	***563.5***	***11,120***	***76.8***	***3,696,927***

Source: Compiled by Planning Solutions, Inc. with information provided by Hawaiian Electric (2013)

Table 5.12. Emissions Reductions as a Result of the Kahe Utility-Scale Photovoltaic Project

Unit Whose Generation is Replaced	*Power Generated (MWh)*	*Emissions in Pounds per Year*					
		PM^{10}	*SO_2*	*CO*	*NO_x*	*VOC*	*CO_2*
CIP	119	19	3	889	311	15	373,225
Honolulu	259	100	1,785	2	2,418	1	660,452
Kahe	16,810	7,009	74,282	4,288	92,165	665	29,617,793
Waiau	5,812	2,161	28,699	1,112	29,240	176	10,616,220

Source: Planning Solutions based on Hawaiian Electric spreadsheet titled *2012 HECO Net Power and Emissions lbs per MWhr*

Because these calculations assume that the reduction in operations will be proportional to the amount of electricity that each Generating Station produced in 2012, the greatest beneficiary of the reductions indicated in the table would be the area closest to the Kahe Generating Station. Emissions reductions at CIP, Waiau, or Honolulu Generating Stations are too distant to have a measurable effect on air quality in Kahe Valley or the Leeward Coast, due to their distance. However, those reductions will have a beneficial effect on pollutant levels near these facilities, all of which are closer to sizeable population centers on O‘ahu than KGS.

While photovoltaic systems do not have any air pollutant emissions during normal operation, it is possible for emissions to occur if they are ignited (e.g., by wildfire). The panels themselves are not flammable; however a potential fire could begin if nearby vegetation were to ignite, as is possible in a brush fire. So long as the vegetation beneath and around the solar array is maintained in accordance with the Vegetation Management Plan outlined in Appendix B, the potential for this to occur is low. If a sufficiently intense and prolonged fire were to occur, metals used in some types of PV panels could vaporize and escape into the atmosphere. However, because these materials (such as cadmium, selenium, and tellurium) are either not present, or are present in only minute quantities, in the panels which Hawaiian Electric will use, the danger from the fire itself would keep fire-fighters and others far enough away to avoid significant exposure to any of the toxins.

5.4.2.3 Decommissioning

The potential for adverse air quality effects as a result of decommissioning is negligible. Neither removing the panels from the mountings nor extracting the foundation posts from the ground disturbs the soil to the extent that it will produce substantial quantities of fugitive dust. Emissions from the

equipment used to perform the work are also very small, particularly relative to the adjacent highway and power plant. Some airborne particulate can be expected if the foundations for the electrical equipment pads and/or conduits are excavated and removed.

5.5 BIOTA

5.5.1 EXISTING CONDITIONS

5.5.1.1 Existing Flora

A botanical survey of the project site undertaken on January 20, 2014, entailed a wandering pedestrian transect that traversed primarily those parts of the property proposed for the solar panels and appurtenant structures. Plant species were identified as they were encountered and notations were recorded and used to develop a qualitative sense of abundance as the survey progressed. The survey period encompassed the wet season and the vegetation appeared generally well watered.

As described in detail in the biological report reproduced in Appendix A, the vegetation present on the site consists principally of grassland with scattered shrubs and trees, except were drainages cross the site and shrubland prevails.[38] The dominant grass here is buffelgrass (*Cenchrus ciliaris*) and in some places, Guinea grass (*Urochloa maxima*). The scrubland along gulch bottoms is mostly short-stature *koa haole* (*Leucaena leucocephala*) with a Guinea grass understory. *Kiawe* (*Prosopis pallida*) trees and *klu* (*Acacia farnesiana*) shrubs are scattered across the area. In a few areas, native cotton plants or *ma‘o* (*Gossypium tomentosum*) are moderately abundant. Several other native shrubs are also abundant in these same areas: hoary abutilon (*Abutilon incanum*), *‘ilima* (*Sida fallax*), and ‘*uhaloa* (*Watheria indica*). In some areas, the vegetation approaches that of a savanna (grassland with an open canopy of trees). These conditions are illustrated in Figure 5.7.

A total of 42 species of vascular plant species was recorded; most of them are introduced species, but the site does have three natives and one early Polynesian introduction. While this proportion of these (~10 percent) is typical for lowland O‘ahu, the abundance of these “native” plants is higher than usual. Three of the species are widespread, especially in dry areas of the island; only native cotton or *ma‘o* (*Gossypium tomentosum*) is considered uncommon on O‘ahu. A majority of the cotton plant population on this site is distributed on slopes above the planned PV area.

5.5.1.2 Existing Fauna

An avian and mammalian survey was conducted at the same time as the botanical survey. Seven avian count stations were sited equidistant from each other within the study area, and a single eight-minute avian point count was made at each count station. The count and subsequent search of the remainder of the site was conducted between 8:00 a.m. and 10:30 a.m. Weather conditions were ideal, with no rain, unlimited visibility and winds of between 1 and 3 kilometers an hour. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *‘ōpe‘ape‘a* as it is known locally, all terrestrial mammals currently found on the Island of O‘ahu are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all terrestrial vertebrate mammalian species detected within the project area.

[38] Table 1 in Appendix A consists of plant checklist compiled from field observations. Included in the list are scientific name, common name, and status (for example, whether native or non-native, naturalized or ornamental) for each species observed during the survey.

Figure 5.7. Typical Vegetation

Typical grassland with shrubs.

Shallow swale of more or less bare soil dominated by ʻilima with buffelgrass encroaching at the edges.
Source: David and Guinther, February 26, 2014.

As shown in Table 5.13, total of 106 individual birds of 18 species, representing 11 separate families, were recorded during station counts. All of the species recorded are alien to the Hawaiian Islands. No avian species detected during the course of this survey are protected or proposed for protection under either the federal or State of Hawaiʻi endangered species statutes.

Avian diversity and densities were both low, though in keeping with the habitats present on the site. Three species, House Finch (*Haemorhous mexicanus*), Common Waxbill (*Estrilda astrild*) and Common Myna (*Acridotheres tristis*) accounted for half of all birds recorded during station counts. The most frequently recorded species was House Finch, which accounted for slightly more than one-fifth of the total number of individual birds recorded during station point counts.

Table 5.13 Avian Species Detected Within the Kahe Photovoltaic Project Site

Common Name	*Scientific Name*	*ST*	*RA*
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Black Francolin	*Francolinus francolinus*	A	0.14
Erckel's Francolin	*Francolinus erckelii*	A	0.29
	COLUMBIFORMES		
	COLUMBIDAE – Pigeons & Doves		
Rock Pigeon	*Columba livia*	**A**	1.29
Spotted Dove	*Streptopelia chinensis*	**A**	0.29
Zebra Dove	*Geopelia striata*	**A**	0.57
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	**A**	2.00
	ZOSTEROPIDAE – White-eyes		
Japanese White-eye	*Zosterops japonicus*	**A**	1.86
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	**A**	0.14
	STURNIDAE – Starlings		
Common Myna	*Acridotheres tristis*	**A**	2.29
	THRAUPIDAE - Tanagers		
Red-crested Cardinal	*Paroaria coronata*	**A**	0.86
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	**A**	0.71
	FRINGILLIDAE – Fringilline and Carduleline Finches & Allies		
	Carduelidae – Carduline Finches		
House Finch	*Haemorhous mexicanus*	**A**	3.43
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	**A**	0.29
Common Name	*Scientific Name*	**ST**	RA
	ESTRILDIDAE – Estrildid Finches		
Common Waxbill	*Estrilda astrild*	**A**	2.71
African Silverbill	*Lonchura cantans*	**A**	0.14
Chestnut Munia	*Lonchura atricapilla*	**A**	0.29
Java Sparrow	*Padda oryzivora*	**A**	0.71
ST= Status			
A= Alien – Introduced to the Hawaiian Islands by humans			
RA= Relative Abundance - Number of birds detected divided by the number of count stations (7)			
Source: David and Guinther, February 26, 2014. (see Appendix A)			

Three terrestrial mammalian species were detected adjacent to the site during the course of this survey. Specifically, tracks, of dog (*Canis familiaris*), small Indian mongoose (*Herpestes auropunctatus*), and cat (*Felis catus*), were seen in the mud on the storm runoff channel located between the site and the existing Kahe Generating Station. No mammals were encountered within the site, including those protected or proposed for protection under either the federal or State of Hawai‘i endangered species programs.

5.5.2 PROBABLE IMPACTS ON BIOTA

5.5.2.1 Effects on Flora

The findings of the reconnaissance level botanical survey were in keeping with the xeric, lowland nature of the site. The property does have a slightly higher presence of native species than might be found on typically more disturbed properties along the leeward coast, but only *ma'o* (*G. tomentosum* or Hawaiian cotton) is of any special interest, as the other natives are quite common. Hawaiian cotton has been considered for listing in the past (USFWS, 1985; described as "vulnerable" in Wagner, Herbst, & Sohmer, 1990). Presently, this native endemic species is not listed under endangered species statutes. Moreover, the majority of cotton plants observed on the property occur on slopes above the area on which PV panels would be erected. In view of this, the proposed project appears unlikely to have any significant effects on flora.

5.5.2.2 Avian and Terrestrial Fauna

All species known to be present on the project site are alien to the Hawaiian Islands. All of the introduced mammalian predators are deleterious to native ecosystems and the native faunal species dependent on them. Moreover, the minimal ground disturbance and other changes that will result from the proposed project do not have the potential to alter the habitat on which these species depend. No Hawaiian hoary bats were detected during the course of this or previous surveys and, given the paucity of documented records of this species on O'ahu and the complete lack of suitable roosting vegetation on the site the chance that any use resources on the subject property are extremely low. Consequently, the proposed project does not have the potential to have a significant adverse effect on fauna.

There are no known nesting colonies of any protected bird species near the project site. The proposed project does not contain any exterior lighting that might attract or disorient fledgling nocturnally seabirds, nor will nighttime construction occur. The panels themselves are low-lying (less than 10 feet above the ground) and do not, therefore, constitute a significant avian collision hazard. The few poles that would be installed to carry the proposed new 46 kV circuit from the proposed substation to the existing switchyard within the Kahe Generating Station complex are slightly higher. However, in the absence of substantial known seabird use of the airspace, these do not constitute a substantial new risk. Hence, collision with manmade structures is not an issue with respect to the proposed project.

5.5.2.3 Critical Habitat

There is no federally delineated Critical Habitat present on the property. Thus the development and operation of the proposed PV project will not result in impacts to federally designated Critical Habitat. There is no equivalent statute under state law.

5.6 NOISE

5.6.1 REGULATORY CONTEXT

Hawai'i Administrative Rules Title 11, Chapter 46, Section 4 (HAR §11-46-4) defines the maximum permissible community sound levels in dBA. These differ according to the kind of land uses that are involved (as defined by the zoning district) and time of day (daytime or nighttime). These limits are shown in Table 5.14 below. Definitions of two technical terms used in this discussion are as follows:

- *A-Weighted Sound Level (dBA).* The sound level, in decibels, read from a standard sound-level meter using the "A-weighted network". The human ear is not equally sensitive in all octave bands.

The A-weighting network discriminates against the lower frequencies according to a relationship approximating the auditory sensitivity of the human ear.

- *Decibel (dB).* This is the unit that is used to measure the volume of a sound.[39] The decibel scale is logarithmic, which means that the combined sound level of 10 sources, each producing 70 dB will be 80 dB, not 700 dB. It also means that reducing the sound level from 100 dB to 97 dB requires a 50 percent reduction in the sound energy, not a 3 percent reduction. Perceptually, a source that is 10 dB louder than another source sounds about twice as loud. Most people find it difficult to perceive a change of less than 3 dB.

The maximum permissible sound levels specified in HAR §11-46-4(b) apply to any excessive noise source emanating from within the specified zoning district. They are as measured at or beyond the property line of the premises from which the noise emanates. Mobile noise sources, such as construction equipment or motor vehicles are not required to meet the 70 dBA noise limit. Instead, construction noise levels above these limits are regulated using a curfew system whereby noisy construction activities are not normally permitted during the nighttime periods, on Sundays, and on holidays. Construction activities (which could typically exceed the limits established for fixed machinery) are normally allowed during the normal daytime work hours on weekdays and on Saturdays using a system involving the issuance of construction noise permit.

Table 5.14 Hawai‘i Administrative Rules §11-46 Noise Limits

Zoning District	*Noise Limit (in dBA)*	
	Daytime (7:00 a.m. to 10:00 p.m.)	*Nighttime (10:00 p.m. to 7:00 a.m.)*
Class A: Areas equivalent to lands zoned residential, conservation, preservation, public space, open 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, country, industrial, or similar type.	70	70
Source: Hawai‘i Administrative Rules §11-46 *Community Noise Control*		

All of Hawaiian Electric’s property in Kahe Valley is zoned I-2 Intensive Industrial, which makes it a Class C area, the least restrictive for the purposes of noise. There are no nearby residential or other noise-sensitive uses near the area that would be affected by the project. Kahe Beach Park, located on the *makai* side of Farrington Highway opposite the site is a public open space. Were it adjacent to Hawaiian Electric’s property rather than separated from it by the relatively noisy roadway, the lower limits associated with Class A categories would apply.

5.6.2 EXISTING SOUND LEVELS

No on-site noise measurements were made during preparation of this document. However, anecdotal observations confirm that there are only two notable sources of noise in the project area. The first is vehicles travelling on Farrington Highway; the second is the equipment at the Kahe Generating

[39] The sound pressure in decibels is equal to twenty times the logarithm to the base ten of the ration of the pressure of the sound measured to a reference pressure of 20 micropascals, or 0.0002 dynes per square centimeter.

Station. Because the major noise sources at the KGS are situated away from the area where the PV facilities would be constructed, highway noise is by far the greater contributor to background noise there.

While no site-specific data were collected, sound level measurements for two locations in situations comparable to those on the KUSPP site that are reported in the *Environmental Noise Assessment Report for the University of Hawai‘i West O‘ahu Campus* (D.L. Adams Associates, Ltd., June 2006) provide a reasonable approximation for those likely to be present on the project site. One of them (Station L1) is in an open field on the site; the other (Station L2) is approximately 100 feet from the edge of Farrington Highway. At Station L1 daytime L_{eq} ranged from 42 to 57 dBA and nighttime L_{eq} ranged from 34 to 55 dBA. Station L2 daytime L_{eq} ranged from 48 to 63 dBA and nighttime L_{eq} ranged from 39 to 59 dBA. The dominant noise sources at L1 were wind, birds, and aircraft. The dominant noise source at L2 was vehicular traffic from Farrington Highway and H-1.

5.6.3 PROBABLE NOISE IMPACTS

5.6.3.1 Construction Noise

Grubbing, grading, and construction activities will involve the use of excavators, bulldozers, and other heavy equipment. Construction will also entail the use of trucks with backup alarms and vibratory pile drivers used to install the PV panel supports. As depicted in Table 5.15, some of the equipment is inherently noisy. Because of the very limited amount of earthmoving that will be required, vibratory pile drivers (which generate noise of up to 95 dBA at a distance of 50 feet) will be the most noticeable source of construction noise.

Noise from the operation of construction equipment is expected to exceed the property line noise limits during installation of at least some of supports on which the PV panels will be mounted. Because of this, the contractor is expected to seek a construction noise permit in accordance with the provisions of HAR 11-46. However, as the nearest residence is well over a half mile from the closest point on the project site and intervening ridges block the direct noise path, construction noise will be so attenuated by the time it reaches noise-sensitive areas that it will be well below 50 dBA. The implementation of State DOH construction noise permit procedures will require that noisy construction activities do not occur during the nighttime, Sundays, and holidays. These permit procedures, which are routinely applied to noisy construction activities, are intended to minimize adverse noise impacts at residences.

Construction worker vehicles traveling to and from the project site will increase peak traffic volumes on Farrington Highway. The addition of these to the baseline traffic volumes (nearly 3,000 vehicles per hour during peak commute period) will increase total traffic noise levels by no more than a few tenths of a decibel, which will be very difficult to measure. This means that KUSPP-related construction will not cause a significant change in highway noise.

5.6.3.2 Operations and Maintenance

Once constructed, the photovoltaic panels, mounting racks, pull boxes, and electrical interconnections will make little or no noise. The only noise emission from the photovoltaic equipment and associated electronics would be from the cooling fans inside each of the inverters, and a low hum from the transformers located at each equipment pad. Tests of inverters at other locations indicate that the inverter produces 65.4 dBA at a distance of approximately 10 feet (3 m).[40] This will not be audible off the project site.

[40] Tests were conducted by Advanced Energy, Inc. per Acoustic Emissions Standard IEC/EN 61010-1.

Table 5.15 Construction Equipment Noise Emissions Levels

Equipment	*Typical Noise Levels (dBA) 50 ft., U.S. Dept. of Trans. Study (1979)*	*Average Noise Level (dBA) 50 ft., CA/T Project Study (1994)*	*Typical Noise Level (dBA) 50 ft., U.S. Dept. of Trans. Study (1995)*	*Lmax Noise (dBA) 50 ft., CA/T Project Spec. 721.560*
Air Compressor	--	85	81	80
Backhoe	84	83	80	80
Chain Saw	--	--	--	85
Compactor	82	--	82	80
Compressor	82	--	82	80
Concrete Truck	--	81	--	85
Concrete Mixer	--	--	85	85
Concrete Pump	--	--	85	85
Concrete Vibrator	--	--	76	80
Crane, Derrick	86	87	88	85
Crane, Mobile	--	87	83	85
Dozer	88	84	85	85
Drill Rig	--	88	--	85
Dump Truck	--	84	--	84
Excavator	--	--	--	85
Generator	84	78	81	82
Gradall	--	86	--	85
Hoe Ram	--	85	--	90
Impact Wrench	--	--	85	85
Jackhammer[1]	--	89	88	85
Loader	87	86	85	80
Paver	80	--	89	85
Pile Driver, Impact	--	101	101	95
Pile Driver, Sonic	--	--	96	95
Pump	80	--	85	77
Rock Drill	--	--	98	85
Roller	--	--	74	80
Scraper	89	--	89	85
Slurry Machine	--	91	--	82
Slurry Plant	--	--	--	78
Truck	89	85	88	84
Vacuum Excavator	--	--	--	85

Note 1: There are 82 dBA @ 7 meter rated jackhammers (90 lbs. class) available. This would be equivalent to 74 dBA @ 50 ft. These are silenced with molded intricate muffler tools.

Source: http://ops.fhwa.dot.gov/wz/workshops/accessible/Schexnayder_paper.htm

Transformers emit a continuous 120 Hz hum with harmonics when connected to 60 Hz circuits. The fundamental frequency is the "hum" that annoys people primarily because of its continuous nature. The sound emissions from the step-up transformers that will serve each of the twelve 1-Megawatt PV modules will vary depending on the exact model selected, but the sound emissions will comply with the NEMA TR-1 Sound Emission Standard for Transformers, [41] which means they will be no more than 58 and 67 dB(A) at 2 meters. This sound will not be audible off the project site.

Motor vehicles will occasionally travel the on-site access roads and access the photovoltaic panels as part of regular operations and maintenance activities. Given the presence of Farrington Highway only a short distance away, the occasional presence of a few vehicles is not significant. The occasional operation of the type or equipment called for in the VMG will not involve activities in excess of the standards or that might otherwise interfere with uses of the surrounding land.

5.7 ARCHAEOLOGICAL, HISTORIC, AND CULTURAL RESOURCES

In 2011, Hawaiian Electric commissioned Cultural Surveys Hawaiʻi, Inc. (CSH) to conduct an archaeological inventory survey (AIS) for portions of Kahe Valley that had not previously been studied in detail. The resulting report, *Archaeological Inventory Survey Report For Portions of Kahe Valley, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu Island TMK: [1] 9-2-003:027 por.* (Yucha & Hammet, 2012) the SHPD approved on October 8, 2012,[42] forms the basis for the discussion of potential impacts to archaeological resources contained in this report. CSH also completed a *Cultural Impact Assessment Cultural Impact Assessment for the Kahe Valley Photovoltaic Project, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu TMK: [1] 9-2-003:027 (por.)* in February 2014 to assess potential impacts to ongoing cultural properties and practices which might result from the proposed project. The findings of this CIA are summarized in Section 5.7.2.

5.7.1 EXISTING ARCHAEOLOGICAL AND HISTORIC RESOURCES

The Kahe Generating Station is situated within the *ahupuaʻa* of Honouliuli, the largest traditional *ahupuaʻa* land unit on the island of Oʻahu. Honouliuli includes nearly all the land from the western boundary of Pearl Harbor (West Loch or Kaihuopalaʻai) westward around the southwest corner of Oʻahu to the ʻEwa/Waiʻanae District Boundary. The only portion of this region that is not in Honouliuli is the western side of the entrance to Pearl Harbor (the ʻEwa Beach/Iroquois Point area), which is in the *ahupuaʻa* of Puʻuloa. Honouliuli *ahupuaʻa* includes approximately 12 miles of open coastline from Oneʻula westward to the boundary known as Pili o Kahe.

Neither Thrum (1906), McAllister (1933), nor Sterling and Summers (1978) indicate any lore on the Kahe area or its place names and state that the area northwest of Kahe Point and into Nānākuli seems to be devoid of almost any archaeological remains. The paucity of material distinguishes it from the area south of Kahe, in the West Beach area and in Waimānalo and Makaīwa Gulches, where archaeological studies have located a number of both prehistoric and post-contact sites. The most recent Waimānalo Gulch investigation was conducted for the expansion of the sanitary landfill (Hammatt and Shideler 1999). No archaeological sites were located within the landfill expansion area. However, two sites – the Battery Arizona bunker complex and a modern "shrine" site – were observed along the northern ridge which separates Waimānalo Gulch from the Kahe Generating Station property, south of the current project area. The stones from that site were understood to have been previously relocated from the central portion of Waimānalo Gulch circa 1988.

[41] NEMA is the National Electrical Manufacturers Association.

[42] Letter dated October 8, 2012, from Theresa K. Donham, Archaeology Chief Branch, to Mr. David Shideler, Cultural Surveys Hawaiʻi, Inc, Log No. 2012.2667, DOC No. 1210SL13.

The Kahe Generating Station and surrounding areas have been the subject of extensive archaeological reconnaissance. The most recent of these is an archaeological inventory survey (AIS) of two adjacent survey areas (termed Survey Area A and Survey Area B - see Figure 5.8), within TMK 9-2-003:027 (Yucha and Hammatt, 2014). Survey Area A (approximately 72 acres) includes the majority of undeveloped land below +120-foot msl elevation. Survey Area B (approximately 88 acres) includes the majority of undeveloped land between +120 feet and +200 feet msl. The AIS involved: (*i*) a 100 percent coverage pedestrian inspection of both survey areas at 5 to 10 meter intervals; (*ii*) subsurface testing of selected features;[43] and (*iii*) climber inspection of cliff faces.[44] The work was conducted in accordance with the guidelines contained in HAR §13-13-282.

Background research included a review of previous archaeological studies on file at the SHPD/DLNR library and of historical 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 Archives of the Bishop Museum. In addition, researchers studied historic photographs at the Hawai‘i State Archives and the Archives of the Bishop Museum, historic maps at the Hawai‘i State Land Survey Division, and historic maps and photographs at the CSH library. This research provided the environmental, cultural, historic, and archaeological background for the project area. It also helped the researchers formulate a predictive model regarding the expected types and locations of historic properties that may be located in the project area.

The AIS report identified ten historic and archaeological properties within the Kahe Generating Station parcel. Of those ten, only three are within the KUSPP project site (see Table 5.16) and the following discussion of sites, interviews, and mitigation are limited to those.[45]

Table 5.16 Known Historic Properties within the Project Site

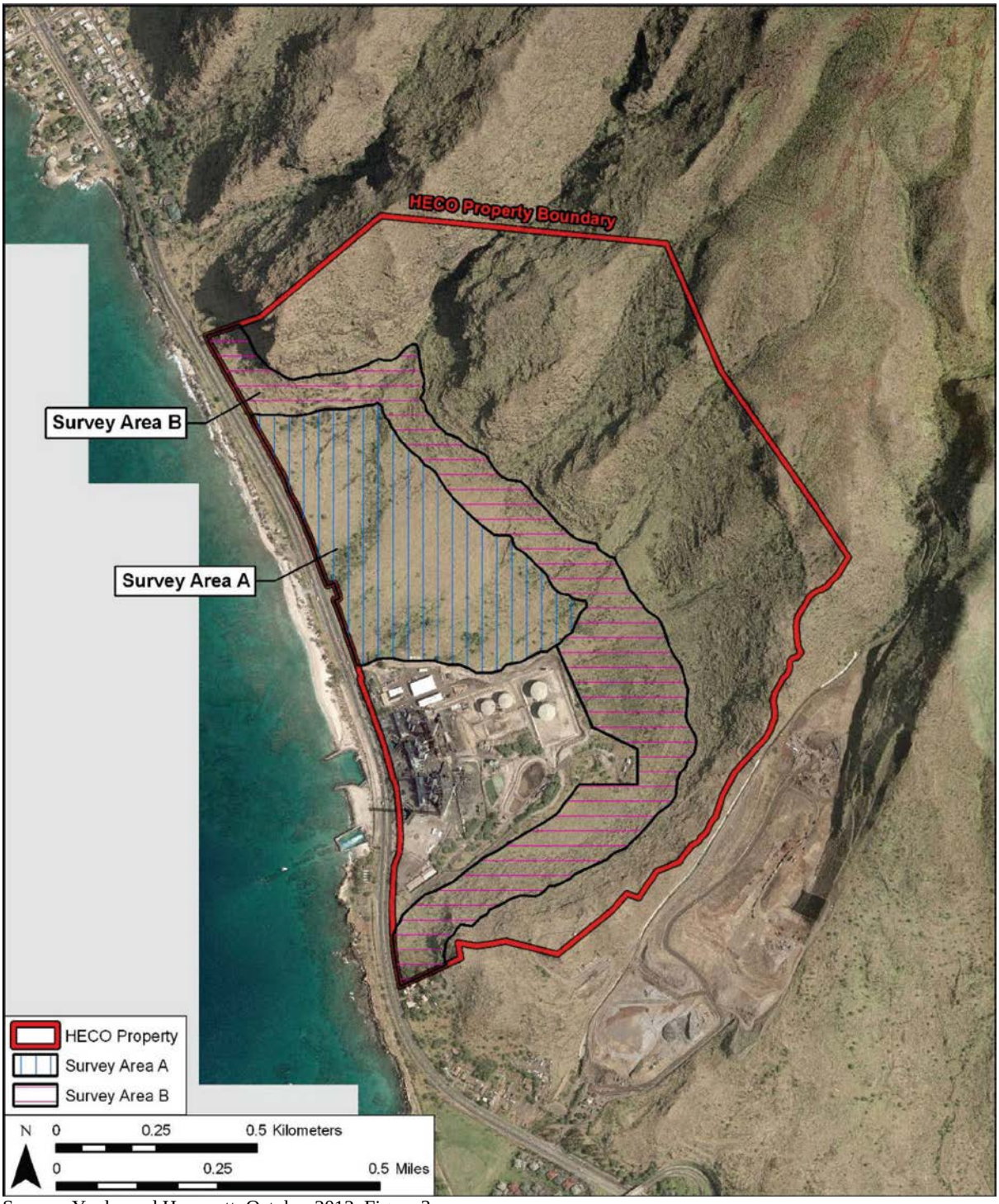
State Inventory of Historic Places (SIHP) Number	*Site Description*	*Recommendation*
#50-80-12-6647	A pre-contact to historic era agricultural and/or ceremonial complex consisting of three features.	Develop preservation plan.
#50-80-12-6648	A historic habitation/infrastructure complex consisting of three features.	No further preservation work.
#50-80-12-6650	A pre-contact agricultural complex consisting of eight features.	No further preservation work.
Source: Yucha and Hammatt (October 2012)		

[43] Subsurface testing consisted of the partial excavation, by hand, of selected surface archaeological features located during the pedestrian survey. All excavated material was screened to separate out the soil matrix. Each test excavation was documented with a scale section profile, photographs, and sediment descriptions.

[44] The cliff faces were inspected because of a disassociated human skeletal element that had been found at the base of the cliff. Climbers completed a thorough visual inspection of each cavity, terrace, or cave within the overlying vicinity of the disassociated human skeletal element, documenting their work with photographs and field notes.

[45] SIHP# -7139, SIHP# -7140A, SIHP# -7140B, SIHP# -7141, and SIHP# -7142 are to the north of Limaloa Gulch and are, therefore, outside the project area. SIHP# -6649 lies to the west of the project boundary, and SIHP# -7138 is situated to the east of the area where work would be conducted.

Figure 5.8 Archaeological Inventory Survey Areas



Source: Yucha and Hammatt, October 2012, Figure 3

SIHP No. 50-80-12-6647. This site has been identified as an agricultural or ceremonial feature dating from the pre- and early post-contact period. It is a complex of three features, A through C, located within Keone‘ō‘io Gulch, along the southern boundary of Survey Area A (see Figure 5.8).

- Feature A is a stacked limestone wall; it appears to be well-constructed and in excellent condition, with no obvious signs of collapse. The limestone boulders are stacked three courses high on the upslope side and five courses high on the downslope side. Feature A is believed to be a product of ranching activities in the historic era.
- Feature B is a possible *ko‘a*, or fishing shrine, located at the base of the gulch, adjacent to the southern gulch face. The shrine is constructed using both upright and stacked limestone boulders and adjacent to the exposed limestone bedrock along the gulch face creating an inner level platform. Two pieces of branch coral and several water rounded coral cobles were observed within the interior cobble fill. The shrine, which is in fair condition, is a pre- and/or early post-contact structure of possible ceremonial function.
- Feature C is a small boulder terrace located at the base of Keone‘ō‘io Gulch, with a retaining wall stacked three to four courses high; this feature is also believed to be from the late pre- or early post-contact period, with an agricultural function.

Site 50-80-12-6647 is the only site in the project area for which the development of a preservation plan (see Section 5.7.1.2 below) is recommended.

SIHP No. 50-80-12-6648. This site contains three features (A through C) located in the central portion of Survey Area A.

- Feature A is a poured concrete foundation with a possible doorway opening in the southwestern side of the foundation.
- Feature B is a group of structure ruins composed of dressed basalt rocks, concrete, and a section of yellow bricks.
- Feature C consists of a series of brick and mortar wall ruins in a U-shaped arrangement.

This site has been interpreted as the remnants of a poured foundation of what may have been a single-family residence or infrastructure related to ranching or agriculture. No further preservation work is recommended for this site.

SIHP No. 50-80-12-6650. The final site is a complex of eight predominantly limestone boulder and cobble mound and platform features (A through H) dating from the pre- and early post-contact period located atop the emerged limestone reef plain. Sample screening has shown the presence of shell and cartilaginous midden located at least one of the features, but no other cultural material has been observed. All of these platform, paving, and mound structures are of likely traditional Hawaiian construction and are presumed to have served an agricultural function. CSH performed subsurface testing at four of the features to assess their content, including human burials, and function, as well as to possibly obtain datable materials for later radiocarbon dating. No artifacts or diagnostic material were found.

5.7.1.1 Archaeological Inventory Survey Interviews

Following the completion of its field work for the AIS (on June 13, 2011), CSH sent consultation letters seeking archaeological, cultural, and historic information about the survey areas, as well as past land use information for the vicinity to the individuals identified in Table 5.17 below. It was able to obtain information from the majority of these individuals, and in August 2011, CSH conducted in-depth interviews with two of them, Glen Kila and Nettie Tiffany. During the interviews, the interviewees were asked about past land use within the two survey areas and their vicinity. Historic maps and aerial photographs were used to further the discussion. A further

interview with Eric Enos was conducted on August 24, 2011 which provided additional information regarding interpretation of several sites, including SIHP No. 50-80-12-6647.

Table 5.17 Parties Consulted in Preparation of the AIS

Name	*Organization*	*Position*	*Provided Input*
William Ailā	Department of Land and Natural Resources, State of Hawai‘i Hui Mālama I Nā Kūpuna ‘O Hawai‘i Nei	Director, DLNR	No
Eric Enos	The Cultural Learning Center at Ka‘ala	Director, Educator, and Cultural Practitioner	Yes
Josiah “Black” Ho‘ohuli	Wai‘anae Coast Neighborhood Board No. 24	Board Member	Yes
Kamaki Kanahele	Wai‘anae Coast Comprehensive Health Center – Native Hawaiian Traditional Healing Center	Co-founder and *Lā‘au Lapa‘au* Practitioner	No
Nettie Tiffany	Kahu of Lanikuhonua at Ko‘olina Formerly of O‘ahu Island Burial Council	Member	Yes
Shad Kane	‘Ahahui Siwila Hawai'i O Kapolei – Hawaiian Civic Club	Member	Yes
Glen Kila	Koa Mana Koa ‘Ike	Member	Yes
Douglas “McD” Philpotts	Hawaiian Cultural Practitioner, Campbell descendant, Makakilo kama‘āina	Hawaiian Cultural Practitioner, Campbell Family Descendent, & Makakilo Kama‘āina.	Yes
Note: CSH mailed the consultation letters on June 13, 2011.			
Source: Yucha and Hammatt (October 2012), Section 2.3			

5.7.1.2 Preservation Plan for Site No. 50-80-12-6647

In November, 2013 CSH issued a separate *Preservation Plan for SIHP No. 50-80-12-6647, SIHP No.50-80-12-7137, SIHP No. 50-80-12-7139, and SIHP No. 50-80-12-7140 at Kahe Valley, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu TMK: [1] 9-2-003:027 por.* report. Most of the sites treated in the *Preservation Plan* are outside the KUSPP site; the exception to this is SIHP No. 50-80-12-6647.

Elements of the *Preservation Plan* related to this site are summarized in Table 5.18 and discussed below. They cover a series of interim (i.e., for the construction period) and long-term preservation measures that Hawaiian Electric will undertake at this site, as well as other sites on the Hawaiian Electric property. The SHPD has reviewed and approved an archaeological monitoring plan that includes the area that would be disturbed during construction of the KUSPP.[46]

5.7.2 EXISTING CULTURAL RESOURCES AND PRACTICES

The *Cultural Impact Assessment Cultural Impact Assessment for the Kahe Valley Photovoltaic Project* was prepared by CSH to comply with the State of Hawai‘i’s environmental review process under Hawai‘i Revised Statutes Chapter 343, which requires consideration of the proposed project’s potential effect on cultural beliefs, practices, and resources. The Cultural Impact Assessment (CIA)

[46] Letter dated February 25, 2014, from Susan A. Lebo, O‘ahu Lead Archaeologist, to Mr. David W. Shideler Cultural Surveys Hawai‘i, Inc.; Log No: 2014.00793, stating that the AMP (Hammatt and Shideler 2012) and the Addendum AMP (Hammatt and Shideler 2014) together contain the information required in Hawai‘i Administrative Rules (HAR) §13-279-4(a)(1 through 8) regarding monitoring plans.

addresses this requirement by presenting the results of documentary research and cultural consultation, to assist project planners and agency regulators in assessing the potential impacts of the proposed action on ongoing cultural resources and practices. The CIA was composed according to the Office of Environmental Quality Control's (OEQC) *Guidelines for Assessing Cultural Impacts.* This section of the EA is based on that CIA; the full text of the CIA is included in Appendix C.

5.7.2.1 Summary of Background CIA Research

The project area is located along the western coast of the Honouliuli *ahupuaʻa*, the largest and westernmost *ahupuaʻa* in the ʻEwa *moku*, or district. Honouliuli translates literally as "dark water," "dark bay," or "blue harbor." It is named for the waters of Pearl Harbor, which marks the eastern boundary of the *ahupuaʻa*. Honouliuli appears in many traditional stories, known as *moʻolelo*, *ʻōlelo noʻeau* (traditional sayings), *ʻoli* or chants, and possesses many *wahi pana*, or storied places. This rich oral history speaks to the importance of the Honouliuli *ahupuaʻa* in times past, with its abundance of natural resources and thriving Native Hawaiian population.

Many *moʻolelo* took place along the plains of Honouliuli, such as:

- The story of the demigod Kamapuaʻa and his grandmother;
- Pele's sister Hiʻiaka, on the plains of Kaupeʻa and Keahumoa;
- The wandering ghosts of Kaupeʻa, Puʻuokapolei, and Kanēhili;
- The demigod Maui and his stolen wife;
- The *pōhaku* of Pukaua;
- The hero Pikoi and his arrow-shooting skills;
- The warrior Palila and his supernatural war club; and
- The hero Nāmakaokapaoʻo.

Table 5.18 Proposed Preservation Measures for Site 55-80-12-6647

Phase	*Preservation Measure*
Interim	Prior to construction/development within the project area, the location of individual archaeological features will be marked by an archaeologist using flagging tape. The historic property boundaries will then be located by a licensed surveyor and indicated on all plans. A buffer of 20′ from the outer boundary of the site—known as the "preserve buffer"—will be indicated on all plans. The preserve buffer for this site will extend from the historic property boundary of each site.
Interim	A continuous barrier will be installed along each preserve buffer using orange web event fencing or similar highly-visible material under the supervision of an archaeologist. The continuous barriers will act as exclusion zones for heavy machinery during all construction activity, and will remain in place throughout the construction period.
Interim	In areas with little or no planned project construction, passive preservation is recommended. Demarcation will exist on paper only, and will consist exclusively of the preservation easements recorded by a certified land surveyor.
Interim	No land-disturbing or stockpiling activities will be allowed within the preserve buffer areas. A preconstruction meeting between project construction personnel and the monitoring archaeologist will be held to communicate the location and significance of the site.
Long-term	The long-term buffer zone will include an area extending 20′ in radius from the perimeter of the historic property. The long-term buffers are identical to the interim preserve buffers.
Long-term	A physical long-term buffer will be installed around the site using permanent fencing and/or boulder barriers. Any construction activity within this area is prohibited. The style and construction of this permanent barrier should be developed in consultation with consulted community members.
Long-term	If vegetation removal from the site is necessary, all clearing on and around the features will be conducted by hand, using hand-held tools, under the supervision of an archaeologist.
Long-term	Wheeled vehicles will not be used inside the buffer zones.
Long-term	No stabilization measures are anticipated in the foreseeable future for this site. If future stabilization is required it should be conducted in consultation with SHPD
Long-term	No landscaping is planned for the site. If landscaping is to occur in the future, it should use *ti*, *laua'e*, or other native dryland species that require minimal irrigation and can act as a buffer between the site and development.
Long-term	No hardscape construction, pathways, benches, or lighting will be built within the preserve buffer. Any future plans will be made in consultation with SHPD.
Long-term	Access to the archaeological site will be restricted to individuals or small groups for legitimate cultural practices, for education/research purposes, and to SHPD staff with prior written consent of Hawaiian Electric, Inc..
Long-term	Periodic removal of any buildup of litter will be conducted by hand.
Long-term	To prevent unauthorized access and possible vandalism, small signs may be placed on the perimeter reading: *PRESERVE HAWAII'S PAST FOR THE FUTURE.* *PLEASE DO NOT DISTURB THIS ARCHAEOLOGICAL SITE.* *Damage to this Historic Site is Punishable by Fine or Imprisonment* *Under §6E-11, Hawai'i Revised Statutes* *To report violations contact the State Historic Preservation Division (808) 692-8015.*
Long-term	Noncompliance with the provisions and procedures of this preservation plan may result in a directive not to proceed with construction in the project area, a denial of SHPD's written concurrence, and penalties HRS §6e-11, HAR §13-275, 13-278, 13-281, 13-282, 13-284, and other applicable laws.
Source: Yucha and Hammatt (November 2013), Sections 5.1 and 5.2	

Stories and sayings associated with the natural resources of Honouliuli include:

- The many shark stories of Puʻuloa;
- The guardian shark of Kaʻahupāhau;
- The *pipi* and *ʻānae-holo* of Puʻuloa;
- The *kāī-koi kalo* of ʻEwa;
- The fishponds of Puʻuloa involving the gods Kane and Kū;
- Kaihupalaʻai and Ihuopalaʻai;
- The planting of the first breadfruit from Kahiki; and
- The *ōlohe* people who were humans with dog tails who dwelled in the caves of Honouliuli.

Many of these *moʻolelo* and *ʻōlelo noʻeau* are presented in greater detail in the CIA report, included in Appendix C.

Early historical accounts and the presence of permanent habitation sites, fishing shrines (*koʻa*) and subsistence-related features along the coast suggest that portions of ʻEwa were widely inhabited and home to many *aliʻi* (chiefs and royalty) during the pre-contact period. Successful coastal settlement was likely supported by the abundance of marine resources, particularly the lochs of Pearl Harbor. Also present were irrigated lowlands suitable for wetland taro, banana, and sugarcane cultivation seen nowhere else on Oʻahu, as well as the nearby presence of forest resources along the slopes of the Waiʻanae Range, which could serve as a source of alternative subsistence in times of famine. In contrast with this, accounts of early missionaries in 1823 and 1824 suggest that the land further inland from the ʻEwa coastline were largely uncultivated and habitation was scarce.

Honouliuli was the most populous *ahupuaʻa* on Oʻahu at the time of contact with European explorers, with the majority of the population focused around Pearl Harbor. The inland area of ʻEwa was likely abandoned by the mid-19th century due to the decline in population that resulted from the introduction of previously unknown diseases and consolidation of the remaining people in the towns of Honouliuli, Waipahu, and Waiawa. Today, Honouliuli is once again among the fastest growing *ahupuaʻa* on the island.

A *heiau* (altar and/or associated shrine) was once located on Puʻuokapolei, a hill in Honouliuli thought to have been named after "beloved Kapo," the sisters of the volcano goddess, Pele. By the time McAllister surveyed Oʻahu in the early 1930s, the *heiau* had been destroyed and its stones used elsewhere. Puʻuokapolei was used as a site for astronomical observations and it 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.

ʻEwa was known for the many limestone caves formed in the uplifted coral called the ʻEwa Karst. Some of these caves, known as *ka-lua-ōlohe*, were inhabited by the *ōlohe*, a type of people that looked like humans but had tails like dogs. 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, lived in Līhuʻe in upland Honouliuli, and was said to be an *ōlohe*.

Several historic trails traversed ʻEwa, including the lateral trail that connected Honolulu to the Waiʻanae district, and likely passed just *makai* side of the project site. The trail is described by native historian John Papa ʻĪʻī as dipping down, "toward the coast towards…Puʻuokapolei [and] crossed into Waiʻanae at the coast near Pili o Kahe."

The boundaries of Honouliuli were often contested with the people of Waiʻanae. However, the boundaries of those two districts are said to be marked by a stone known as Pili-o-Kahe, which translates to "clinging to flow" and refers to the female, or Waiʻanae side of the hill. Many battles took place in ʻEwa, including in Honouliuli *ahupuaʻa*, dating back to at least the twelfth century.

Many *ali‘i* came from Ewa and chiefs from Līhu‘e, Wahiawā, and Halemano were called *lō‘āli‘i* (from whom a guaranteed chief might be obtained, *loa‘a*). Samuel M. Kamakau (1991) records that these *lō‘āli‘i* were regarded as being, “like gods, unseen, resembling men”. The supremacy of the ‘Ewa chiefs came to an end with the invasion of O‘ahu by the forces of Kamehameha I, culminating in the Battle of Nu‘uanu.

In 1795, Kamehameha I gave the Honouliuli *ahupua‘a* to Kalanimōkū, an early supporter of his. It was subsequently inherited by Kalanimōkū’s sister, Wahinepi‘o. During the Mahele of 1848, 96 land claims were made and 72 claims were awarded to commoners. Claims ranged in size from 0.1 to 5.5 acres and almost all of them were adjacent to Honouliuli Gulch and contained fishponds and irrigated taro patches, or *lo‘i*. In 1855, the Land Commission awarded all 43,250 acres of unclaimed land in Honouliuli to Miriam Ke‘ahikuni Kekau‘ōnohi, a granddaughter of Kamehameha I and by Kalanimōkū’s heir.

The property passed through a series of heirs until 1877, when James Campbell purchased Honouliuli *ahupua‘a* (except the *‘ili* of Pu‘uloa) for $95,000 and started the Honouliuli Ranch, which was used almost exclusively for cattle. Cattle ranching continued into modern times, and Honouliuli Ranch was considered the fattening area for the other ranches in the region. Though Honouliuli Ranch was not in operation until the late 1870s, a longhorn cattle ranch was reported to exist in nearby Wai‘anae as early as 1840.

Grazing ranch animals and the logging of the sandalwood forests in the upland forests disturbed the ecosystem of the ‘Ewa plain, allowing exotic vegetation to thrive, further changing the landscape. Rice cultivation began in Honouliuli around the 1880s, and by 1885 200 acres of rice had replaced much of the former taro lands in the lowland areas surrounding Pearl Harbor. The ancient *kalo lo‘i*—irrigated terraced patches of taro—and *‘auwai*, the traditional irrigation ditches, were modified and expanded to support rice cultivation, a process which was dominated by the Chinese. By the early 20th century, rice farming declined and was succeeded by sugar. Sisal, a plant used to make fibers for rope and other material, was also experimented with between 1898 and the 1920s, mainly on the coastal plain of Honouliuli in Kanēhili.

Sugarcane became a dominant industry in Hawai‘i during the second half of the 1800s. At first it expanded slowly, but the success in 1879 of the first artesian well drilled in ‘Ewa opened great irrigation possibilities. Three sugar companies were established in the district, including the Ewa Plantation Company (EPC), which was located in Honouliuli. The EPC started in 1890 and by the 1930s, it encompassed much of the eastern half of the *ahupua‘a*. EPC was once termed the “richest sugar plantation in the world”. The Oahu Sugar Company took over the EPC in 1970 and continued operations until 1995. Plantation villages to house a growing immigrant labor force developed on Honouliuli but by the 1930s and 40s, the Second World War siphoned off much of the plantation labor force.

The Oahu Railway and Land Company (OR&L) extended a rail line from Honolulu to Pearl City in 1890, and on to Wai‘anae in 1895, eventually running across the center of the ‘Ewa Plain. To attract business to the new railroad system, much land in Honouliuli was subleased to the sugar plantations. The U.S. Army also used the sugarcane rail system to haul ammunition, and the Navy took over a section of the OR&L track for its own use. After the Second World War, most of the more than 150 miles of track were pried up and the locomotives were sold off to businesses on the American mainland; most of the railcars were simply scrapped.

Though Pearl Harbor is located east of the project area, military development on Pearl Harbor and the events of World War II significantly changed the history of Honouliuli and of Hawai‘i at large, beginning with the Reciprocity Treaty of 1875. Since then, the American military has acquired much of coastal ‘Ewa for its naval and air force bases, and developed the surrounding areas of ‘Ewa with infrastructure to support its operation. By 1943, the military attracted more than 24,000 people who

worked at Pearl Harbor and naval housing areas had grown large enough to be considered separate cities. Barracks and temporary housing for workers were built for miles between Pearl Harbor and the outskirts of Honolulu.

Following the Japanese bombing of Pearl Harbor on December 7, 1941, the Army began to develop a coastal defense battery at Kahe Point to accommodate one of the two 14″ naval gun turrets that was salvaged from the wreck of the battleship *USS Arizona*. While the guns themselves were put in place, the battery was never completed and the complex was dismantled during the years following the war.

5.7.2.2 Results of Community Consultation During Preparation of the CIA

As part of the Cultural Impact Assessment process, an effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of or concerns about traditional cultural practices related to the project area. This effort was made by letter, email, telephone, and in-person contacts and was in addition to the contacts that had been made in support of the archaeological inventory survey (see Table 5.17). The initial outreach effort began on October 30, 2013 and community consultation was concluded in February 2014. In the majority of cases, a letter, map, and an aerial photograph of the project area were mailed. In most cases, several attempts were made to contact the individuals, organizations, and agencies listed. Finally, during design of the facility, the layout of the panels has shifted somewhat since the original cultural consultation. CSH is in the process of re-contacting key cultural informants to ensure that this change does not affect the conclusions of the CIA.

The results of the CIA community consultation process are summarized in Table 5.19, below. Written statements from organizations, agencies, and community members are presented in the CIA which is reproduced in Appendix C. CSH met with and interviewed Mr. Glen Kila and Mr. Christopher Oliveira on November 7, 2013, at the Kahe Valley project area following a site visit to inspect archaeological features throughout the property. Both describe themselves as *kupukaʻāina*—lineal descendants of the aboriginal families of Waiʻanae, from the first settlers. Together, they run the Marae Haʻa Koa cultural learning center that their *kūpuna* had established in Waiʻanae centuries ago. They shared with CSH their *manaʻo* (knowledge) regarding the project area. CSH also met with Mr. Eric Enos at Kaʻala Farms in Waiʻanae, where he is executive director, on November 8, 2013; he shared his *manaʻo* about the project area at that time. Mr. Enos has spent his whole life in Makaha since his parents moved there from Kalihi when he was a child.

According to Mr. Kila and Mr. Oliveira, the project area was traditionally part of Waiʻanae *moku* when Oʻahu originally had three *moku* before political boundaries were changed in 1909. During that time, the Waiʻanae district was composed of two sub-districts, Waiʻanae Makai and Waiʻanae Uka. The project area was part of Waiʻanae Makai, which included the coastal area encompassing Nānākuli, Waiʻanae, Lualualei, Makaha, all the way to Kaʻena Point. Waiʻanae Uka included portions of Waiʻanae, Wahiawa, and parts of existing Honouliuli; thus, the project area has been tied to Waiʻanae throughout the historic era.

Mr. Kila explained that, while part of Kahe, the project area has long been referred to as Koʻolina as well, illustrating the close ties the areas has long held to Honouliuli to the east. He explained that Honouliuli is one of the largest ahupuaʻa on the island of Oʻahu, but that Honouliuli as a place name generally refers to the area in the vicinity of Pearl Harbor, with areas further west having their own monikers. The coastal area fronting the project site is also known as Keanaʻōʻio, the caves of the *ʻōʻio* (*Albula vulpes*, or bonefish) which Mr. Oliveira said is common to the area. This contrasts with the place name of the gulch on the project site, Keoneʻōʻio, "the sands of the ʻōʻio", which appears on the USGS map of the area. Mr. Oliveira speculates that Keoneʻōʻio may refer to the larger coastal area in the vicinity of the project, and Keanaʻōʻio refers more specifically to the coast immediately fronting the project site.

Table 5.19 Community Consultation for the Cultural Impact Assessment

Name	*Affiliation/Background*	*Comments*
Aila, William	Cultural Practitioner Chairperson, DLNR	CSH mailed letter and figures mailed October 30, 2013.
Alakaʻi, Robert	Cultural Practitioner	CSH mailed letter and figures mailed November 5, 2013.
Amaral, Annelle	Member, ʻAhahui Siwila Hawaiʻi O Kapolei Civic Club	CSH mailed letter and figures mailed October 30, 2013.
Awana, Karen	House District 43 Rep.	CSH mailed letters and figure October 30, 2013.
Ayau, Halealoha	Hui Mālama i Nā Kūpuna ʻO Hawaiʻi Nei	CSH emailed letter and figures 6 November, 2013
Cayan, Phyllis "Coochie"	Hui Kakoʻo	CSH emailed letter and figures 6 November, 2013
Cope, Auntie Aggie Kalanihookaha	Founder, Waiʻanae Coast	CSH mailed letter and figures 30 October, 2013
Crabbe, Dr. Kamanaʻopono	CEO, Office of Hawaiian Affairs	CSH mailed letter and figures 30 October, 2013
Eaton, Arlene	Kūpuna, Hale O Naʻauao	CSH mailed letter and figures 30 October 2013; letter was returned 4 November 2013
Enos, Eric	Cultural Practitioner; Director, Kaʻala Farm	CSH emailed letter and figures to Mr. Enos October 25, 2013. CSH emailed Mr. Enos November 5, 2013 to set up an interview on November 8, 2013. Mr. Enos responded on the same day and organized an interview for November 8, 2013 at Kaʻala Farms. Mr. Enos was interviewed November 8, 2013. Mr. Enos sent CSH an email November 10, 2013 giving thanks for meeting and also sent along an *ʻoli awa*. CSH responded via email and thanked Mr. Enos. Mr. Enos approved his interview 25 January 2014.
Greenwood, Alice Auntie	Nani ʻO Waianae LCC-Waiʻanae	CSH mailed letter and figures October 30, 2013; letter was returned 4 November 2013.
Hoʻohuli, Josiah "Black"	Cultural Practitioner; Vice President, Auamo I Na Alakaʻi (AINA)	CSH mailed letter and figures October 30, 2013
Jordan, Georgette "Jo"	House District 44 Representative	CSH emailed letter and figures November 6, 2013
Kanahele, Kamaki	DHHL Nānākuli Homesteads, State Council of Hawaiian Homestead Associations	CSH mailed letter and figures October 30, 2013
Kane, Shad	Member, Oʻahu Island Burial Council	CSH emailed letter and figures November 6, 2013
Kila, Glen	Kumu, Program Director of Marae Haʻa Koa (Hawaiian Cultural Center)	CSH emailed Mr. Kila October 25 and 30, and November 5, 2013. Mr. Kila wrote CSH on November 1 and 5, 2013. CSH met with Mr. Kila and his nephew, Mr. Christian Oliveira, on November 7, 2013. Mr. Kila approved his interview summary February 4, 2014.
Maunakea, Ruby	President, Nānāikapono Hawaiian Civic Club	CSH mailed letter and figures October 30, 2013
McKeague, Kawika	Cultural Practitioner, Honouliuli historian and longtime resident.	CSH emailed letter and figures November 6, 2013
Philpotts, Douglas	Descendant of Campbell family	CSH mailed letter and figures October 30, 2013
Rodenhurst, Roda	President, ʻAhahui Siwila Hawaiʻi O Kapolei Hawaiian Civic Club	CSH emailed letter and figures November 6, 2013
Shimabukuro, Maile	Senator, District 21	CSH emailed letter and figures November 6, 2013
Tiffany, Nettie	Kahu, Lanikuhonua	CSH mailed letter and figures October 30, 2013; letter came back November 5, 2013. CSH emailed November 14, 2013
Wong-Kalu, Hinaleimoana K.K.	Chair, Oʻahu Island Burial Council; Director of Culture, Halau Lokahi Public Charter School	CSH mailed letter and figures October 30, 2013
Source: Faʻanunu and Hammat (February 2014)		

Mr. Enos pointed out that Wai‘anae lands were very important to Native Hawaiians in times past because it provided access to deep sea fisheries combined with an abundance of spices such as salt, *limu* (seaweed), and *‘inamona*.[47] He referenced the *mo‘olelo* of Maui, who drew the islands up out of the ocean, and explained that the story was not just about pulling islands out of the sea but an acknowledgement of the deep sea, where the *‘ahi* (*Thunnus albacares*) and *aku* (*Katsuwonus pelamis*)—both valuable resources for the livelihood of the people—come from.

Mr. Kila explained that the project area was not a place of permanent settlement because of the lack of accessible fresh water and fertile soil for cultivation. Instead, it was a place that people passed through on their way to and from ‘Ewa or to the fishing and surfing areas for which these coastal areas are known. According to Mr. Kila and Mr. Oliveira, petroglyphs also indicate places of previous settlement, usually near sources of fresh water, where people could drink and refresh themselves before travelling on. Petroglyphs exist north and south of, but not within, the project area; this reinforces the notion that this was not an area of permanent settlement. Mr. Kila further stated that stick figure petroglyphs dating back 1,000 years are found by Kahe Point near Pili-o-Kahe, by the area known as Black Rocks.

Attracted by the excellent surfing and fishing areas along this section of coastline, Mr. Kila stated that the *ali‘i* like Kakuihewa and Ka‘ihikapu loved and frequented the area. They lived at Lanikuhonua by Ko‘olina because of water at Waimānalo. Mr. Enos added that nearby Līhu‘e (known today as Schofield), at the birthing stones of Kukaniloko, was the birthplace of the O‘ahu *ali‘i*. From Līhu‘e, the ali‘i could look down to the rich lands of Pu‘uloa in Honouliuli and command the *limu*, salt, and large fish from that area.

According to Mr. Kila, there are two types of fishing shrines or *ko‘a*: *kū‘ula ko‘a*, a lava rock or coral fashioned god used to attract fish, and *kane ko‘a*, which were stone structures placed near waterways for fish like *‘o‘opu* (families *Eleotridae*, *Gobiidae*, and *Blennidae*). He believes the structure on the property, identified by archaeologists as a possible fishing shrine, is unlikely because of its location well inland from the ocean, and because its structural composition is uncharacteristic of fishing *ko‘a*. Instead, he speculates that the structure may have burials beneath it (see Section 5.7.1). Mr. Enos explained that *ko‘a* were built to align with mountain peaks and acted as transects indicating fishing grounds, particularly for *‘ōpelu* and *akule*. Though family members spoke of some cattle ranching in the area previously, Mr. Kila and Mr. Oliveira were skeptical that a rock wall along the gulch within the project area was for cattle, as indicated by archaeologists.

Numerous stories associated with the area of Kahe include Kāne and Kanaloa, Hi‘iaka at Mauna Kapu, and the Pili-o-Kahe landmark that marks the boundary between Kahe and Nānākuli, and the birthplace of Maui Akalana across from Pilo-o-Kahe. The predominance of Kāne, god of the sun, to the western part of O‘ahu including Kahe, speaks to the significance of the sun to these areas. In addition, the setting of the sun in the west, where the project site faces, is also associated with the spirit world and night marchers. Mr. Kila and Mr. Oliveira felt that the proposed photovoltaic project, in harnessing the power of the sun, was consistent with the area’s close traditional association with the sun and Kāne. In sharing their knowledge of the culture of the area, Mr. Kila and Mr. Oliveira emphasized and discussed, with regard to the proposed project, the importance of the vital Hawaiian value of *ka‘ananiau*—managing the beauty of time—by gracefully balancing meaningful development with protection of natural and cultural resources.

[47] *Inamona* is an important condiment used in traditional Hawaiian cooking; it is made of roasted *kuku‘i* (candlenut) and sea salt.

All three interview subjects pointed out that native plants grow throughout the project area, such as *ma'o* (*Gossypium sandvicense*), *'ilima* (*Sida fallax*), and *'uhaloa* (*Waltheria indica* var. *americana*). Mr. Kila stated that Hawaiian cotton, *ma'o*, is important because there used to be acres of Hawaiian cotton in the area and the other plants are used in *lā'au lapa'au* (traditional Hawaiian medicine).

5.7.3 PROBABLE IMPACTS & MITIGATION MEASURES

5.7.3.1 Construction Period

All three of the three archaeological sites within the project site, SIHP Nos. 50-80-12-6647, -6648, and -6650, have been tested and found not to contain information of archaeological, historic, or cultural significance. One of the three, SIHP No. 50-80-12-6647, was recommended for preservation because it may contain a site of ritual significance. Hawaiian Electric has established 20-foot wide buffer zones around the sites that more than satisfy the requirements of the Site Preservation Plan that was submitted to the SHPD on December 3, 2013 and is still under review. Observance of the interim and long-term preservation measures provided for under this plan will prevent adverse effects to these archaeological resources as a result of the proposed project.

While Hawaiian Electric believes that the likelihood of further discoveries in the area is very low, given the extensive previous survey work which it has conducted, mitigation to address this potential for the discovery of undocumented archaeological and/or historical remains will include, but are not limited to: (*i*) the immediate cessation of work in the area of the find; and (*ii*) notification of the State Historic Preservation Division (SHPD) to assess impacts. As appropriate, further mitigation measures will be proposed and coordinated with SHPD.

In addition to following the approved Archaeological Preservation Plan and the approved Archaeological Monitoring Plan, Hawaiian Electric will adhere to recommendations that CIA informants made pertaining to the avoidance of potential adverse impacts to Native Hawaiian cultural beliefs, practices, and resources. They are:

- While none are known to exist in the project site, should any burial be discovered, work will be halted and the burial will be placed under the jurisdiction of the O'ahu Island Burial Council and the State Historic Preservation Division and the community consulted in the development of a Burial Treatment Plan.
- Sites, including modern-era remnants of military activity, will be preserved as important artifacts of the area's history in the early and mid-20th century.
- If any rocks are to be removed from the site, they will be offered to the cultural community center Marae Ha'a Koa, where they can be used to teach children how to replicate traditional cultural structures.[48]
- Native plants, like *ma'o* (*Gossypium sandvicense*), (*naio* (*Myoporum sandwicense*), *'uhaloa* (*Waltheria indica*), *'a'ali'i* (*Dodonaea* spp.), *iliahi* (*Santalum* spp.), *'ilima* (*Sida fallax*), and coconut trees will be used for landscaping.
- Hawaiian Electric will continue to consult with the community and in particular, recognized families with ties to this area and Native Hawaiian cultural organizations, to prevent impacts to cultural resources and, if necessary, develop a plan for cultural monitoring of select sites.

Given the general consensus that there is no ongoing use of the area for traditional cultural purposes, and the fact that it will not further impair or limit the ability of native Hawaiian practitioners to access

[48] Alternatively, Hawaiian Electric may elect to use these stones on site as barriers around cultural sites, consistent with its Site Preservation Plan.

cultural resources in adjacent lands leads to the conclusion that the proposed project will not have an adverse effect on archaeological, historic, or cultural resources.

5.7.3.2 Operation and Maintenance Activities

Once constructed the proposed photovoltaic facility will not have the potential to harm archaeological, historic, or cultural properties in any way. Neither will their operation limit or otherwise adversely affect traditional and customary practices.

5.8 NATURAL HAZARDS

5.8.1 SUSCEPTIBILITY TO SEISMIC DAMAGE AND VOLCANIC HAZARDS

5.8.1.1 Seismicity

The Uniform Building Code (UBC) establishes minimum design criteria for structures to address the potential for damages due to seismic disturbances. The scale is from Seismic Zone 0 through Seismic Zone 4, with Zone 0 having the lowest level for potential seismic induced ground movement.

Like all of O‘ahu, Kahe Valley is designated Seismic Zone 2a (U.S. Geological Survey, 2001). All of the proposed structures will conform to Seismic Zone 2a Building Standards, and their construction and operation will not increase the seismic vulnerability of the area.

5.8.1.2 Volcanic Hazards

The Wai‘anae and Ko‘olau volcanoes that formed the bulk of Oahu are extinct. Smaller vents in the Honolulu Volcanic Series are more recent and formed volcanic features such as Diamond Head, Punchbowl, Salt Lake Crater, Koko Head, and Koko Crater. In general, these features are believed to be between 70,000 and 500,000 years old, although some scientists have theorized that a few features at the far eastern end of the island (such as Koko Head) may be more recent. Scientists agree that there is virtually no possibility of eruptions that could affect the project site.

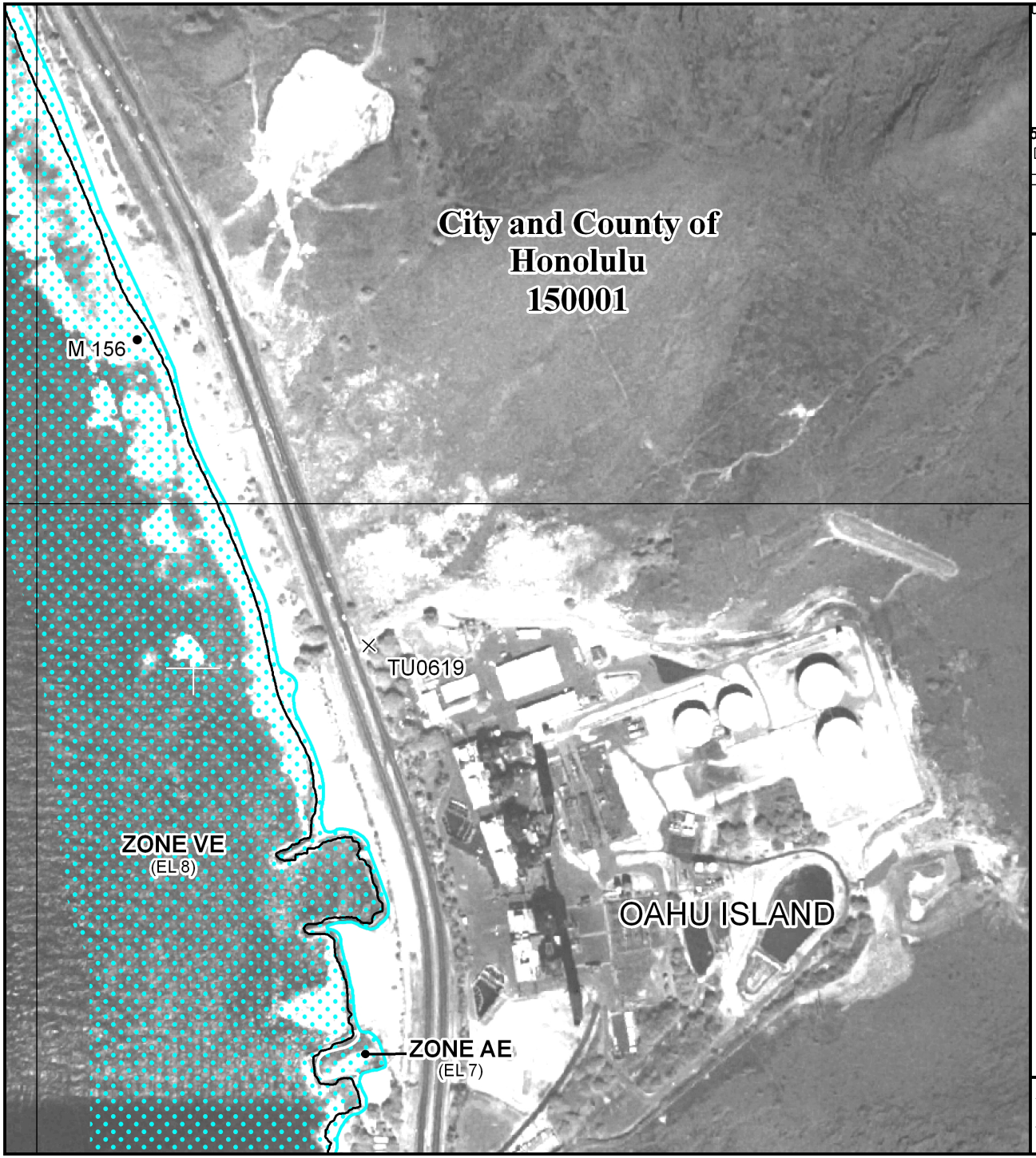
5.8.2 SUSCEPTIBILITY TO FLOODING AND TSUNAMI INUNDATION

5.8.2.1 Tsunami Inundation/Evacuation

The Flood Insurance Rate Map (FIRM) for the area (Map Number 15003C0301G, revised January 19, 2011, in Figure 5.9 below) shows that the project site is located in Flood Zone D, signifying that it is in an area where flood hazards are undetermined.[49] While this classification indicates that a detailed flood analysis has not been conducted in settled urban areas, the general practice is to assign Zone D status only to areas where there is no history of flooding.

As shown in Figure 5.9, the area selected for the proposed photovoltaic project extends from the Farrington Highway edge of the project parcel inland and up the sloping northern side of Kahe Valley. The latest tsunami evacuation zone maps for the area (see the map dated Apr. 12, 2010 at http://www1.honolulu.gov/dem/map16pokaibaytokahepointinset2.pdf) indicate that the extreme southwestern corner of the project site is within the tsunami evacuation zone. Engineers for the KUSPP have determined that there would be no flooding with velocity in the event of a tsunami, but believe it is possible that water could reach a few feet up the posts that support a few of the PV panels if the area were struck by the design wave. The panels themselves and the related electrical infrastructure would not be adversely affected. Hence, Hawaiian Electric believes that any damage

[49] The Zone D designation on NFIP maps is used for areas where there are possible but undetermined flood hazards. Mandatory flood insurance purchase requirements do not apply, but coverage is available.



ional Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

50 0 500 1000

FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0301G

FIRM

FLOOD INSURANCE RATE MAP

CITY AND COUNTY OF HONOLULU, HAWAII

PANEL 301 OF 395

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HONOLULU, CITY AND COUNTY OF	150001	0301	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
15003C0301G

MAP REVISED
JANUARY 19, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

from such an event could be repaired quickly and without compromising the ability of the system to continuing power to the grid at close to its rated capacity.

5.8.2.2 Stream Flooding

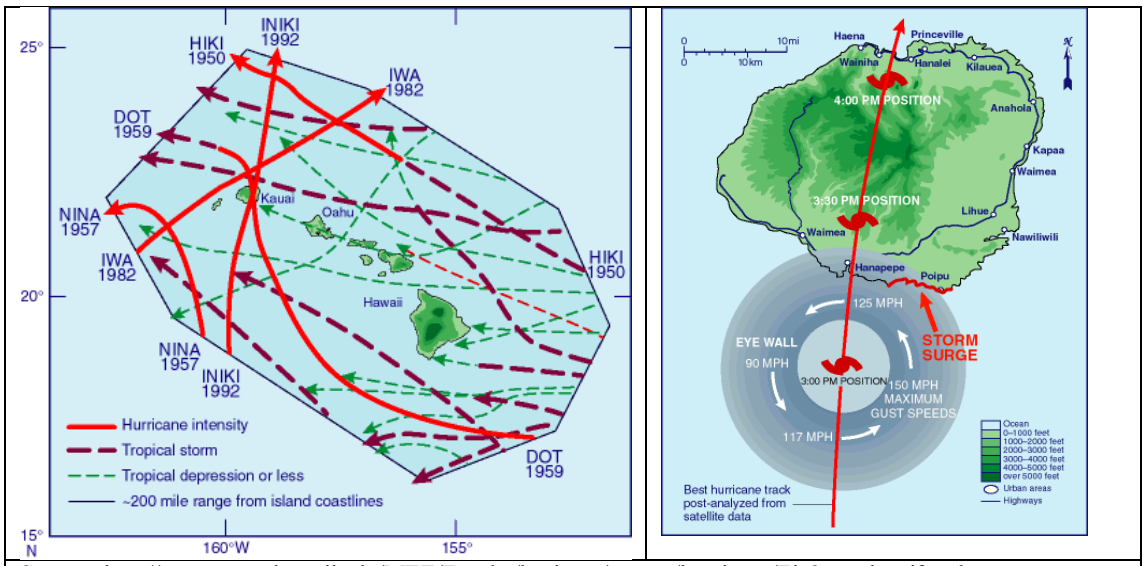
The proposed photovoltaic array and associated equipment would be located at elevations ranging from 15 to 175 feet above sea level (msl). The OHWM for the intermittent drainage ways that pass through the site were established by field surveys and certified by the Corps of Engineers; no facilities will be developed within those limits. Because of this design, the proposed facilities will not be susceptible to damage from runoff and do not have the ability to increase the risk of flooding on adjacent areas by restricting the floodway.

5.8.3 SUSCEPTIBILITY TO HURRICANE DAMAGE

Hurricane season in the Hawaiian Islands begins in June and lasts through November. During the last 60 years, many hurricanes and tropical storms have come close to the Hawaiian Islands, but only three hurricanes have had direct impact (see Figure 5.10 and Table 5.20). In all three cases, Kaua‘i was the hardest hit, although O‘ahu suffered significant damage as well.

In August of 1959, losses in Hurricane Dot were approximately $6 million dollars. In November 1982, Hurricane ‘Iwa caused over $250 million dollars in damages. Hurricane ‘Iniki, which struck in September of 1992, was by far the most destructive to strike Hawai‘i in recorded history, with widespread wind and water damage exceeding 2.2 billion dollars. None of the facilities at the Kahe Generating Station adjacent to the project site were damaged by the two most recent of these major storm events; the Kahe Generating Station did not exist when Hurricane Dot passed the island.

Figure 5.10 Tracks of Major Hurricanes Affecting the State of Hawai‘i (1950-2012)



Source: http://www.soest.hawaii.edu/MET/Faculty/businger/ poster/hurricane/Fig2_tracks.gif and Fig4_kauai_track.gif

The proposed project will be designed and constructed to withstand wind loadings specified in the Uniform Building Code and would, therefore, be expected to escape substantial damage from hurricane winds similar to those that have been experienced in the past. In considering the effect of hurricane forces on the photovoltaic modules and mounts, two potential sources of failure were considered: applied pressure loads generated by extremely high winds, and impact from foreign

objects which may become airborne in a hurricane environment. The distinction is important because they represent very different potential sources of failure:

Table 5.20 Major Hurricanes Affecting the State of Hawai'i: 1950-2010

Name	*Date*	*Maximum Recorded Winds Ashore (mph)*		*Category*	*Deaths*
		Sustained	*Peak Gusts*		
Hiki	Aug. 15-17, 1950	68	NA	1	1
Nina	Dec. 1-2, 1957	NA	92	1	1
Dot	Aug. 6, 1959	81	103	2	-
'Iwa	Nov. 23, 1982	65	117	3	1
'Iniki	Sept. 11, 1992	92	143	4	8

*Note: Category is based on the Saffir-Simpson Hurricane Scale:
Category 1 – Wind speed of 74-95 mph, minimal damage.
Category 2 – Wind speed of 96-110 mph, moderate damage.
Category 3 – Wind speed of 111-130 mph, extensive damage.
Category 4 – Wind speed of 131-155 mph, extreme damage.
Category 5 – Wind speed of >155 mph, catastrophic damage.

Source: *State of Hawaii Data Book 2010*

- *Impact Damage.* An object striking a photovoltaic panel is a concentrated load whereas high winds apply a distributed load. The panels which will be used for this project are guaranteed against impacts up to 51 mph. Above this speed, it becomes unrealistic to expect that the glass panels will survive impacts from flying objects moving at speeds far above this rating.
- *Wind Load Damage.* With respect to wind loads, the module manufacturer, Trina Solar Energy Co. Ltd., has tested their photovoltaic modules to significantly higher pressure load than the 50.1 pounds per square-foot which would correspond to the 51 mph rating discussed above. As seen in the graph reproduced in Figure 5.9, the ultimate load a module may support before failure is 112.8 pounds per square foot.

Based on the American Society of Civil Engineers (ASSCE) Section 7 standards for building wind loading, a wind speed of 150 mph could generate an applied pressure of 57 pounds per square foot on a photovoltaic module. This is well below both the design and maximum loads listed by the manufacturer. In addition, both the mounting racks and the driven piles which support the photovoltaic panels will be designed to withstand the 105 mph wind speed required by the Revised Ordinances of Honolulu. While they will eventually fail when wind speeds greatly exceed that limit, it would not be a catastrophic failure. Instead, the structural elements would distort, but hold fast.

In view of these findings, it appears likely that while an extremely powerful hurricane (i.e., one that is Category 4 or higher on the Saffir-Simpson Hurricane Scale) could damage the solar array, it is unlikely to uproot the equipment and allow it to become airborne. Hence, it does not represent a measurable threat to adjacent uses.

5.9 SCENIC & AESTHETIC RESOURCES

This section discusses the effect that construction and operation of the proposed photovoltaic array would have on visual resources in the area. It is organized as follows:

- Section 5.9.1 summarize the existing scenic and aesthetic resources in the project vicinity;
- Section 5.9.2.1 discusses the visibility of the project site and proposed components;

- Section 5.9.2.2 describes the concurrent, but functionally unrelated, Farrington Highway landscaping project that will affect the extent of visual impacts resulting from the proposed project;
- Section 5.9.3 concludes with a description of the effects that the proposed project would have on views from key vantage points.

5.9.1 EXISTING CONDITIONS

Visually, Kahe Valley consists of two distinct parts (see Figure 1.2). The southern part close to Farrington Highway is highly industrialized, with large buildings and tall exhaust stacks. The existing exhaust stacks in particular, the tallest of which stands 400 feet tall, are visual landmarks familiar to all who pass them on their way to and from the Wai‘anae Coast. A belt of landscaping along Farrington Highway *makai* of these structures screens, but does not entirely obscure, these facilities from view from people in passing cars and in the parking areas the recreational areas on the *makai* side of the highway. Outside of the developed portion of the project parcel, a very different visual environment is present. There, the valley floor is relatively broad but not deep and slopes gently up and away from the highway. The terrain is covered by low-lying invasive grasses and shrubs, dotted with occasional trees on the valley floor. The steep hillsides which form the valley walls are grassed in sloping areas, but sheer surfaces on the northern side of the valley often reveal the bare lava rock substrate.

The *‘Ewa Development Plan* lists views of the ocean from Farrington Highway between Kahe Point and the boundary of the *Wai‘anae Development Plan* area as a significant view and vista that should be preserved. No portion of the proposed project is *makai* of the highway and so is consistent with this precept.

5.9.2 PROJECT VISIBILITY

5.9.2.1 Existing Site Visibility

At present, the *makai* portions of the Kahe Valley, including the Generating Station complex and the project site, are visible from Farrington Highway and from the roadside portions of Kahe Point and Tracks Beach Parks, directly across the highway to the west. With the exception of the exhaust stacks (and in some cases the tops of the tallest structures), they are not visible from the beach itself. This is because of the way the land slopes sharply from the roadside down to the ocean and, in some areas, the presence of intervening vegetation. The existing generating complex is obscured from public vantage points to the north and south of Kahe by the ridges that form the valley sides (see Figure 1.2).

The project’s location within the lower portion of a valley that is surrounded by relatively high ridges limits the areas from which it can be seen to those immediately *makai* of the site, principally vehicles traveling on Farrington Highway. As can be seen from the photos in Figure 5.11 and Figure 5.12, views inland are relatively open at the present time. As discussed in Section 5.9.2.2, the situation will change substantially once Hawaiian Electric has completed its Farrington Highway Landscaping Project and the new plantings have grown in.

5.9.2.2 “Existing” Site Visibility Post-Farrington Highway Landscaping Project

As this is written in early March, 2014, Hawaiian Electric has nearly completed its Farrington Highway Landscaping Project. This undertaking, which is entirely separate from the KUSPP, involves planting a strip of Native Hawaiian and Polynesian-introduced vegetation on an approximately 35-foot wide by 3,000-foot long (2.4 acre) portion of vacant land company-owned land fronting Farrington Highway to the north of the Kahe Generating Station. The plan calls for the landscaping to be divided into three distinct sub-sections (from south to north): (*i*) a *la‘au lapa‘au* medicinal garden; (*ii*) a *lawai‘a* fishing garden; and (*iii*) a *Kumulipo* garden with plants used for *kapa* textile dyeing. This landscaping will already be planted and in the process of growing-in by the time

that Hawaiian Electric begins construction of the photovoltaic facility. Table 5.21 below contains a list of the plants which will be used, the total number planned, and their respective percentage of total. Figure 5.13 shows a conceptual landscape plan.

Table 5.21 Farrington Highway Landscaping Project Trees, Shrubs, and Grasses

Scientific Name	*Hawaiian Name*	*Percent of Total*	*Number*
Trees			
Psydrax odorata	Alahe'e	3	13
Morinda citrifolia	Noni	1	4
Pandanus spp.	Hala	4	18
Sapindus oahuensis	Lonomea	5	22
Thespesia populnea	Milo	5	22
Sapindus saponaria	Manele	4	18
Artocarpus altilis	Ulu	1	4
Cocos nucifera	Niu	4	18
Gardenia brighamii	Na'u	4	18
Senna gaudichaudii	Kolomona	1	4
Aleurites moluccana	Kukui	3	13
	TOTAL	35	156
Shrubs			
Dodonaea viscosa	A'ali'i	2	80
Wikstroemia uva-ursi	Akia	2	80
Plumbago zylanica	I'lie'e	4	160
Sida fallax	Ilima	2	80
Osteomeles anthyllidifolia	Ulei	2	80
Sesbania tomentosa	Ohai	2	80
Waltheria indica	Uhaloa	2	80
Chenopodium oahuense	Aweoweo	1	40
Myoporum sandwicense	Naio	5	200
Scaevola sericea	Naupaka	3	120
Bidens spp.	Ko'oko'olau	1	40
Solanum sandwicense	Popolo	2	80
Curcuma longa	Olena	3	120
Gossypium tomentosum	Ma'o	2	80
Hibiscus brackenridgei	Ma'ohauhele	2	80
Cordyline fruticosa	Ki	1	40
Saccharum officinarum	Ko	2	80
Nototrichium sandwicense	Kulu'i	1	40
Piper methysticum	Awa	1	40
	TOTAL	40	1,603
Grasses and Vines			
Heteropogon contortus	Pili	2	223
Ipomea batatas	Uala	11	1,225
Ipomea pes-caprae	Pohuehue	12	1,336
	TOTAL	25	2,783
		TOTAL PLANTS	***4,542***

Source: Hui Kū Maoli Ola (2013)

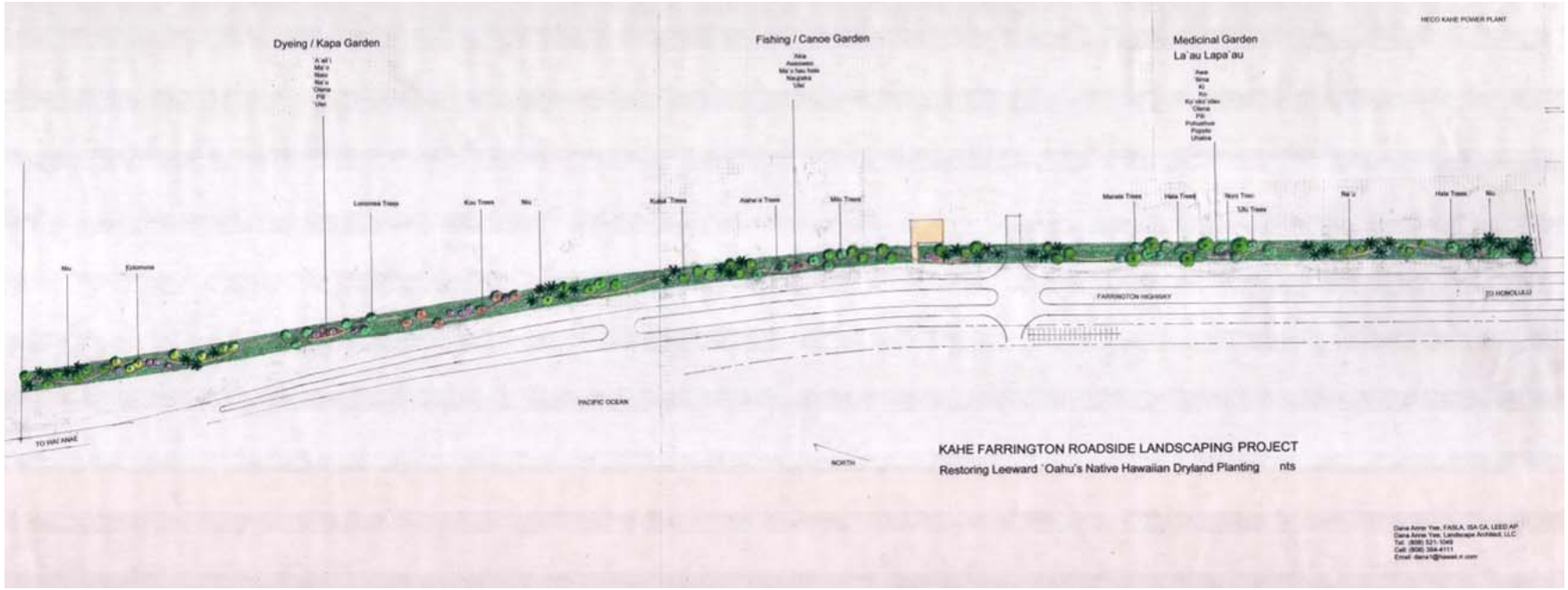
Figure 5.11 Existing Views of the Project Site from *Mauka* Side of Farrington Highway

	
Waianae-bound view from Farrington Highway showing partially completed landscaping strip. Note drip irrigation lines and recently planted trees.	*View from Farrington Highway looking towards ridgeline on the northern side of. Partially completed landscaping strip in foreground with scattered kiawe trees and grassland behind.*
	
View from Farrington Highway looking eastward. Disturbed ground shows work underway on landscaping strip. Scattered kiawe trees and grassland behind with existing Kahe Generating Station facilities on right.	*View from Farrington Highway looking south towards Kahe Generating Station. Partially completed landscaping strip in foreground with scattered kiawe trees and grassland behind.*
	
View of Existing drainage ditch along Farrington Highway, with landscaping project work underway.	*View from Farrington Highway looking south towards Kahe Generating Station. Terrain hides most site.*
Source: Hawaiian Electric Company, Inc. Photos taken February 18, 2014.	

Figure 5.12 Existing Views of the Project Site from *Makai* Side of Farrington Highway

	
View looking north from access road to Tracks Park. Landscaping work not clearly visible.	*View looking northeast from access road to Tracks Park. Landscaping work not clearly visible. Note natural vegetation. .*
	
View looking east from access road to Tracks Park. Landscaping work not clearly visible. Note absence of vegetative screen because plantings not grown in.	*View looking southeast from access road to Tracks Park. Landscaping work not clearly visible. Fuel oil storage tanks visible on right.*
	
View looking south from access road to Tracks Park. Generating Station visible in distance with tall stack the dominant feature from this distance.	
Source: Hawaiian Electric Company, Inc. Photos taken February 18, 2014.	

Figure 5.13 Plan View of Farrington Highway Landscaping Project



Source: Hawaiian Electric Company, Inc. (2013)

Once the roadside landscaping that is now being installed as part of that separate effort has matured, views of the project site will be filtered by the intervening vegetation. While this landscaping project is distinct from the Kahe Utility-Scale Photovoltaic Project, it will create an intervening vegetation filter.

5.9.3 PROBABLE IMPACTS

The high ridges that surround Kahe Valley and the mass of the facilities at the existing KGS limits the areas from which it can be seen to those immediately *makai* of the site, principally vehicles traveling on Farrington Highway. As can be seen from the photos in Figure 5.11 and Figure 5.12, views inland are relatively open at the present time. This will change as the plantings in the Landscaping project grow in, and this factor is integrated into the following discussion, which focuses on views from vehicles traveling in either direction on Farrington Highway and from the portion of Kahe Beach Park that is directly west of the project site.

Individually, the panels and mounts that comprise the vast majority of the equipment that would be installed on the site are relatively low-profile (they stand less than 10 feet above grade). If they were installed on a level site only those closest to the viewer would be visible. In the case of the KUSPP, however, the sloping nature of the valley floor will allow a significant portion of the panels to be seen from the highway. Thus, despite the presence of intervening vegetation and the generally low-lying stance of the modules, the sheer number of panels present will create a new visual presence where previously there were only grass, shrubs, and *kiawe*. One aspect of the presence is the potential for glare if sunlight reflects off the panels into the eyes of persons in adjacent areas. This potential, as well as the measures that Hawaiian Electric has committed to in order to minimize glare, are discussed in Appendix E. So long as the measures are implemented, glare from the panels does not have the potential to cause significant adverse effects.

At 12-feet above grade, the equipment on the twelve electrical equipment pads is only slightly higher than the PV panels.[50] Hence, other than having a different color and shape, it would not stand out. Some of the structures in the substation and the overhead electrical power line connecting the substation to the KGS switchyard are taller, and these will also be visible from some vantage points along Farrington Highway. Because it is relatively close to Farrington Highway and contains some bulky equipment as well as the take-off structures, the substation is likely to be a stronger visual element than the transmission line itself. Both will be partially screened as the landscaping vegetation grows in.

5.9.3.1 Effects on Views from Farrington Highway

The proposed Kahe Utility-Scale Photovoltaic Project will be constructed immediately north of the developed portion of KGS in an area which is generally visible from both northbound and southbound vehicles on an approximately half-mile long segment of Farrington Highway. In the case of northbound vehicles, the facility would not become visible until they had passed the existing intervening structures (i.e., the generator and administration buildings) already present at Kahe. Thus, with the exception of a very short stretch just past the existing parking lot at the KGS, those persons traveling in the northbound direction would generally have to turn and look directly to their right to have a view of the facilities that is not muted by the landscaping strip, a generally uncommon thing to do.

[50] The electrical equipment enclosures are approximately 12-feet high. The tallest components of the substation are approximately 35-feet high. The poles carrying the power from the substation to the Kahe Generating Station Switchyard are

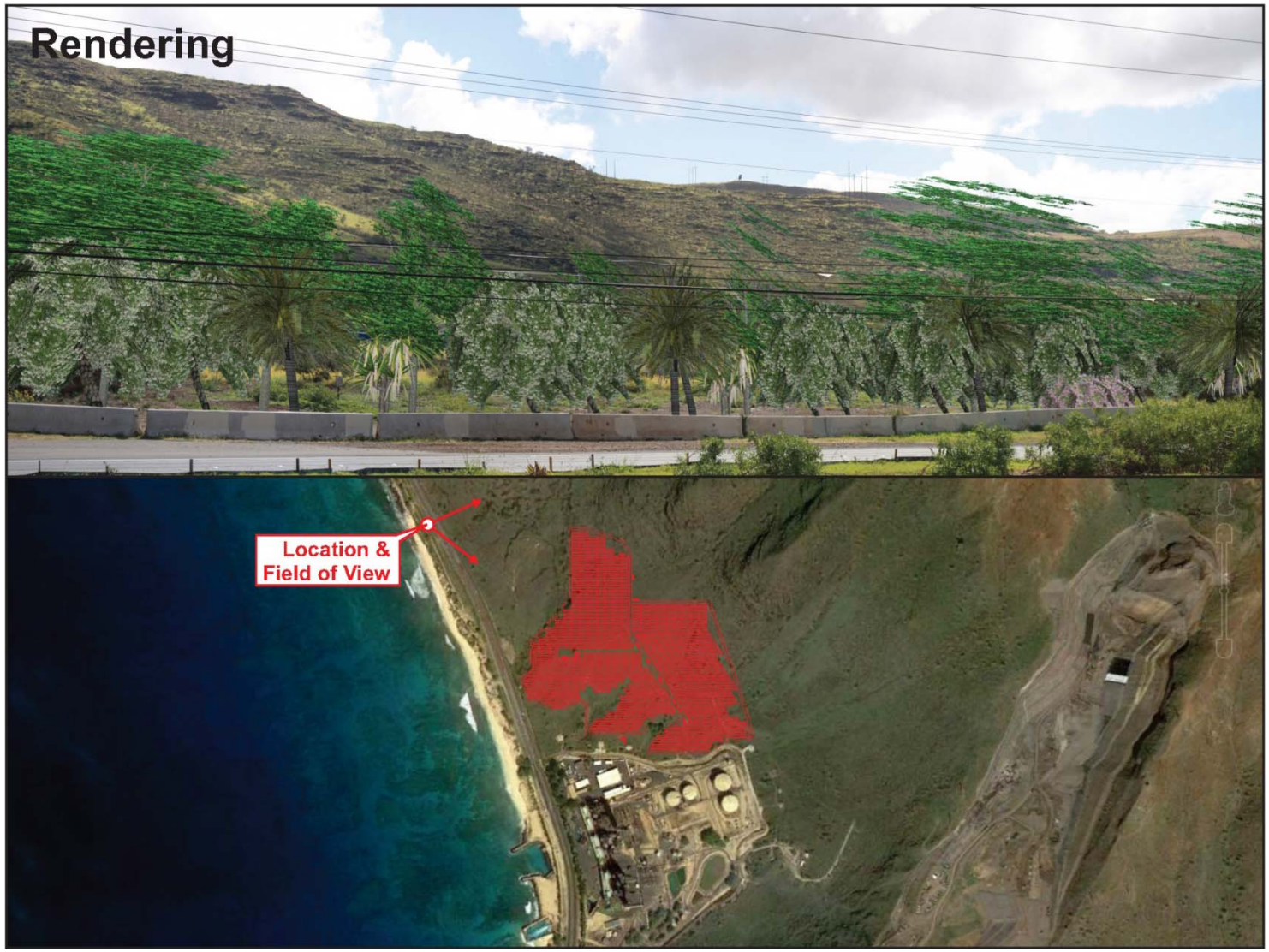
Persons traveling in southbound vehicles would also be able to see the proposed facilities from an approximately half-mile segment of Farrington Highway as they approach from the Nānākuli side. Figure 5.14 and Figure 5.15 depict artist's renderings of selected views of the project site paired with satellite photography taken from Google Maps©, allowing the reader to gain a sense of what the proposed facility might look like from various points along Farrington Highway.

From these photo-renderings it is apparent that, in the absence of an intervening object such as the plantings in the landscaping project described in 5.9.2.2 much of the project site is visible from Farrington Highway, but that vegetation can act as an effective screen, softening the visual presence of the proposed facility. Drivers travelling along Farrington Highway, particularly in a southbound direction, will have views of the facility, including the substation. While the view now is mostly of buffelgrass and other invasive species (e.g., *kiawe*), in the future a barrier of native trees, shrubs, and other plants will soften, but not eliminate the visual presence of the new photovoltaic facility. The sheer number of panels, stretching back and up the sloping floor of Kahe Valley will be visible to vehicle occupants headed in either direction. The substation, in the foreground close to the highway, will be partially obscured by plantings, but other elements of the facility such as the electrical equipment pads and panels, will be visible in the background. However, the presence of the adjacent power plant, with much larger structures, will mean that this section of the proposed project is a visual continuation of the existing facility, rather than an entirely new presence.

5.9.3.2 Effects on Views from Makai of Farrington Highway

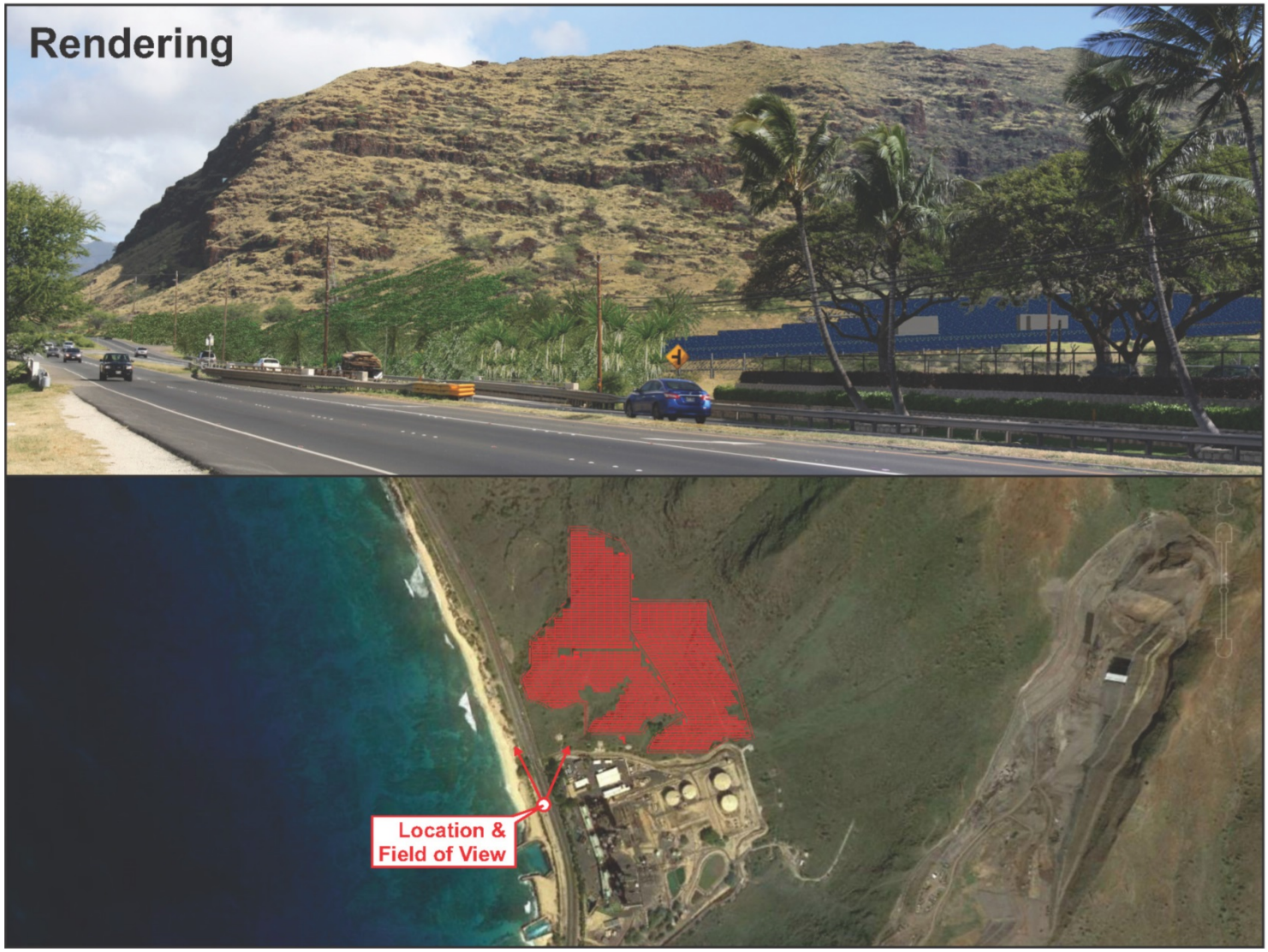
The areas immediately makai of Kahe Generating Station are occupied by two beach parks (Kahe Beach Park and Tracks Beach Park) and by cooling water facilities related to the power plant (the latter are not accessible to the public). Both of these beach parks consist of relatively narrow strips of land and both are beach parks whose functional orientation is toward the ocean rather than *mauka* where the proposed solar facility would be located. Figure 5.16 presents a conceptual rendering of how the project would appear as seen from vehicles returning to Farrington Highway from Tracks Beach Park. Because of the existing topography at these beaches, individuals situated along the actual strand at water's edge will not have a clear view of the project area. The parking areas that serve Tracks Beach Park are most exposed, and there are gaps in the existing vegetation and berm that will allow persons there to see across Farrington Highway when they are standing by their vehicles. The scenic character of that view is already dominated by the vehicles that pass it on Farrington Highway, but the solar array would be visible through the landscaping. The fact that the solar array would have a low profile and is directly adjacent to the tall, industrial structures (e.g., the large fuel storage tanks adjacent to the project site) present at Kahe Generating Station would limit the magnitude of the change.

Figure 5.14 Rendering of Project Site from the North on Farrington Highway



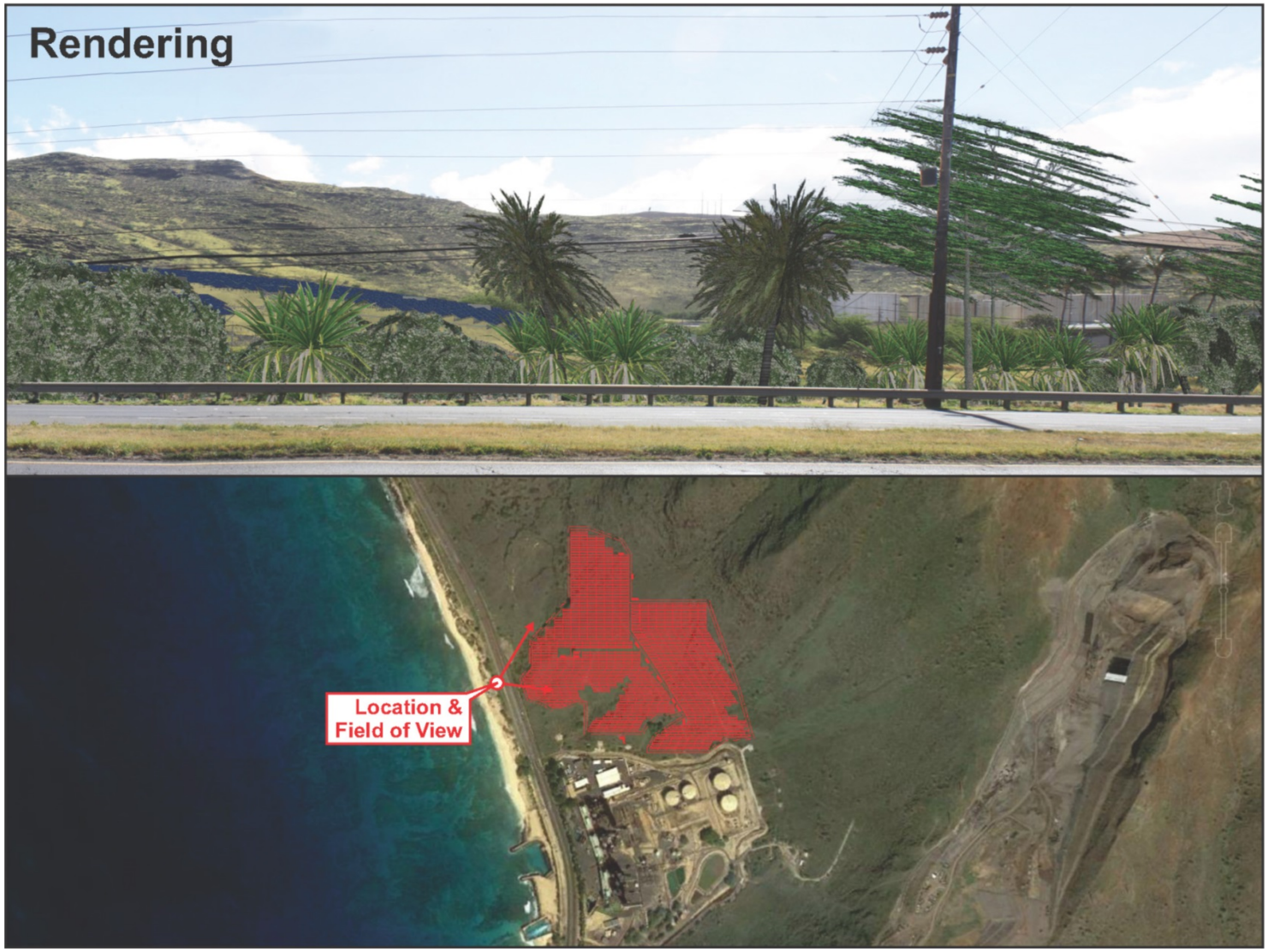
Note: View of project site from the north from Farrington Highway. Note the visual screen created by the Farrington Highway Landscaping Project.

Figure 5.15. Rendering of Project Site from the South on Farrington Highway



Note: View from Farrington Highway towards the southern side of the Project Site. Tracks Beach Park is directly to the west.

Figure 5.16 Rendering of Project Site from Entrance to Tracks Beach Park



Note: View from the entrance to Tracks Beach Park, directly east towards the project site.

5.10 IMPACTS ON UTILITIES AND PUBLIC INFRASTRUCTURE/SERVICES

5.10.1 PUBLIC INFRASTRUCTURE

5.10.1.1 Existing Conditions

Electric Power. There is presently no electrical power service to the project site. However, the adjacent Kahe Generating Station is a major source of the energy for Hawaiian Electric's island wide electric power grid, and power generated there is delivered to the transmission and distribution system through the existing Kahe Substation and switchyard.

Telecommunications. There is presently no telecommunications service to the KUSPP site. Hawaiian Electric has its own internal telecommunications system, which it uses to control the operation of the various generating, transmission, and distribution facilities that it owns. However, certain functions at Kahe are also connected into Hawaiian Telcom's voice telecommunications system through telephone lines along Farrington Highway.

Water Supply. There is presently no potable water available on the project site. The potable water that is used at the adjacent Kahe Generating Station is obtained from the existing Honolulu Board of Water Supply system 24-inch water line along Farrington Highway. A lateral from the main enters the generating station site near the main gate, and smaller lines distribute it throughout the property. Similarly, while there is presently no reclaimed water available on the project site, Hawaiian Electric has installed a reclaimed water pipeline to transport RO reuse water from the Honouliuli Wastewater Treatment Plant (WWTP) to the adjacent Kahe Power Plant, and water from that source is being used for the landscaping strip that the Company has just installed along Farrington Highway.

Sanitary Wastewater. There is no municipal sanitary wastewater system serving Kahe Valley.[51] The existing Kahe Generating Station is served by one individual wastewater system ("IWS") and one cesspool system. The IWS was installed in 2006-2007 to replace three then-existing Class 5 cesspool systems in the Kahe Power Plant Sanitary Wastewater system in order to comply with new U.S. Environmental Protection Agency requirements.[52] The IWS consists of: (*i*) four low pressure sewage ("LPS") pump systems at the locations of the old cesspools; (*ii*) approximately 7,200 linear feet of sanitary sewer force mains; and (*iii*) approximately 10 septic tanks. The septic tanks connect into an adjacent disposal field where the wastewater drains into the ground.

5.10.1.2 Probable Impacts

The proposed project will not disturb any existing public electrical, wastewater, water, or other utility lines, nor require that any new ones be installed. It would not require additional Kahe-based operational or maintenance personnel and would not, therefore, increase water use or place any additional burden on the existing electric power, water supply, or wastewater disposal facilities.

5.10.2 PUBLIC SERVICES

5.10.2.1 Existing Conditions

Police. Honolulu Police Department District 8 encompasses the Wai'anae Coast, Makakilo, 'Ewa, and the City of Kapolei. The district headquarters is in Kapolei. A substation is located in Wai'anae, providing a base of operations for officers patrolling the Wai'anae Coast.

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[51] The nearest possible points of connection are the interceptor sewer at Fort Barrett Road in Kapolei or the Nānākuli Wastewater Pump Station.

[52] The IWS serves Kahe Units 1 through 6, and the office building.

Fire Protection. Leeward O'ahu is served by the Honolulu Fire Department's Fourth Battalion, which is headquartered at Station 40, the Kapolei Fire Station. The Nānākuli Fire Station (Station 28) and Wai'anae Fire Station (Station 26), each have an engine and a tanker. The Makakilo Fire Station (Station 35) has a single engine, as does the 'Ewa Beach Fire Station (Station 24).

Health Services. Leeward O'ahu is served by: Queen's Medical Center – West O'ahu (the former (St. Francis West); Pali Momi Medical Center in Pearl City; the Wai'anae Coast Comprehensive Health Clinic, between Nānākuli and Wai'anae; and clinics in Kapolei maintained by other health care providers. Emergency Medical Services (EMS) Division staff and trucks are located at the Wai'anae Fire Station and at Pali Momi in Pearl City. A quick response unit—with a paramedic and a truck—but without the ability to transport patients is located at the Navy medical clinic in Barbers Point. The Fire Department co-responds to calls for emergency services.

Solid Waste Management. Currently the project site is fallow former agricultural land with no solid waste present on the site. Refuse from the adjacent Kahe Generating Station is picked up by a private contractor paid for by Hawaiian Electric and hauled to disposal sites as appropriate. The nearest construction waste disposal site is the nearby PVT Landfill in Nānākuli, and it is likely that it would be used by the contractor installing the equipment at Kahe.

5.10.2.2 Probable Impacts

Police, Health, and Educational Services. The proposed action will not measurably increase the burden on existing police and health services or facilities; neither will it result in any changes that would measurably change the level of police protection that is needed. The facilities will be entirely surrounded by a security fence, and Hawaiian Electric will monitor the facility with its own security systems and personnel. Because the solar facility will not require a substantial increase in staffing, its operation and maintenance will have no effect on the number of people present on the property that might require medical attention. The absence of any significant long-term increase in on-site employment means that there is no potential to place demands upon education or healthcare services.

Fire Protection. Hawaiian Electric has made the provision of adequate fire protection a fundamental aspect of the design program for the proposed project. All facilities would comply with the National Fire Protection Association's (NFPA) recommendations, local codes, and other applicable fire protection regulations. This includes compliance with the applicable provisions of the *NFPA 1 Fire Code Handbook* §11.12.3, which provides fire prevention guidance for ground-mounted photovoltaic installations. These require a cleared area 10-feet wide around the photovoltaic array, and a non-combustible base installed under and around the photovoltaic installations.[53] Hawaiian Electric has met with the Honolulu Fire Department (HFD) on March 21, 2014 and shared its plans for the facility with them. Its design for the photovoltaic array will be consistent with the requirements of HFD and the Uniform Fire Code.

The solar panels and other electrical equipment are largely free of flammable materials.[54] Some such materials are present within the photovoltaic array area in very small quantities, but frequent site inspections, site security, and vegetation management are intended to keep the risk of fire at a minimum.

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[53] NFPA 1 Fire Code Handbook (2012) §A.11.12.3.2 states: *"Though dirt with minor growth is not considered noncombustible, the AHJ might approve dirt bases as long as any growth is maintained under and around the installation to reduce the risk of ignition from the electrical system."*

[54] The mineral oil in the transformers has a flashpoint of 335° F. The U.S. Occupational Safety and Health Administration (OSHA) defines a flammable liquid as any liquid having a flashpoint at or below 199.4°F. Thus mineral oil, while combustible, is not considered a highly flammable liquid.

Solid Waste. The kind of construction that is required to install the PV panels and electrical equipment generates relatively little solid waste. The approximately 50,000 panels would be shipped to Hawai'i and transported to the project site in reusable 40-foot shipping containers. They are grouped inside the container in sets that are of manageable size using reusable materials. What little construction waste and scrap is generated will either be sold to a dealer for recycling or disposed of at an approved off-site location.

5.11 HAZARDOUS MATERIALS

5.11.1 EXISTING CONDITIONS

Hawaiian Electric does not store and has not disposed of any hazardous materials in the vicinity of the planned construction activities. The company's review of historical aerial photography confirms that the project site has not seen use since the military facilities constructed during the Second World War were decommissioned. Because the actual project area has no history of previous development or industrial usage, and has lay fallow for decades, no Phase 1 Site Assessment was conducted as part of the planning process. Hawaiian Electric believes that the likelihood of hazardous materials being present within the area is so low and the need for remedial action so unlikely that no such assessment is necessary.[55] As might be expected in an area such as this, various types of solid waste may be found throughout the project area. This waste may include stone and metal debris, car parts, glass and plastic bottles, and other containers. Because the previous agricultural use of the areas was as a cattle pasture, the fertilizers, pesticides, herbicides, and other soil contaminants commonly used in more intensive cultivation are not likely to be present.

5.11.2 PROBABLE IMPACTS

5.11.2.1 Installation, Operation, and Maintenance

With three exceptions, all equipment to be installed as part of the photovoltaic facility and associated electronics are dry-type solid state equipment that does not pose a threat of hazardous waste. The exceptions are: (*i*) the methyl-alcohol/water mixture used as coolant within the AE Solaron 1000 kW inverters; (*ii*) the mineral oil filled transformers installed at each equipment pad; and (*iii*) the diesel fuel used by the pile-drivers and other construction vehicles.

The inverter system that is proposed uses a 5-gallon closed-loop cooling system; the coolant in the inverters and the mineral oil in the transformers could only be spilled if physical damage occurred to the units. The diesel used by the combustion-engine construction equipment will be stored in a closed tank on the same platform as the fuel pump or fuel truck. As with the other two sources of hazardous materials noted above, only physical damage to the tank or pump could result in the release of diesel. The storage, maintenance, and fueling of vehicles will be in compliance with all NPDES regulations and best management practices.

At completed photovoltaic installations, the potential for hazardous materials to be released into the environment is very small, since the small amounts that are present are incorporated into the materials of which the panels are constructed. The only way in which they could be released is due to fire. Importantly cadmium, which could be a potential concern with some photovoltaic technologies (e.g., thin-film panels) is not present in the modules proposed for use at Kahe. Other chemicals that have inhalation toxicity factors are present only during the manufacturing process. Leaching of metals from the installed modules is not likely to be a concern, as documented in a study by Steinberger (1998). The transformers that are planned as part of the electrical system would contain mineral oil, a

[55] Phase 1 Site Assessments do not include any sampling activities or analysis of suspect soil or other materials.

highly refined hydrocarbon-based oil used as an insulation medium and coolant; it is not a cancer-causing chemical.

5.11.2.2 Manufacture of Photovoltaic Modules and Other Equipment

To a very large extent, the KUSPP is what might be termed an "installation project". In other words, the bulk of the work associated with its implementation has to do with the manufacture of the equipment and only a small proportion of the effort is related to installation activities on the project site. Because of the disproportionate amount of off-site manufacturing activity that the proposed project would require, Hawaiian Electric has considered the kinds of impacts that the off-site work would entail. The evaluation was not meant as a substitute for environmental review that would occur at the point(s) of manufacture; rather it was intended as a cross-check to ensure that Hawaiian Electric-funded activities would not unintentionally lead to significant adverse environmental consequences elsewhere.

The panels that will be installed for the Kahe Utility-Scale Photovoltaic Project are composed or multicrystalline silicon, also sometimes referred to as "polycrystalline silicon". This material is composed of many smaller silicon grains of varied crystallographic orientation. It can be synthesized easily by allowing liquid silicon to cool using a seed crystal of the desire crystal structure. The abundance, stability, and low toxicity of silicon, combined with the low cost of polysilicon relative to single crystals makes this variety of material attractive for photovoltaic production (Platzer, 2012).

Manufacture of a crystalline silicon system involves several stages:

- *Polysilicon Manufacturing.* Polysilicon, based on sand, is used to make the semiconductors used in PV panels. Silicon dioxide consisting of either quartzite gravel or crushed quartz is placed into an electric arc furnace and a carbon arc is then applied to release the oxygen. The products are carbon dioxide and 99-percent pure molten silicon. This is then purified even further using physical processes (generally referred to as the "floating zone" technique).
- *Wafer Manufacturing.* Manufacturers use traditional semiconductor manufacturing equipment, to shape polysilicon into ingots and then slice the ingots into thin wafers. They then cut, clean, and coat the wafers according to the specifications of the system manufacturers.
- *Cell Manufacturing.* Solar cells are the basic building blocks of a PV system. They are made by cutting wafers into the desired dimensions and shapes and then attaching very thin copper leads so the cell can be linked to other cells. Metals such as palladium/silver, nickel, or copper are vacuum-evaporated through a photoresist, silkscreened, or merely deposited on the exposed portion of cells that have been partially covered with wax. After the contacts are in place, thin strips (most often tin-coated copper) are placed between cells.
- *Module Manufacturing.* Modules, which normally weigh 60.8 pounds each, are created by mounting 60 to 72 cells on a plastic backing within a frame, usually made of aluminum. The module is covered by solar glass to protect against the elements and to maximize the efficiency with which the unit coverts sunlight into power. Pure silicon is relatively shiny (it can reflect can reflect up to 35 percent of the sunlight), so an anti-reflective coating is put on the silicon wafer; most commonly this is titanium dioxide and silicon oxide.

Materials Used in the Production of Multicrystalline Silicon Solar Cells. The production of photovoltaic devices involves the use of a variety of chemicals and materials, with the amounts and types of chemicals used varying depending upon the type of cell being produced. There is also some variability among different manufacturers with respect to the chemicals used for manufacturing the same type of photovoltaic cells. Table 5.22, below, provides a list of chemicals and materials used in the production of multicrystalline silicon solar cells such as those selected for the proposed project. It was obtained from a report by the Public Interest Energy Research Program (PIER) titled *Potential Health and Environmental Impacts Associated with the Manufacture and Use of Photovoltaic Cells*

(2004). While the report provides and sound discussion of the topic, it is based on generic information that is now nearly a decade old, a significant interval in an industry which is evolving as rapidly as photovoltaic wafer manufacturing. Hence, the materials used in the manufacture of the modules used in the Kahe project may differ from this.

Table 5.22 Chemicals and Materials Used to Produce Multicrystalline Silicon Cells

Aluminum	Phosphine
Ammonia	Phosphorus trichloride
Arsine	Silicon
Boron trichloride	Silicon dioxide
Copper catalyst	Silane
Diborane	Silicon trioxide
Ethyl acetate	Silicon tetrachloride
Ethyl vinyl acetate	Silver
Hydrochloric acid	Sodium hydroxide
Hydrogen	Stannic chloride
Hydrogen fluoride	Sulfuric acid
Hydrogen peroxide	Tantalum pentoxide
Ion amine catalyst	Titanium
Isopropyl alcohol	Titanium dioxide
Nitric acid	Trichlorosilane
Nitrogen	
Source: EPRI and California Energy Commission. (August 2004). *Potential Health and Environmental Impacts Associated with the Manufacture and Use of Photovoltaic Cells.*	

A variety of acids or corrosive liquids (e.g., hydrochloric acid, sulfuric acid, nitric acid, and hydrogen fluoride) are used in fairly large quantities during the manufacturing process, primarily for cleaning of wafers or to remove impurities from raw semiconductor materials.[56] Solvents including 1,1,1-trichloroethane and acetone are also used in large quantities in the various cleaning steps conducted during the production process. Etching compounds such as sodium hydroxide can also be used in relatively large quantities. A number of these chemicals are classified as hazardous by the U.S. Department of Transportation.

Toxicity/Human Health Risk Associated With Manufacture of Photovoltaic Modules. Based on a review of the chemical information reported in the U.S. EPA's Toxics Release Inventory System (TRIS) database for six photovoltaic companies producing solar cells, EPRI and the California Energy Commission (EPRI 2004) reported that it appeared that most of the chemicals used by the U.S. manufacturing companies it studied are not released in reportable quantities. Similar information is not available for photovoltaic modules manufactured in China, which is the source of the modules being used in the Kahe Utility-Scale Photovoltaic Project.

[56] The amount of a given chemical used will vary depending upon numerous factors including the type of cell being produced, the amount of material processing required, and the amount of wafer cleaning required. The manufacturing processes are constantly evolving and changing, and this makes it impossible to provide a definitive list.

A comprehensive analysis of the possible effects of photovoltaic manufacturing conducted by Tetra Tech (2003) included an extensive discussion of potential human health risks. While noting that the potential for human exposure to these materials can occur during the manufacturing process, from the leaching of cracked or broken modules, or from the combustion of modules, the greatest risks are related to manufacturing, rather than installation, of these devices.

The Silicon Valley Toxics Coalition (SVTC), a non-profit organization formed out of concern for groundwater contamination near, and exposure to toxic substances in, high-tech manufacturing facilities, monitors the global silicon manufacturing industry and issues an annual "Scorecard" that, in its words: "*... reveals how companies perform on SVTC's sustainability and social justice benchmarks.*" Its 2013 rating places Trina, the supplier of the panes that Hawaiian Electric proposes to use, in first place overall out of the 40 companies rated. Trina received top scores for low module toxicity, recycling, chemical reduction, and other related items.[57]

Accidental Release of Toxic Gases. Short-term exposures to highly toxic substances used in the photovoltaic industry could occur as a result of the accidental release of toxic gases (e.g., silane, arsine, phosphine, hydrogen sulfide, and hydrogen selenide). These can present health risks to both workers and the general public. Such releases are likely to be contained within the manufacturing plant, placing plant workers at the highest risk for exposure. However, persons living in the vicinity of the plant may be at risk from a catastrophic release of toxic gases (e.g., a large explosion at the manufacturing facility). No catastrophic release of toxic gases from photovoltaic manufacturing facilities is known to have occurred, and the likelihood of such a catastrophic release is believed to be very small.

Long-Term Exposure. Exposure to low levels of toxic materials used in the manufacture of photovoltaic modules over long period of time may present potential health risks to both workers and the general public. In production facilities, workers may be directly exposed to hazardous compounds through the air they breathe, from ingestion by hand-to-mouth contact, or from absorption through the skin. The general public may be exposed to low levels of chemicals through indirect pathways such as the contamination of public drinking water from the improper disposal or treatment of plant effluent (Fthenakis and Moskowitz, 2000).

End of Life Issues. The U.S. regulatory framework for photovoltaic end-of-life procedures is based on the federal Resource Conservation and Recovery Act (RCRA) and state policies like California's Hazardous Waste Control Law (HWCL). If photovoltaic components are determined to be hazardous waste, RCRA could be used to regulate their handling, recycling, reuse, storage, treatment, and disposal. Decommissioned solar panels are currently considered hazardous waste if they do not meet the U.S. Environmental Protection Agency's (EPA) Toxicity Characteristic Leaching Procedure (TCLP) standards and, therefore, have the potential to leach into the ground water near waste disposal sites. The TCLP test is required for all new solar panels that enter the U.S. market.

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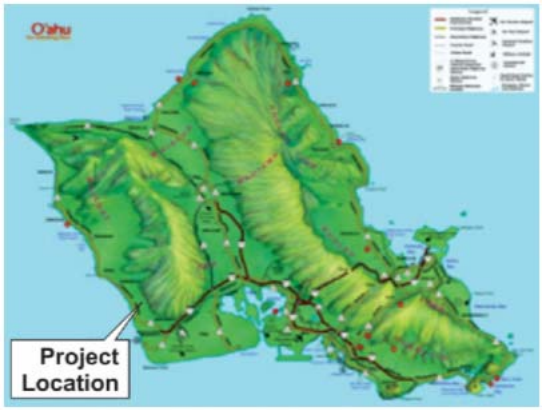
[57] SVTC's 2013 Solar Scorecard included 40 companies representing an estimated 82.8 percent of the PV industry market share. The Scorecard takes into account: (*i*) module toxicity (the absence of toxic heavy metals); (*ii*) emissions transparency (complete reporting of all categories of emissions including chemical waste, hazardous waste and heavy metals, air pollutants, ozone depleting substances, and landfill disposal); (*iii*) the manufacturer's implementation of a chemical reduction plan to reduce chemical use per module; (*iv*) assumption of extended producer responsibility that has a collection and recycling system for end-of-life PV modules; (*v*) cradle-to-cradle recycling with all recycling activities at a facility with a documented environmental management system and 95 percent of the PV module is recycled into products of similar value and quality; (*vi*) energy and greenhouse gasses emissions reporting to a third party; (*vii*) required supply chain reporting of chemical emissions from module upstream to polysilicon production or semiconductor preparation; (*viii*) maintenance of zero direct impact on wildlife or biodiversity; (*ix*) water conservation/quality maintenance (reporting volume of water use and wastewater generated: (*x*) prohibition of prison labor; (*xi*) corporate policy explicitly forbidding prison labor; and (*xii*) adoption of corporate code of conduct that protects worker rights, health, and safety that goes beyond compliance with local laws and regulations.

Substation. In addition to the materials which may be related to the photovoltaic array, very small amounts of hazardous materials are present in equipment intended for use within the substation. The design of the proposed facility provides proper storage and containment of these properties, and Hawaiian Electric will operate the substation in accordance with all applicable regulations and guidelines. Consequently, no adverse effects are anticipated.

5.12 IMPACTS ON TRANSPORTATION FACILITIES

5.12.1 ROADWAYS & TRAFFIC

5.12.1.1 Existing Conditions



Road access to the entrance to the Kahe Generating Station is from Farrington Highway, State Route 93. From the point where it connects with the H-1 Freeway, Farrington Highway is a four-lane, two-way roadway. The speed limit in the segment fronting the generating station is 35 miles per hour. Peak-hour traffic volumes on Farrington Highway are relatively high (see Table 5.23). As a result, it is congested during peak periods.

The State of Hawai‘i Department of Transportation, Highways Division, Highways Planning Survey Section conducts regular traffic counts for Farrington Highway near the Kahe Generating Station. The most recent count was conducted on January 11 and 12, 2012. The 24-hour traffic volumes were similar on the two days: 40,840 on January 11 and 40,796 on January 12. The peak-hour volumes on the two days were also similar. To be conservative, the following discussion is based on the data from January 11, when total volumes were marginally higher, although peak hour volumes were slightly greater (by 47 vehicles) on January 12. The difference between the two counts was not significant and would not have altered the conclusions.

Table 5.23. Existing Traffic Volumes on Farrington Highway at Keone‘ō‘io Bridge Near Kahe

Direction	*Waianae-Bound*	*Town-Bound*	*Total*
24-Hour Volume	20,961	19,879	40,840
Morning Peak-Hour (6:30-7:30 a.m.)	923	1,921	2,844
Afternoon Peak-Hour (3:30-4:30 p.m.)	1,920	1,053	2,973

Note: Site ID No. B72009300330 Farrington highway at Keone‘ō‘io Bridge between Piliokahi Avenue and Kahe Generating Station.

At present, road access into the Kahe Generating Station from Farrington Highway is possible at two points.

- As depicted in Figure 1.2, the main entrance is situated toward the northwestern corner of the complex, between Kahe Unit No. 1 and the main offices. A 300-foot long deceleration lane allows vehicles traveling northbound on the highway to slow before turning right into the facility; a 300-foot long left turn deceleration and storage lane allows vehicles southbound on Farrington Highway to queue as they wait to turn left into the facility at that point. Finally, a 150-foot-long acceleration lane allows vehicles exiting the power plant in the southbound direction to turn left across the near-

lane traffic and pause before merging with the through-traffic. Because of the heavy peak-hour traffic, vehicles making left-turns into and out of the facility (i.e., turns that have to cross in front of oncoming traffic) can experience short delays.

- A secondary access road (the "south entrance") is located approximately 2,200 feet to the south. It is closed most of the time, but can be opened to accommodate special needs such as access by oversize vehicles. Because it is rarely used, there are no turning lanes on Farrington Highway at this point.

For security and other reasons, Hawaiian Electric has determined that with the exception of a few oversize vehicles, all construction vehicle access to the project site will be via the main gate.

Hawaiian Electric security staff recorded existing traffic volumes into the Kahe Generating Station during September and October 2013. The results of its vehicle-counts are shown in Table 5.24.

These figures do not account for vehicles that do not pass through security but instead park immediately outside the security entrance gate in the 78-stall parking area that is on the *makai* side of the plant offices. Counts of the numbers of vehicles entering and leaving that parking area are not available, and so the volume was estimated using other information as described below.

- Nearly all use of this external parking area is used by employees; only a few parking spaces are used by visitors to the facility.
- Hawaiian Electric estimates that approximately 40 to 45 percent of the stalls (i.e., 30 to 35 stalls) are typically used by employee vehicles, and that these generally arrive between 6:30 and 6:50 a.m. so that workers can start their shifts at 7:00 a.m., and leave between 3:40 p.m. and 4:00 p.m., after the work shift ends at 3:30 p.m.
- For the purpose of this analysis we have assumed that the *makai* parking area would be the source of 35 vehicle round-trips per day and that all of them would occur during the peak hour. These numbers were added to the security gate counts to arrive at the estimated number of vehicles using the Farrington Highway entrance to the facility.

A comparison of data in Table 5.23 and Table 5.24 shows that Kahe Generating Station accounts for no more than a fraction of one percent of the overall traffic on Farrington Highway.

Table 5.24 Existing Average Daily Vehicle-Entrances to Kahe Generating Station

Month	*Average Vehicles Per Day*		
	Security Gate	*Parking Area*	*Total*
September, 2013	157	35	192
October, 2013	163	35	198

Note: The Parking area numbers are estimates by security guard personnel rather than actual counts. The numbers can be higher during times when plant overhauls are underway, but these are sporadically and generally last for periods of only a few weeks at a time. The estimates were cross-checked by reviewing the number of occupied parking stalls shown on five satellite images of Kahe taken on 2/21/2001 (~15), 8/30/04 (~45), 7/30/2006 (~15), 12/30/2008 (~15), and 1/29/2013 (~45). The figures are reported as "approximate" because the trees within the parking area obscured some stalls. Where this occurred, the status (occupied/unoccupied) was estimated based on the occupancy of other nearby stalls.

Source: Data collected at KGS Main Gate by Hawaiian Electric Company, Inc. Security Division (2013)

5.12.1.2 Probable Impacts: Operational Period

Normal operations and regular maintenance (e.g., vegetation maintenance, equipment checks, etc.) of the proposed project does not require on-site staffing or involve activities with the potential to significantly affect transportation infrastructure. Occasional maintenance trucks would access the site, but this would represent no more than one or two vehicle-trips per day during typical business hours. To the extent that these service trips can be handled by staff already present at Kahe, they would not add any vehicle-trips to area roadways. Thus, none of the proposed project activities are expected to generate significant additional trip volume on public roads.

5.12.1.3 Probable Impacts: Construction Period

Activities required to construct the KUSPP would generate vehicle-trips on area roadways. As these would occur while the existing operations continue in their present form, they would lead to a short-term increase in the number of vehicles entering and leaving the facility.

Because they are by far the largest component of project-related traffic, Hawaiian Electric's assessment of the effects that construction activity would have on area roadways began with estimates of the construction-worker vehicle-trips that would be generated. This was done using construction employment numbers provided by its photovoltaic contractor, SolarCity (see Table 5.25). Since the site preparation work would be essentially complete before other work commences, there is no overlap between site preparation employment and employment during PV and Substation construction. Construction work on the substation will overlap slightly with that of the PV arrays, but the timing is such that the total monthly on-site employment will not exceed the 60 persons shown for the PV arrays alone.

Table 5.25. Estimated Construction Workforce

Construction Component	*Typical Peak-Period Employment*	*Expected Duration (in mo.)*	
		Peak Period	*Start-to-Finish*
Site Preparation	20	1	2
Photovoltaic Array	60	8	12
Substation	25	3	4
Source: SolarCity (2013)			

Construction Worker Vehicle-Trips. The contractor's estimate of the number of workers that would be employed on-site during a typical "busy" period during the construction of each of the three project elements was used to estimate the number of construction-worker vehicle-trips that the proposed project would generate (see Table 5.26). Based on normal work schedules, most of the "to-work" trips would be between 6:30 and 7:00 a.m.; most of the "from-work" trips would be between 3:30 and 4:00 or, if the contractor opts for a 10-hour work-day, between 5:00 and 5:30 p.m.

Equipment & Material Delivery Trips. Construction of the proposed photovoltaic facility will involve the importation of several relatively large pieces of diesel-powered construction equipment such as trucks, bulldozers, and earthmovers. Many smaller pieces of equipment will be needed as well. This equipment will all have to be brought in from elsewhere on the island. In addition, construction activities will involve the transport of construction materials to the site, including posts,

racking mounts, photovoltaic panels, concrete, steel, and pre-fabricated pieces of electrical equipment and housings. Also gravel, fencing, and potentially some small quantities of fill material will also be brought in from off-site.[58] Most of the material will be brought to the site in 40-foot containers. The number of equipment and material deliveries is expected by low, amounting to no more than one per day, even on the busiest day. A few—principally the inverters—may require oversize loads. If so, such deliveries would be made at off-peak times.

Table 5.26 Construction Phase Vehicle-Trip-Generation (Excluding Materials)

Time Period	Type	Site Preparation			Photovoltaic Array			Substation			Total Peak Month		
		In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total
5:00am to 9:00am	Worker	20	0	20	60	0	60	25	0	25	60	0	60
	Other	2	1	3	3	1	4	1	1	2	3	1	4
9:00am to 2:00pm	Worker	0	0	0	0	0	0	0	0	0	0	0	0
	Other	1	2	3	2	3	5	1	1	2	2	3	5
2:00pm to 11:00pm	Worker	0	20	20	0	60	60	0	25	25	0	60	60
	Other	1	2	3	2	3	5	1	1	2	2	3	5
24-hour TOTAL		***24***	***25***	***49***	***67***	***67***	***134***	***28***	***28***	***56***	***67***	***67***	***134***

Note: Estimates do not include material deliveries because they will be irregular and will generally be limited to brief periods during project construction.

Source: Compiled by Planning Solutions, Inc. using estimates by SolarCity (2013).

Construction Waste. Construction of the proposed facilities will generate some construction waste from packing materials, assembly work, wiring, and other consumables. Waste materials produced during construction will be deposited in on-site dumpsters and trucked away for disposal or recycling at an approved location (e.g., the PVT construction waste landfill in Nānākuli.) The number of truck-trips that this will require is small, with no more than 5 trips per week, or one trip per day. These would occur at off-peak hours.

Fill Material. Preliminary plans indicate that it will be possible to balance the amount of cut and fill required for site grading. Hawaiian Electric anticipates the need to import small amounts of select structural fill, and this will be obtained from suitable offsite sources and trucked to the Kahe site. The volume of such material would be of such small quantities (i.e., a few tens of cubic yards) that trucking it in would not have any measurable impact on area roadways. These would occur at off-peak hours.

5.12.1.4 Potential Impacts on Area Roadways

The proposed project does not involve any work outside Hawaiian Electric's Kahe parcel. It will not require temporary lane closures or any other actions that would affect the area's roadways ability to accommodate traffic. The only mechanism through which the proposed project could affect the level of service of area roadways is through the temporary increase in traffic that the project will cause as a result of construction worker and construction material related vehicle-trips.

[58] SolarCity also estimated the number and timing of vehicle-trips needed to deliver equipment and material. In the case of the solar array, the principal consideration is the delivery of the approximately 50,000 solar panels that are at the heart of the project. In the case of the substation components, the volume of material that needs to be delivered is of less consequence than the size of a few pieces of equipment.

As indicated in Table 2.1, construction of the proposed facilities is expected to take place over several months. Some aspects of construction, such as site preparation, must be completed before others (i.e., installation of the photovoltaic modules) can be initiated. Thus, not all construction-period traffic will overlap. When all factors are considered, Hawaiian Electric anticipates that project-related construction traffic during the busiest month of construction will be as shown in the right-hand columns of Table 5.26.

Even during this peak construction period, the number of vehicles traveling to and from the project site during peak hours would amount to no more than a small fraction of the vehicles on the roadway (see Table 5.27 and Table 5.28). The largest proportional effect (a 5 percent increase) would be in the number of Wai‘anae-bound vehicles on the Kahe Point side of the power traveling towards Wai‘anae. However, as traffic in that direction is relatively light at that time of day and there is a deceleration lane for vehicles turning right into the Generating Station, this would not alter the level of service on the roadway. Vehicles turning left out of the Kahe Generating Station onto Farrington Highway northbound will experience somewhat greater delays as a result of the construction traffic. However, as the backup will be behind them and into the generating station, it will not affect through-traffic or the level of service.

Table 5.27 Peak-Hour Vehicle-Trip-Generation: By Direction

Time Period	*Type*	*Vehicle-Trips on Average Day During Peak Month*					
		In			*Out*		
		From Waianae	*From Honolulu*	*Total*	*To Waianae*	*To Honolulu*	*Total*
6:30 a.m. to 7:30 a.m.	Worker	**15**	45	60	0	**0**	0
	Other	**0**	3	3	0	**1**	1
	Total	**15**	48	63	0	**1**	1
3:30 p.m. to 4:30 p.m.	Worker	**0**	0	0	15	**45**	60
	Other	**2**	0	2	0	**3**	3
	Total	**2**	0	63	15	**48**	63

Note: Estimates assume that 25 percent of workers will reside along the Wai‘anae Coast and that car-pooling will not occur.
The bolded numbers in the table represent vehicle trips that would, if the contractor does not establish project-specific procedures, likely involve left turns in or out of the facility that must pass in front of through-traffic.

Source: Compiled by Planning Solutions, Inc. using construction worker estimates by SolarCity (2013).

While the great majority of the vehicle-trips that would be generated by the proposed project would be by passenger cars and light trucks, some would be by medium (WB-40 class) trucks and a few would be large (WB-50 class) trucks. Because of their size, WB-50 class trucks turning left out of the main entrance to Kahe Generating Station onto Farrington Highway southbound could run over the pavement striping and the edge of the grassed median. Because this would occur only a few times during the construction phase of the project, Hawaiian Electric believes this does not warrant highway improvements and will continue to coordinate with the Design Branch of DOT-Highways throughout the permitting process.

Table 5.28. Peak-Hour Construction Period Traffic As Percent of Existing

Time Period	*Existing Farrington Highway (vehicle-trips per hour)*			*Peak Period Project-Related Vehicle Trips*				*Proposed Project As % of Total*			
	Waianae Bound	*Town Bound*	*Total*	*In*		*Out*		*In*		*Out*	
				from Town	*from Wai‘anae*	*to Town*	*to Wai‘anae*	*from Town*	*from Wai‘anae*	*to Town*	*to Wai‘anae*
Morning Peak-Hour (6:30 a.m. to 7:30 a.m.)	923	1,921	2,844	48	15	1	0	5.2%	0.78%	0.05%	0%
Afternoon Peak-Hour (3:30-4:30 p.m.)	1,920	1,053	2,973	0	2	48	15	0.0%	0.19%	4.56%	0.78%
Note: Site ID No. B72009300330 Farrington highway at Keone‘ō‘io Bridge between Piliokahi Avenue and Kahe Generating Station.											
Source: Planning Solutions, Inc. (December 2013)											

5.12.2 AIR AND OCEAN TRANSPORTATION FACILITIES

5.12.2.1 Existing Facilities Airport and Harbor

Airports. The project site is approximately 12 miles west from the end of the nearest runway at Honolulu International Airport (HIA), the principal commercial aviation airport serving the island of O‘ahu. A vehicle trip between the project site and HIA takes approximately 30 minutes. HIA is owned and operated by the State of Hawai‘i Department of Transportation. In 2011, it handled over 262,700 aircraft operations, 18 million passengers, and almost one-third billion metric tons of cargo. In terms of passengers, it is one of the top 25 busiest airports in the world.

The Airports Division also owns and operates Kalaeloa Airport. Once a Naval airfield, the facility now accommodates general aviation, Hawai‘i National Guard, and Coast Guard aircraft. The end of the nearest runway at Kalaeloa Airport is approximately five miles south of the project site and separated from it by the high ridgeline on the southern side of Kahe Valley. During the 12-month period ending May 31, 2011, 27 aircraft of all types were based there and there were just under 120,000 operations of all types (see http://www.aopa.org/airports/PHJR).

Harbors. The nearest commercial harbor is the State of Hawai‘i’s Kalaeloa Harbor, which is located approximately 3.5 miles southeast of the project site. It handles most of the bulk cargo (e.g., coal, cement, etc.) that arrives on O‘ahu. Honolulu Harbor, which like Kalaeloa Harbor, is operated by the Harbors Division of the State Department of Transportation, is situated approximately 16 miles east of the project site. With more than 200 acres of container yards and over 30 major berths, Honolulu Harbor is by far the largest port facility in the Hawaiian Islands and most of the products that enter and leave the State of Hawai‘i pass through it.

5.12.2.2 Probable Impacts on Air and Ocean Transportation Facilities

The project would not directly affect air or ocean transportation facilities. However, most of the construction materials and equipment needed for its construction would be imported by sea, increasing the volume of cargo passing through the State’s facilities. The volume of material which would pass through these transportation facilities amounts to a very small fraction of their capacity and is well within their capabilities. All of the proposed structures are far below the height that would require notification of the Federal Aviation Administration. Hence, the project does not have the potential to adversely affect air and sea transportation.

5.13 PROBABLE LAND USE AND SOCIO-ECONOMIC IMPACTS

The KUSPP project is consistent with the property's I-2 "Intensive Industrial" zoning. The intent of the I-2 intensive industrial district is to set aside areas for the full range of industrial uses necessary to support the city. It is intended for areas with necessary supporting public infrastructure, near major transportation systems and with other locational characteristics necessary to support industrial centers; also, I-2 zones must be situated in areas away from residential communities. The KUSPP project site conforms to these characteristics, allowing Hawaiian Electric to develop clean, renewable energy close to its electrical transmission infrastructure at Kahe Generating Station while removed from residential areas.

While the KUSPP would increase the level of activity on the project site, the area has long been identified as appropriate for intensive industrial activities and is adjacent to the largest power plant in the state. Thus, while itself a new development, it would not drastically alter the overall intensity of development in the area. Further, the proposed photovoltaic facility does not have the potential to generate secondary growth or development which would lead to other land use changes in adjoining areas. Thus, Hawaiian Electric believes that the proposed project compatible with, and in the interest of, the planned for and intended use of the area.

While substantial, the construction expenditures are small relative to the overall level of construction activity on the island, which is estimated at $1.7 billion in new construction authorizations in 2012.[59] Hence, the project does not have the potential to have a major impact on the local economy or to cause demand for construction workers that cannot be met by the existing local labor force. Moreover, the proposed changes will not create a significant new revenue stream or create substantial ongoing costs that would have a considerable effect on the island's economy. At most, the construction will provide short-term employment. Apart from some few individuals who may be intermittently tasked with maintenance of the facility—at least some of who are already working at the adjacent Kahe Generating Station or other Hawaiian Electric facilities—the projects would not increase the number of employees at the power plant or attract new residents to the area. No persons would be displaced by the proposed project.

5.14 IMPACTS ON RECREATION & SHORELINE ACCESS

5.14.1 EXISTING CONDITIONS

The proposed project is located in the City and County of Honolulu Department of Parks and Recreation's District III, which encompasses 23 parks on the leeward side of O'ahu. These include parks in each of the major residential zones and numerous beach parks (along the Wai'anae Coast, at Barbers Point and Campbell Industrial Park, and 'Ewa Beach).

There are two parks on the makai side of Farrington Highway opposite Hawaiian Electric land. The southernmost is Kahe Beach Park (the portion of that which is directly across from the KGS is often referred to as "Electrics"). The northernmost is Tracks Beach Park. These beach pars support recreational activities typical across the leeward coast including, but not limited to swimming, sunbathing, surfing, and fishing.

[59] Estimate based on State of Hawai'i Department of Business and Economic Development, Construction Expenditures estimates, Table E-8. "Estimated Value of Private Building Construction Authorizations, by County," assumes that Q4 construction expenditures (which were not available at the time the table was compiled) were the average of the level experienced during the first three quarters of 2012. http://hawaii.gov/dbedt/info/economic/data_reports/qser/construction

5.14.2 PROBABLE IMPACTS ON RECREATION & SHORELINE ACCESS

The existing parks are separated from the Kahe Generating Station by Farrington Highway. An existing landscaped fence along the *makai* side of Hawaiian Electric property partially obscures views of the developed portion of the power plant from beachgoers. However, despite the future presence of planned landscaping along the northern portion of the project parcel fronting Farrington Highway, beachgoers would have at least a partial view of the photovoltaic facility, particularly from the beach park's parking area; see Figure 5.16 for a computer rendering of a view of the project site from the entrance to Tracks Beach Park off of Farrington Highway. Construction and operation of the proposed facility will not generate noise or air emissions that have the potential to adversely affect the quality of the existing recreational experience. Neither will it generate vehicular traffic or changes in water quality that could degrade the recreational experience. Consequently, no recreational impacts are anticipated.

5.15 SUMMARY OF MITIGATION MEASURES

Table 5.29 summarizes the mitigation measures introduced in this chapter.

Table 5.29 Summary of Mitigation Measures

Section	*Committed Mitigation Measures*
5.1 – Topography, Geology & Soils	Use best management practices to minimize soil erosion.
5.2 – Hydrology	Maintain existing patterns and avoid increase in storm water runoff. Implement Best Management Practices (BMP) in NPDES Permit.
5.3 – Climate/Micro-Climate	None
5.4 – Air Quality	Implement construction minimization measures as called for in Section 5.4.2.1
5.5 – Biota	None
5.6 – Noise	Adhere to HAR §11-46
5.7 – Archaeological, Historical, & Cultural Resources	If undocumented cultural properties are encountered, Hawaiian Electric will, at a minimum: (*i*) immediately cease all work in the area; and (*ii*) notify the State Historic preservation Division to assess impacts. As appropriate, further mitigation measures would be proposed and coordinated with SHPD.
5.8 – Natural Hazards	Design to appropriate standards as discussed in Section 5.8.
5.9 – Scenic & Aesthetic Resources	Erect and maintain landscape screens as proposed.
5.10 – Public Infrastructure	Install water and telecommunications connections as proposed.
5.11 – Hazardous Materials	None
5.12 – Transportation Facilities	None
5.13 – Socioeconomic	None
5.14 – Recreation & Shoreline Access	None. -
Source: Planning Solutions, Inc. (2013)	

6. CONSISTENCY WITH EXISTING POLICIES, CONTROLS, AND LAND USE PLANS

In accordance with the requirements of HAR §11-220-17(h), this chapter discusses the relationship of the proposed action to land use plans, policies, and controls for the area. Hawaiian Electric has evaluated the proposed photovoltaic project for consistency with these regulations. It has also identified the extent to which the proposed actions would conform or conflict with objectives and specific terms of approved or proposed land use plans, policies, and controls. The discussion is organized first by jurisdiction (i.e., county, state, or federal) and then by specific ordinance, regulation, or law. This is followed by a listing of the required permits and approvals.

6.1 CITY & COUNTY OF HONOLULU

6.1.1 O'AHU GENERAL PLAN

The *O'ahu General Plan* poses several objectives with regard to utilities. In Section V, Transportation and Utilities, Objective C states: "To maintain a high level of service for all utilities." The proposed improvements to the Kahe Generating Station are consistent with and support this objective by allowing Hawaiian Electric to ensure the safety and efficient of its operations while providing affordable and dependable electricity to O'ahu's residents, businesses, and public institutions. By adding the proposed new photovoltaic array to its existing facilities, the Company (and hence the consumer) will be able to reduce costs and increase the flexibility of its system.

Section VI of the General Plan poses several objectives and policies related to energy, and several of these relate to the proposed renewable energy (i.e., solar photovoltaic) facility which Hawaiian Electric is proposing. They include the following:

- *Objective A. To maintain an adequate, dependable, and economical supply of energy for Oahu residents.*
  - *Policy 1. Develop and maintain a comprehensive plan to guide and coordinate energy conservation and alternative energy development and utilization programs on Oahu.*
  - *Policy 2. Establish economic incentives and regulatory measures which will reduce Oahu's dependence on petroleum as its primary source of energy.*
  - *Policy 3. Support programs and projects which contribute to the attainment of energy self-sufficiency on Oahu.*

- *Objective C. To fully utilize proven alternative sources of energy.*
  - *Policy 2. Support the increased use of operational solid waste energy recovery and other biomass energy conversion systems.*

- *Objective D. To develop and apply new, locally available energy resources.*
  - *Policy 1. Support and participate in research, development, demonstration, and commercialization programs aimed at producing new, economical, and environmentally sound energy supplies from:*

    a. solar insolation;
    b. biomass energy conversion;
    c. wind energy conversion;
    d. geothermal energy; and
    e. ocean thermal energy conversion.

To the extent that the proposed photovoltaic array will produce electrical power, it will offset the need for Hawaiian Electric to meet its generating commitments using fossil fuels. This, in turn, will help the Company carry through with the renewable energy commitments required by state law, supporting the objectives of the *O'ahu General Plan* by creating a new, economical, and environmentally sound energy source.

6.1.2 'EWA DEVELOPMENT PLAN

The island of O'ahu is divided into eight Development/Sustainable Communities Plan areas. Each plan implements the objectives and policies of the *O'ahu General Plan* and serves as a guide for public policy, investment, and decision-making within its respective region. The project site is located within the region encompassed by the *'Ewa Development Plan* (EDP).

The EDP was adopted by Ordinance 97-49 in 1997 and most recently revised in mid-2013, when Ordinance 13-26 was signed into law. Section 3.12 of the updated plan recognizes Kahe Valley as one of 'Ewa's major Industrial Centers. Among its general policies for Industrial Centers, Section 3.12.1 calls for the City to maintain industrial activity at Kahe Valley. More specifically, it states:

> *Hawaiian Electric Company generating plant in Kahe Valley is and should remain the largest source of electrical power on O'ahu. Allow the plant to be expanded to take advantage of available land area, cooling system capacity, and power transmission lines, if needed.*

Finally, the implementation matrix (Table 5.1) in the plan states:

> *Allow the Hawaiian Electric Company generating plant in Kahe Valley to be expanded to take advantage of available land area, cooling system capacity, and power transmission lines.*

The proposed project is intended to allow Hawaiian Electric to continue to focus its generation activities at Kahe Generating Station, even as it transitions to safe and efficient sources of renewable power and is, therefore, consistent with this EDP policy. The addition of the photovoltaic array is intended to be part of ongoing system improvements at Kahe intended to support the facility's continued central role in supplying electrical power to O'ahu.

6.1.3 CITY AND COUNTY OF HONOLULU LAND USE ORDINANCE (LUO)

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. It does this by establishing zoning districts and specifying the kinds of development and development standards that must be adhered to within each zoning district.

Kahe Generating Station is located in the I-2, or "Intensive Industrial" zoning district. The proposed photovoltaic facility is consistent with the applicable height limitations, setback requirements, and other design standards of this zoning district (LUO §21-3.130). As discussed in Chapter 5, construction, operation, and maintenance of this facility is not expected to significantly impact surrounding properties with more sensitive zoning and land uses.

The Kahe Generating Station was granted an Existing Use Permit for Type B Utility Installation in 1989 (89/CUP 1-46). The permit has been modified several times in subsequent years. If the Special Management Area Permit application which this document supports is approved, Hawaiian Electric will apply for another minor modification to its Existing Use Permit to allow the proposed modifications to the complex that are discussed in this Environmental Assessment.

6.1.4 SPECIAL MANAGEMENT AREA REVIEW

As mentioned in Section 1.2, the proposed photovoltaic facility would take place in the Special Management Area (SMA) and will require Hawaiian Electric to obtain a Special Management Area Use Permit (SMP). The following subsections discuss the project's consistency with the SMA Review Guidelines found in the *Revised Ordinances of Honolulu 1990* (ROH), Chapter 25 (Shoreline Management). Each subsection addresses on of the guidelines listed in this ordinance. For convenience, the guidelines are reproduced in italics.

6.1.4.1 Impacts on Public Access

All development in the special management area shall be subject to reasonable terms and conditions set by the council to ensure that:

§25-3.2a(1) Adequate access, by dedication or other means, to publicly owned or used beaches, recreation areas and natural reserves is provided to the extent consistent with sound conservation principles;

Discussion: The proposed project would be located entirely within Hawaiian Electric property on the *mauka* side of Farrington Highway. It would not affect the shoreline and would not impair access to beaches, recreation areas, or reserves (see Section 5.14).

6.1.4.2 Impacts on Recreation Areas and Wildlife Reserves

All development in the special management area shall be subject to reasonable terms and conditions set by the council to ensure that:

§25-3.2a(2): Adequate and properly located public recreation areas and wildlife preserves are reserved;

Discussion: As discussed in Section 5.14, the only recreational resources in the project area are Kahe Beach Park and Tracks Beach Park. The proposed photovoltaic array may be partially visible from the park, but it is far enough away that construction-related noise and traffic will not create a nuisance to park users. The proposed project will not affect the government's ability to reserve adequate and properly locate public recreation areas and wildlife preserves.

6.1.4.3 Impacts on Solid and Liquid Waste Treatment Facilities

All development in the special management area shall be subject to reasonable terms and conditions set by the council to ensure that:

§25-3.2a(3): Provisions are made for solid and liquid waste treatment, disposition, and management which will minimize adverse effects upon special management area resources;…

Construction of the proposed project would not generate significant quantities of solid or liquid waste. The primary source of construction waste would be packing and installation materials related to the photovoltaic panels and racking mounts. This, and any other waste such as vegetation cleared for the installation of the photovoltaic equipment would be recycled wherever possible and disposed of properly when recycling is inappropriate (see Section 5.10.2). The mitigation measures specified in Section 5.15 and elsewhere in this report will ensure that the proposed project has little or no adverse effect on Special Management Area resources.

6.1.4.4 Impacts on Land Forms, Vegetation, and Water Resources

All development in the special management area shall be subject to reasonable terms and conditions set by the council to ensure that:

§25-3.2a(4) Alterations to existing land forms and vegetation; except crops, and construction of structures shall cause minimum adverse effect to water resources and scenic

and recreational amenities and minimum danger of floods, landslides, erosion, siltation or failure in the event of earthquake.

Discussion: As discussed in Section 2.2, the proposed project will involve some grubbing and grading activities which will affect landforms and vegetation. However, construction best management practices (BMPs) and ongoing maintenance activities described in this report are expected to maintain or reduce the level of erosion below current levels. None of the construction proposed as part of this project is expected to cause adverse effects to hydrological, scenic, or recreational resources or amenities.

6.1.4.5 Cumulative Impacts and Impacts on Planning Options

No development shall be approved unless the council has first found that:

§25-3.2b(1) The development will not have any substantial, adverse environmental or ecological effect except as such adverse effect is minimized to the extent practicable and clearly outweighed by public health and safety, or compelling public interest. Such adverse effect shall include, but not be limited to, the potential cumulative impact of individual developments, each one of which taken in itself might not have a substantial adverse effect and the elimination of planning options;

Discussion: None of the activities proposed in the EA are anticipated to have substantial individual or cumulative adverse environmental effects, as established by the discussion in Chapter 5. Furthermore, the proposed photovoltaic project is not part of a larger action which could have substantial adverse effects or which would eliminate planning options in the future.

6.1.4.6 Consistency with CZMP Objectives and Policies and with the State SMA Guidelines

No development shall be approved unless the council has first found that:

§25-3.2b (2)The development is consistent with the objectives and policies set forth in Section 25-3.1 and area guidelines contained in HRS Section 205A-26;

Discussion: As discussed below in Section 6.2.3, the proposed project is consistent with the Coastal Zone Management (CZM) Program Objectives. The City and County of Honolulu SMA Review Guidelines, discussed in this Section, are based upon and consistent with the State of Hawai‘i SMA Guidelines. A CZM consistency certification is not required for this project.

6.1.4.7 Consistency with County General Plan, Development Plans, and Zoning

No development shall be approved unless the council has first found that:

§25-3.2b(3) The development is consistent with the county general plan, development plans and zoning. Such a finding of consistency does not preclude concurrent processing where a development plan amendment or zone change may also be required.

Discussion: Sections 6.1.1, 6.1.2, and 6.1.3 document the consistency of the proposed project with the appropriate County plans and zoning requirements.

6.1.4.8 Impacts on Bays, Salt Marshes, River Mouths, Sloughs, or Lagoons

The council shall seek to minimize, where reasonable:

§25-3.2c(1) Dredging, filling or otherwise altering any bay, estuary, salt marsh, river mouth, slough or lagoon;

Discussion: Construction, operation, and maintenance of the proposed photovoltaic facility will not involve any dredging, filling, or other modifications to the above-named natural resources.

6.1.4.9 Impacts on Beaches and Public Recreation

The council shall seek to minimize, where reasonable:

§25-3.2c(2) Any development which would reduce the size of any beach or other area usable for public recreation;

Discussion: The proposed project would have no impact on the size of any beach or other area within the SMA that is useable for public recreation.

6.1.4.10 Impacts on Other Coastal Resources within the Special Management Area

The council shall seek to minimize, where reasonable:

§25-3.2c(3) Any development which would reduce or impose restrictions upon public access to tidal and submerged lands, beaches, portions of rivers and streams within the special management area and the mean high tide line where there is no beach;

Discussion: The proposed project would not restrict public access to any coastal resource in the area.

6.1.4.11 Impacts on Lines of Sight Toward the Sea

The council shall seek to minimize, where reasonable:

§25-3.2c(4) Any development which would substantially interfere with or detract from the line of sight toward the sea from the state highway nearest the coast;…

Discussion: The proposed project would not lead to any modifications to existing lines of sight toward the sea. All new above-ground structures proposed as part of this project are mauka of the state highway nearest the coast (Farrington Highway) and would not interfere with any intervening view of the sea.

6.1.4.12 Impacts on Water Quality, Open Water, Fisheries, Fishing Grounds, Wildlife Habitats & Agricultural Land Use

The council shall seek to minimize, where reasonable:

§25-3.2c(5) Any development which would adversely affect water quality, existing areas of open water free of visible structures, existing and potential fisheries and fishing grounds, wildlife habitats, or potential or existing agricultural uses of land.

Discussion: No part of the proposed project would affect any of these resources of concern. There are no such resources on the property, as discussed in Chapter 5.

6.1.4.13 Artificial Light

Special Management Area Permits can be issued only if they are consistent with Chapter 205A, Hawai‘i Revised Statutes, which contains the following relevant provisions related to artificial lights at privately owned non-hotel/hotel-condo properties *(see Section §205A-30.5 Prohibitions”).*

(a) No special management area use permit or special management area minor permit shall be granted for structures that allow artificial light from floodlights, uplights, or spotlights used for decorative or aesthetic purposes when the light:

(1) Directly illuminates the shoreline and ocean waters; or

(2) Is directed to travel across property boundaries toward the shoreline and ocean waters.

Discussion: The proposed project does not involve the use of floodlights, uplights, or spotlights for decorative or aesthetic purposes. In addition, no part of the proposed action will involve illuminating the shoreline or ocean waters.

The only outdoor lighting which will be incorporated into the project design are security lights mounted on the fence posts around the project perimeter. This lighting is intended to provide the minimum illumination needed to ensure the safety and security of workers who most access the area after dark and to deter trespassing. Unless barred from doing so by regulations intended to provide for the safety of workers or the security of the power plant, Hawaiian Electric will use fully shielded lights with lighting control that allow them to be illuminated only when needed.

In view of the foregoing, Hawaiian Electric anticipates that lighting associated with the proposed project will be fully consistent with the provisions of Section 205A-20.5, Hawai‘i Revised Statutes.

6.2 STATE OF HAWAI‘I

6.2.1 HAWAI‘I STATE PLAN

The *Hawai‘i State Plan* is intended to guide the long-range development of the State by:

- Identifying goals, objectives, and policies for the State and its residents;
- Establishing a basis for determining priorities and allocating resources; and
- Providing a unifying vision to enable coordination between the various counties’ plans, programs, policies, projects and regulatory activities to assist them in developing their county plans, programs, and projects and the State’s long-range development objectives.

The *Hawai‘i Sate Plan* is a policy document. It depends upon implementing laws and regulations to achieve its goals. The sections of the *State Plan* that are most relevant to the proposed project are Sections 226-18(a) and (b), which establish objectives and policies for energy facility systems. These sections are reproduced in italics below, and the proposed action’s consistency with them is discussed:

§226-18 (a) 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 self-sufficiency where the ratio of indigenous to imported energy use is increased;

(3) Greater energy security and diversification in the face of threats to Hawaii’s energy supplies and systems; and

(4) Reduction, avoidance, or sequestration of greenhouse gas emissions from energy supply and use.

Discussion: The proposed project would address all of the above concerns by creating a reliable and efficient source of electrical power which is not dependent upon imported fuel sources and would not,

once in operation, produce any additional greenhouse gas emissions. Thus, the project is entirely consistent with the applicable provisions of the *Hawai'i State Plan*.

6.2.2 CHAPTER 205, HAWAI'I REVISED STATUTES - LAND USE LAW

Hawai'i Revised Statutes (HRS), Chapter 205, establishes the State Land Use Commission (SLUC) and gives this body the authority to designate all lands in the State as Urban, Rural, Agricultural, or Conservation District lands. The counties make all land use decisions within the Urban Districts in accordance with their respective county general plans, development plans, and zoning ordinances. The counties also regulate land use in the state Rural and Agricultural Districts, but within the limits allowed by Chapter 205.

The Kahe Generating Station is in the state Urban District. Hawai'i Administrative Rule §15-15-18 characterizes the Urban District as exhibiting "city-like" concentrations of people, structures, streets, with an urban level of services and other related land uses. It also stresses the importance of ensuring availability of basic services and utilities in urban areas. The Kahe Generating Station is consistent with the land uses envisioned for the State Urban District. The proposed project will contribute to that use and will not alter the facility's overall character; therefore, it is an appropriate land use in the Urban District.

The total land area that would be disturbed by the proposed photovoltaic facility covered in this report exceeds one acre. Consequently, this project will require coverage under the State of Hawai'i's NPDES General Permit program (HAR §11-55, Appendix C).

6.2.3 COASTAL ZONE MANAGEMENT PROGRAM (CZM)

The objectives of the Hawai'i Coastal Zone Management (CZM) Program are set forth in Hawai'i Revised Statutes, Chapter 205A. The program is intended to promote the protection and maintenance of valuable coastal resources. All lands in Hawai'i are classified as valuable coastal resources. The State Office of Planning administers Hawai'i's CZM program. A general discussion of the project's consistency with the objectives and policies of Hawai'i's CZM program follows.

6.2.3.1 Recreational Resources

Objective: *Provide coastal recreational opportunities accessible to the public.*

Policies:

1. *Improve coordination and funding of coastal recreational planning and management; and*
2. *Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:*
    a. *Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;*
    b. *Requiring replacement of coastal resources having significant recreational value including, but not limited to, surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;*
    c. *Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;*
    d. *Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;*

e. Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;

f. Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;

g. Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and

h. Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting such dedication against the requirements of section 46-6.

Discussion: The proposed project would have no effect on coastal recreational resources. While some portion of the new photovoltaic array will be visible from the adjacent Kahe Beach Park, construction and operation of the facility would not disrupt ongoing use of the park or access to the shoreline.

6.2.3.2 Historic Resources

Objective: *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.*

Policies:

1. *Identify and analyze significant archaeological resources;*
2. *Maximize information retention through preservation of remains and artifacts or salvage operations; and*
3. *Support state goals for protection, restoration, interpretation, and display of historic resources.*

Discussion: The proposed work will occur in areas that have already been extensively disturbed. Section 5.7 describes the known locations of historic and pre-contact resources and discusses the steps that Hawaiian Electric would take to preserve any resources inadvertently discovered during construction. SHPD will be sent a copy of this EA for review and their comments, if any, will be reproduced in the *Final Environmental Assessment*.

6.2.3.3 Scenic and Open Space Resources

Objective: *Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.*

Policies:

1. *Identify valued scenic resources in the coastal zone management area;*
2. *Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;*

3. *Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and*
4. *Encourage those developments that are not coastal dependent to locate in inland areas.*

Discussion: Coastal open space and scenic resources will not be affected by the proposed action. While the proposed facility will be visible from some public vantage points, the photovoltaic array would be relatively low-profile and with a softer appearance than the distinctly industrial character of the adjacent generator buildings. The proposed action would require only minimal alteration of natural landforms and is situated well away from public views of the shoreline.

6.2.3.4 Coastal Ecosystems

Objective: *Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.*

Policies:

1. *Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;*
2. *Improve the technical basis for natural resource management;*
3. *Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;*
4. *Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and*
5. *Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.*

Discussion: The proposed action will not affect coastal ecosystems or any other water body, as described in Section 5.2.2.

6.2.3.5 Economic Uses

Objective: *Provide public or private facilities and improvements important to the State's economy in suitable locations.*

Policies:

1. *Concentrate coastal dependent development in appropriate areas;*
2. *Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and*
3. *Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:*

a. *Use of presently designated locations is not feasible;*

b. *Adverse environmental effects are minimized; and*

c. *The development is important to the State's economy.*

Discussion: The proposed project would not lead to any changes in the concentration or location of coastal developments. The work would be constructed entirely within an area designated for industrial use and would not change the character or normal use of Kahe Generating Station.

6.2.3.6 Coastal Hazards

Objective: *Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.*

Policies:

1. *Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards;*
2. *Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards;*
3. *Ensure that developments comply with requirements of the Federal Flood Insurance Program; and*
4. *Prevent coastal flooding from inland projects.*

Discussion: Section 5.8.2 confirms that the project is outside the designated Special Flood Hazard Area and, with the exception of the southwestern corner of the unmanned photovoltaic array, not within the City and County of Honolulu's Tsunami Evacuation Zone.

6.2.3.7 Managing Development

Objective: *Improve the development review process, communication, and public participation in the management of coastal resources and hazards.*

Policies:

1. *Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;*
2. *Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and*
3. *Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.*

Discussion: Hawaiian Electric has initiated contact and continues to work cooperatively with all government agencies with oversight responsibilities to facilitate efficient processing of permits and informed decision making by the responsible parties.

6.2.3.8 Public Participation

Objective: *Stimulate public awareness, education, and participation in coastal management.*

Policies:

1. *Promote public involvement in coastal zone management processes;*
2. *Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and*
3. *Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.*

Discussion: The public will have an opportunity to review and comment on the EA, pursuant to the requirements of Hawai‘i Administrative Rules §11-200. In addition, the public participation objective will be addressed during the processing of the Special Management Area permit application, which will include public notification and a public hearing.

6.2.3.9 Beach Protection

Objective: *Protect beaches for public use and recreation.*

Policies:

1. *Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;*
2. *Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and*
3. *Minimize the construction of public erosion-protection structures seaward of the shoreline.*

Discussion: The project poses no risk to beaches. No structures are planned seaward of the shoreline, and no interactions with littoral processes would be involved.

6.2.3.10 Marine Resources

Objective: *Promote the protection, use, and development of marine and coastal resources to assure their sustainability.*

Policies:

1. *Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;*
2. *Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;*
3. *Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone;*
4. *Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and*

5. *Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.*

Discussion: The proposed project does not have the potential to affect marine resources.

6.3 FEDERAL ACTS & LEGISLATION

6.3.1 ARCHEOLOGICAL AND HISTORIC PRESERVATION ACTS

As documented in Section 5.7, Hawaiian Electric has complied fully with the provisions of the Archaeological and Historic Preservation Act (16 U.S.C. §469a-1 and the National Historic Preservation Act (16 U.S.C. §470(f)).

6.3.2 CLEAN AIR ACT (42 U.S.C. § 7506(C))

As discussed in Section 5.4.2, any emissions of fugitive dust during construction of the proposed project are expected to be temporary and relatively minor. The contractors will employ Best Management Practices (BMPs) to control fugitive dust emissions during the construction phase. Normal operation of the proposed photovoltaic array will not produce on-site air emissions, will not alter air flow in the area, and will have no other measurable effect on the area's micro-climate. Substitution of solar energy for energy produced by burning Low Sulfur Fuel Oil (LSFO) could reduce emissions of regulated pollutants to some extent; hence, the project will have a beneficial effect on air quality.

6.3.3 CLEAN WATER ACT

The Clean Water Act (Federal Water Pollution Control Act, 33 USC 1251, et seq.) is the principal law governing pollution control and the water quality of the nation's waterways. While construction will disturb more than an acre of land, there are no water bodies near the project area that could be affected by construction activities. Its preliminary research indicates that Hawaiian Electric may not need to seek approvals from the U.S. Army Corps of Engineers under the Clean Water Act. It will, however, obtain an NPDES Construction permit (NPDES-NOI-C) from the State of Hawai'i Department of Health.

6.3.4 COASTAL ZONE MANAGEMENT ACT (16 U.S.C. § 1456(C) (1))

Enacted as Chapter 205A, HRS, the Hawaii Coastal Zone Management (CZM) Program was promulgated in 1977 in response to the Federal Coastal Zone Management Act of 1972. The CZM area encompasses the entire state, including all marine waters seaward to the extent of the state's police power and management authority, as well as the 12-mile U.S. territorial sea and all archipelagic waters. Section 6.2.3 above discusses the consistence of the project with the CZM Program's ten policy objectives.

6.3.5 ENDANGERED SPECIES ACT (16 U.S.C. 1536(A)(2) AND (4))

The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the U.S. or elsewhere. The Act mandates that federal agencies seek to conserve endangered and threatened species and use their authority in furtherance of the Act's purposes. It provides for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that have the potential to jeopardize listed species, and contains exceptions and exemptions.

Existing biota on and near the project site is discussed in Section 5.5. The discussion documents the fact that there are no known rare or endangered species on or immediately adjacent to the project site that would be adversely affected by the project.

6.3.6 FLOOD PLAIN MANAGEMENT (42 U.S.C. § 4321, EX. ORDER NO. 11988)

As described in Section 5.8.2, the Kahe Generating Station lies within Flood Zone D, signifying an area with an undetermined risk of flooding. The proposed improvements comply with the standards of the National Flood Insurance Program. The proposed new photovoltaic facility would not exacerbate existing flood hazards in the area.

6.4 REQUIRED PERMITS AND APPROVALS

The permits and approvals that may be required for the proposed project include the following:

Permit Name	***Issued By***
Special Management Area Use Permit	County Council, C&C of Honolulu
PUC Authorization to Commit Funds	State of Hawai‘i Public Utilities Commission
Conditional Use Permit (minor)	Department of Planning and Permitting, C&C of Honolulu
Grubbing, Grading, and Stockpiling Permit	Department of Planning and Permitting, C&C of Honolulu
Building Permits	Department of Planning and Permitting, C&C of Honolulu
Noise Permit and/or Noise Variance (HAR §11-46)	
National Pollutant Discharge Elimination System, NOI-C	Department of Health, Clean Water Branch, State of Hawai‘i
Source: Planning Solutions, Inc.	

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7. ANTICIPATED DETERMINATION

7.1 SIGNIFICANCE CRITERIA

Hawai‘i Administrative Rules (HAR) §11-200-11.2 establishes procedures for determining if an environmental impact statement (EIS) should be prepared or if a finding of no significant impact is warranted. HAR §11-200-11.2 (1) provides that applicants should issues an environmental impact statement preparation notice (EISPN) for actions that it determines may have a significant effect on the environment. HAR §11-200-12 lists the following criteria to be used in making that determination:

In most instances, an action shall be determined to have a significant effect on the environment if it:

1. *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource;*
2. *Curtails the range of beneficial uses of the environment;*
3. *Conflicts with the State's long-term environmental policies or goals as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders;*
4. *Substantially affects the economic or social welfare of the community or State;*
5. *Substantially affects public health;*
6. *Involves substantial secondary impacts, such as population changes or effects on public facilities;*
7. *Involves a substantial degradation of environmental quality;*
8. *Is individually limited but cumulatively has considerable effect on the environment or involves a commitment for larger actions;*
9. *Substantially affects a rare, threatened, or endangered species, or its habitat;*
10. *Detrimentally affects air or water quality or ambient noise levels;*
11. *Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters;*
12. *Substantially affects scenic vistas and view planes identified in county or state plans or studies; or,*
13. *Requires substantial energy consumption.*

7.2 FINDINGS

The potential effects of the proposed project described in Chapter 2 of this document were evaluated using these significance criteria. The findings with respect to each criterion are summarized below.

7.2.1 IRREVOCABLE LOSS OR DESTRUCTION OF VALUABLE RESOURCE

The proposed photovoltaic project would be constructed on Hawaiian Electric property adjacent to the existing Kahe Generating Station facility. It does not involve the loss of any significant cultural or natural resources.

7.2.2 CURTAILS BENEFICIAL USES

Construction and operation of the proposed new photovoltaic facility would support and enhance the existing use of the site for power generation, and would not curtail any beneficial use of the site. It would not substantially modify any of the existing uses of the power plant.

7.2.3 CONFLICTS WITH LONG-TERM ENVIRONMENTAL POLICIES OR GOALS

The proposed project is consistent with the *O'ahu General Plan* (see Section 6.1.1) and with the State's long-term environmental policies and goals as expressed in Chapter 344, Hawai'i Revised Statutes and elsewhere in State law.

7.2.4 SUBSTANTIALLY AFFECTS ECONOMIC OR SOCIAL WELFARE

The proposed action will not have substantial effects on economic or social welfare, except insofar as it will allow Hawaiian Electric to produce power in an economical and efficient manner while maintaining environmental quality.

7.2.5 PUBLIC HEALTH EFFECTS

The proposed project will not adversely affect air quality or any water sources used for drinking or recreation. Neither will it generate large amounts of solid waste or produce other emissions that will have a significant adverse effect on public health.

7.2.6 PRODUCE SUBSTANTIAL SECONDARY IMPACTS

The proposed project will not produce substantial secondary impacts. It is not designed to foster population growth or to promote economic development. Instead, it is intended to support Hawaiian Electric's current power generation activities at Kahe Generating Station.

7.2.7 SUBSTANTIALLY DEGRADE ENVIRONMENTAL QUALITY

The proposed project will not have substantial long-term environmental effects. The work will temporarily elevate noise levels and generate airborne dust during construction, but these impacts will be localized and of limited duration. So long as adequate measures are taken to control the intensity of construction noise and the release of dust, effects will be minimal.

7.2.8 CUMULATIVE EFFECTS OR COMMITMENT TO A LARGER ACTION

The proposed photovoltaic facility does not represent a commitment to a larger action and is not intended to facilitate substantial population growth. It is intended to help Hawaiian Electric meet the growing need for power on Oahu in an economical, efficient, and environmentally sound way.

7.2.9 EFFECTS ON RARE, THREATENED, OR ENDANGERED SPECIES

No rare, threatened, or endangered species are known to utilize the project area. The project will not utilize a resource needed for the protection of rare, threatened, or endangered species.

7.2.10 AFFECTS AIR OR WATER QUALITY OR AMBIENT NOISE LEVELS

Once constructed, the proposed project will not have a measurable effect on air quality or water quality (see Sections 5.2 and 5.4). Noise levels and airborne emissions will temporarily increase during construction of the photovoltaic facility but are not anticipated to affect any noise-sensitive uses, as discussed in Section 5.6).

7.2.11 ENVIRONMENTALLY SENSITIVE AREAS

There are no environmentally sensitive areas or resources in or near the proposed project. The project area, with the exception of the southwestern corner of the site, is outside defined flood and tsunami

hazard zones. The structures built as part of the project will be constructed in a manner consistent with the Hawai‘i Uniform Building Code for Earthquake Zone 2a.

7.2.12 AFFECTS SCENIC VISTAS AND VIEW PLANES

The proposed project is not within a designated scenic area. While it will alter the visual character of the project site to some extent, it will not impact scenic vistas or important views across it (see Section 5.9).

7.2.13 REQUIRES SUBSTANTIAL ENERGY CONSUMPTION

Construction of the proposed project will use some energy, however once in operation the facility will produce, rather than consume, energy and will require only infrequent maintenance.

7.3 ANTICIPATED DETERMINATION

In view of the foregoing, Hawaiian Electric and the DPP have concluded that the proposed project will not have a significant adverse impact on the environment. Consequently, DPP anticipates issuing a Finding of No Significant Impact (FONSI) for the proposed action.

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9. CONSULTATION & DISTRIBUTION

9.1 PARTIES CONSULTED IN PREPARATION OF THE DRAFT EA

Hawaiian Electric consulted with the parties listed in Table 9.1 in the course of preparing this Draft Environmental Assessment.

Table 9.1 Parties Consulted During Preparation of the Draft EA

Organization or Agency
Department of Planning and Permitting, City and County of Honolulu
Nānākuli-Māʻili Neighborhood Board
State Historic Preservation Division, State of Hawaiʻi
Honolulu District, U.S. Army Corps of Engineers
Source: Compiled by Planning Solutions, Inc. (2014)

9.2 DISTRIBUTION OF THE DRAFT EA

The Department of Planning and Permitting and Hawaiian Electric distributed copies of this Draft Environmental Assessment to the parties listed in Table 9.2.

Table 9.2. Draft EA Distribution List

State Agencies	City and County of Honolulu
Office of Environmental Quality Control (1 HC, 1 CD)	Department of Planning & Permitting (5 copies)
Department of Agriculture	Board of Water Supply
Department of Accounting and General Services	Department of Community Services
Department of Business, Economic Development, and Tourism (DBEDT)	Department of Design & Construction
DBEDT - Energy Division	Department of Environmental Services
DBEDT – Office of Planning	Department of Facility Maintenance
Department of Defense	Department of Parks & Recreation
Department of Education	Department of Transportation Services
Department of Hawaiian Home Lands	Honolulu Fire Department
Environmental Planning Office, Department of Health	Honolulu Police Department – City of Kapolei
Clean Air Branch, Department of Health	
Clean Water Branch, Department of Health	**Elected Officials**
Wastewater Branch, Department of Health	U.S. Senator Brian Schatz
Department of Human Services	U.S. Senator Colleen Hanabusa
Department of Labor and Industrial Relations	US Representative Mazie Hirono
Department of Land and Natural Resources (5 copies)	US Representative Tulsi Gabbard
DLNR Historic Preservation Division (1 HC)	State Senator Maile Shimabukuro
Department of Transportation	State Representative Karen Awana
Hawaii Housing Finance and Development Corp.	State Representative Georgette "Jo" Jordan
Office of Hawaiian Affairs	City Councilmember Kymberly Pine (District 1)
UH Environmental Center	Waiʻanae Neighborhood Board #24, Chair, Johnnie-Mae L. Perry
Federal Agencies	Nānākuli-Māʻili Neighborhood Board #36, Chair, Cynthia Rezentes
US Department of the Army, Regulatory Branch	
US Fish and Wildlife Service	**Libraries and Depositories**

	Hawai‘i State Library Hawai‘i Documents Center
Utility Companies	Pearl City Regional Library
Hawaiian Telcom	Kapolei Public Library
The Gas Company	
	News Media
Other	Honolulu Star Advertiser
Nettie Tiffany	
Source: Compiled by Planning Solutions, Inc. (2013)	

A. BIOLOGICAL SURVEY OF THE PROJECT SITE

Biological Surveys Conducted for the Hawaiian Electric Kahe Photovoltaic Project, Kahe Valley, Waiʻanae District, Island of Oʻahu

Prepared by:

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February 26, 2014

Table of Contents

Introduction

Hawaiian Electric is planning to construct an approximately 50-acre utility scale photovoltaic project adjacent to their existing Kahe Generating Station, located in Kahe Valley, Waiʻanae District, Oʻahu. The subject property is owned by Hawaiian Electric and is currently the location of the largest power generation facility in the state (Figure 1).

This report describes the methods used and the results of the botanical avian and mammalian surveys conducted on the subject property as part of the environmental disclosure process associated with the proposed project.

The primary purpose of the surveys was to determine if there are any botanical, avian or mammalian species currently listed, or proposed for listing under either federal or State of Hawaiʻi endangered species statutes within or adjacent to the study area. The federal and State of Hawaiʻi listed species status refers to species identified in the following referenced documents, (Department of Land and Natural Resources (DLNR) 1998 and U. S. Fish & Wildlife Service (USFWS) 2005a, 2005b, 2014). Fieldwork was conducted on January 20, 2014.

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

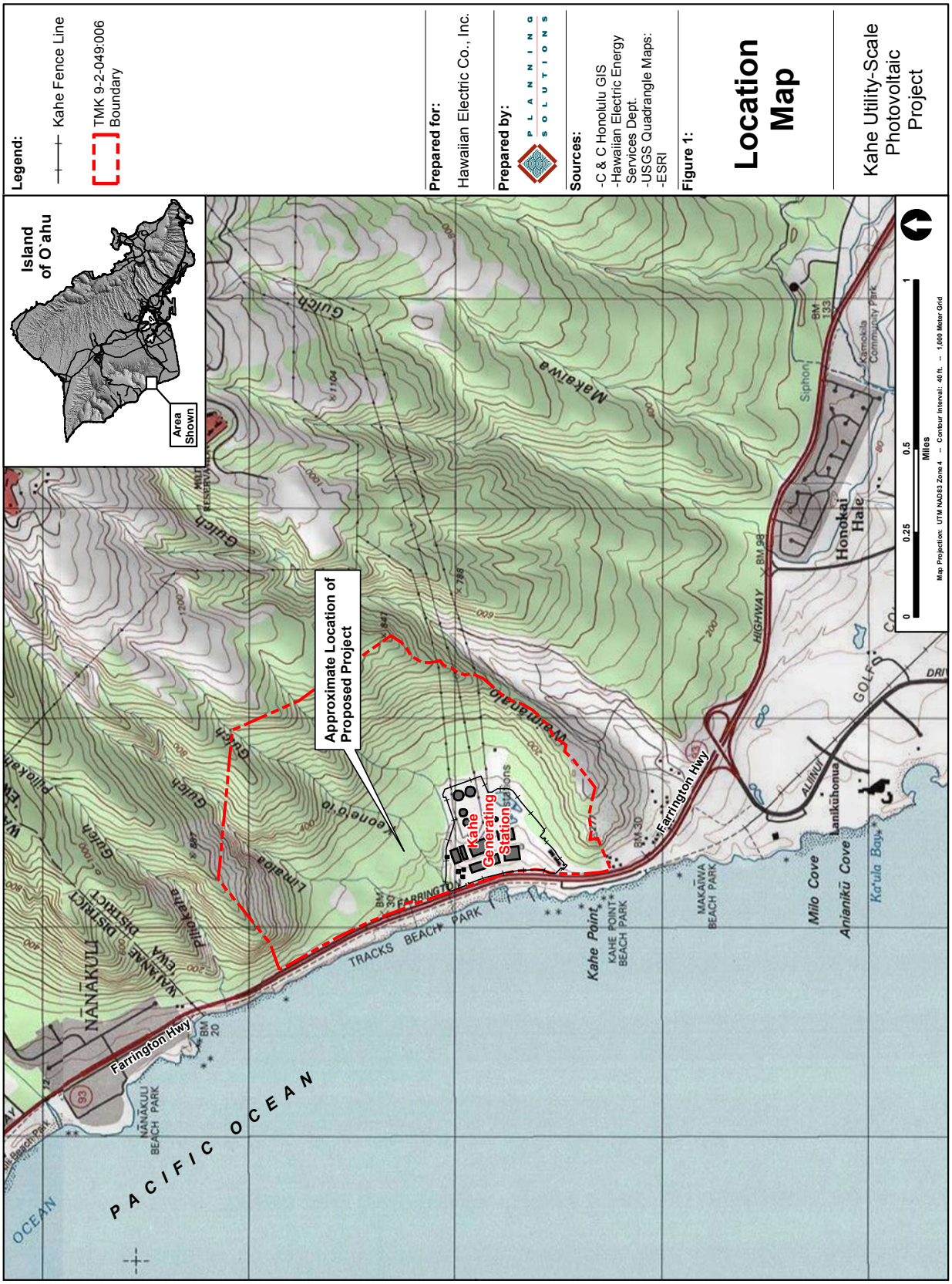
Project Description

The project site is fronted by Farrington Highway, and bound by the walls of Kahe Valley to the north and east (Figure 2). The proposed project involves the construction, installation, and operation of an approximately 11.5 Megawatt (MW) Alternating Current (AC) renewable photovoltaic (PV) electrical generation system located on an undeveloped portion of Hawaiian Electric's existing property at Kahe Generating Station. The project will be tied to the Hawaiian Electric's island-wide electrical grid.

The project will include approximately 50,000, 300-watt fixed-tilt, ground-mounted photovoltaic panels ("modules"). Together, these would generate up to 15 MW of Direct Current (DC) power. To maximize energy output, the panels will be set at a 20-degree tilt to the sun and will be oriented facing south.

Electrical Equipment Pads

The modules will be divided into twelve distinct sub-systems. Groups of modules will be connected to pad-mounted inverters. The inverters will convert the DC power produced by the panels into the AC current that is used in Hawaiian Electric's system. Each inverter will have its own 480 V-12.47 kilovolt (kV) transformer. Eleven of these transformers will be sized 1.0 MW AC and the remaining inverter will be sized at 0.5 MW AC for the 11.5 MW AC total use throughout this report.


Legend:
Kahe Fence Line
TMK 9-2-049:006 Boundary
Island of O'ahu
Area Shown
Prepared for:
Hawaiian Electric Co., Inc.
Prepared by:
PLANNING SOLUTIONS
Sources:
-C & C Honolulu GIS
-Hawaiian Electric Energy Services Dept.
-USGS Quadrangle Maps:
-ESRI
Figure 1:
Location Map
Kahe Utility-Scale Photovoltaic Project
Approximate Location of Proposed Project
Kahe Generating Station
Farrington Hwy
PACIFIC OCEAN
NĀNĀKULI
NĀNĀKULI BEACH PARK
TRACKS BEACH PARK
Kahe Point
KAHE POINT BEACH PARK
MAKAIWA BEACH PARK
Milo Cove
Anianiku Cove
Ka'ula Bay
Honokai Hale
Kamokila Community Park
Makaiwa Gulch
Lualaea Gulch
Pilokahe Gulch
Siphon
HIGHWAY
ALINUI
Map Projection: UTM NAD83 Zone 4 -- Contour Interval: 40 ft. -- 1,000 Meter Grid
0 0.25 0.5 1
Miles


Legend:
HECO Kahe Generating Station Parcel Boundary
0
250
500
1,000
Feet
Survey Area
Tracks Beach Park
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Prepared for:
Hawaiian Electric Co., Inc.
Prepared by:
PLANNING SOLUTIONS
Sources:
-Hawaiian Electric Co., Inc.
-ESRI
Project:
Kahe Utility-Scale Photovoltaic Project
Figure 2:
Survey Area
Figure 2 Survey Area 2014-01-08.mxd

The 12.47 kV power from each of these twelve groups will be carried through electrical cables in underground conduits to the combined output of these twelve transformers will be delivered to the proposed Kahe Utility-Scale Photovoltaic (PV) Substation.

46 Kv Kahe Substation

The combined output from the twelve equipment pads will be delivered to a single 12.47 kV-46 kV transformer in a new 46 kV substation that Hawaiian Electric would construct adjacent to Farrington Highway at the southern end of the PV arrays. Access to the substation would be via Kahe Generating Station and the new 20-foot wide firebreak/access road.

The proposed KUSPP substation would have several different types of equipment including switchgear, six standard oil-filled ANSO/IEEE transformers, voltage regulators, capacitors, and other electrical components. The transformers' purpose is to raise the voltage of the electrical power from the 12.47 kV voltage delivered from the twelve equipment pads to 46 kV that will feed into Hawaiian Electric's existing switch yard at Kahe Generating Station. Each transformer would service two incoming (from the equipment pads) 12.47 kV circuits. The conceptual plan for the substation provides a 10- foot long by 8-foot wide by 10-foot high pre-fabricated SCADA and switchgear building. This small structure would house the relaying and protective controls, station control batteries, communications equipment, and other necessary monitoring and control equipment, tools, and maintenance supplies.

General Site Description

The project site is located immediately *mauka* of Farrington Highway and north of the existing Hawaiian Electric Kahe Generating Station, and is bound by the walls of Kahe Valley to the north and east (Figure 1 & 2). The terrain gently slopes north and east from Farrington Highway from an elevation of approximately three meters above mean sea level (MSL) up to a maximum elevation of approximately 50 meters MSL in the northeast corner of the site.

The vegetation present on the site best is characterized as grassland with very scattered trees (Figure 3), except were drainages cross the site and shrubland prevails. In some areas, the vegetation approaches that of a savanna (grassland with an open canopy of trees).

Figure 3 - Looking down across the middle of site from well upslope of the proposed PV facility site.

Methods

Plant names mostly follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al., 1990, 1999) for native and naturalized flowering plants and *A Tropical Garden Flora* (Staples and Herbst, 2005) for crop and ornamental plants. Some plant species names have been updated following more recently published literature as summarized in Imada (2012). The avian phylogenetic nomenclature used in this report follows the *AOU Check-List of North American Birds* (American Ornithologists' Union, 1998), and the 42nd through the 53rd supplements to the Check-List (American Ornithologists' Union, 2000; Banks et al., 2002, 2003, 2004, 2005, 2006, 2007, 2008; Chesser et al., 2009, 2010, 2011, 2012, 2013). Mammalian species scientific names follow (Wilson and Reeder, 2005). Place names follow (Pukui et al., 1974).

Botanical Survey

The botanical survey was undertaken on January 20, 2014 and entailed a wandering pedestrian transect that traversed primarily those parts of the property proposed for the solar panels and appurtenant structures. A GPS unit (Trimble, GeoXH) was used to record the progress track of the botanist and provide real time feedback on survey coverage. Plant species were identified as they were encountered and notations were recorded and used to develop a qualitative sense of abundance as the survey progressed. The survey period encompassed the wet season and the vegetation appeared generally well watered. For a few species not immediately recognized in the field, photographs were taken and/or material was collected for identification in the laboratory.

Avian Survey

Seven avian count stations were sited equidistant from each other within the study area. A single eight-minute avian point count was made at each count station. Field observations were made with the aid of Leica 10 X 42 binoculars and by listening for vocalizations. The count and subsequent search of the remainder of the site was conducted between 8:00 am and 10:30 am. Time not spent counting the point count stations was used to search the rest of the site for species and habitats not detected during the point counts. Weather conditions were ideal, with no rain, unlimited visibility and winds of between 1 and 3 kilometers an hour.

Mammalian Survey

With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *ʻōpeʻapeʻa* as it is known locally, all terrestrial mammals currently found on the Island of Oʻahu are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all terrestrial vertebrate mammalian species detected within the project area.

Results

Botanical Survey

Vegetation

Vegetation on the proposed PV site is composed mostly of grasses and other herbs. Scattered trees and shrubs are present, although along shallow gulch bottoms. Shrubs dominate the vegetation on the site. The dominant grass here is buffelgrass (*Cenchrus ciliaris*) and in some places, Guinea grass (*Urochloa maxima*). The scrubland along gulch bottoms is mostly short-stature *koa haole* (*Leucaena leucocephala*) with a Guinea grass understory. *Kiawe* (*Prosopis pallida*) trees and *klu* (*Acacia farnesiana*) shrubs are scattered across the area. In a few areas, native cotton plants or *maʻo* (*Gossypium tomentosum*) are moderately abundant. Indeed, in these same areas, several other native shrubs are also abundant: hoary abutilon (*Abutilon incanum*), *ʻilima* (*Sida fallax*), and ʻ*uhaloa* (*Watheria indica*). In some cases, the predominance of natives can be associated with recently cleared ground as in Figure 4.

Figure 4– Shallow swale of partially bare soil dominated by *'ilima* with buffelgrass encroaching at the edges.

Flora

"Flora" is the diversity of plant species living in the survey area. A plant checklist (Table 1) was compiled from field observations, with entries arranged alphabetically under plant family names (standard practice). Included in the list are scientific name, common name, and status (for example, whether native or non-native, naturalized or ornamental) for each species observed during the survey.

Qualitative estimates of plant abundance were recorded for each species. Abundance values are coded in the table as explained in the Legend to Table 1. For some species, a two-level system of abundance is used; with a letter-number code indicating a species having a somewhat clustered distribution. For example, a species infrequently encountered but numerous where found would have an abundance rating of "R" indicating a plant encountered only one to three times during the entire survey of the site, but an "R2" to indicate several to many individuals present where encountered. An "R3" would be a plant similarly seldom encountered (i.e., rare), but locally abundant in one or more of the locations where encountered. A species marked "O3" would be one seen with some regularity, usually occurring in patches of numerous individuals (as opposed to "C" for a species seen with regularity throughout the survey area).

A total of 42 species of vascular plants was recorded during our survey of the area. The 42 species are mostly introduced species, but the site does have a smattering of three natives and one early Polynesian introduction (9.5 percent of the species). While this percentage is typical for lowland Oʻahu, not typical is the moderately high abundance of these "native" plants. Three of the species are widespread, especially in dry areas of the island; only native cotton or *maʻo* (*Gossypium tomentosum*) is considered uncommon on Oʻahu. A majority of the cotton plant population on this site is distributed on slopes above the planned PV area.

Table 1 – Plant species identified from January 2014 survey of the Hawaiian Electric Kahe PVC Site, TMK:

Species listed by family	Common name	Status	Abundance
FLOWERING PLANTS			
DICOTYLEDONES			
AIZOACEAE			
Trianthema tetragonioides (Pall.) Kuntze	---	Nat	R
ASTERACEAE (COMPOSITAE)			
Bidens pilosa L.	*kī*	Nat	U
Emilia fosbergii Nicolson	*pualele*	Nat	R
Pluchia carolinensis (Jacq.) G. Don	sourbush	Nat	U2
Sonchus oleraceus L.	sow thistle	Nat	R
ASTERACEAE (COMPOSITAE) Continued			
Tridax procumbens L.	coat buttons	Nat	R
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	Nat	R
BIGNONIACEAE			
Tecoma stans (L.) Juss. ex Kunth	yellow elder	Nat	R
CHENOPODIACEAE			
Atriplex suberecta Verd.	---	Nat	U3
Salsola tragus L.	Russian thistle	Nat	R
CONVOLVULACEAE			
Ipomoea obscura (L.) Ker-Gawl	---	Nat	R
Merremia aegyptica (L.) Urb.	hairy merremia	Nat	C1
CUCURBITACEAE			
Coccinia grandis (L.) Voigt	scarlet-fruited gourd	Nat	R
Momordica charantia L.	wild bitter melon	Nat	R
EUPHORBIACEAE			
Euphorbia hypericifolia L.	graceful spurge	Nat	O
Euphorbia hirta L.	garden spurge	Nat	R
Ricinus communis L.	castor bean	Nat	U1
FABACEAE			
Acacia farnesiana (L.) Willd.	*klu*	Nat	O

Table 1 (continued)

Species listed by family	Common name	Status	Abundance
FABACEAE continued			
Chamaecrista nictitans (L.) Moench	partridge pea	Nat	R
Crotalaria pallida Aiton	smooth rattlepod	Nat	R
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	Nat	A
Leucaena leucocephala (Lam.) deWit	*koa haole*	Nat	C
Macroptilium atropurpureum (DC.) Urb.	---	Nat	U
Macroptilium lathyroides (L.) Urb.	cow pea	Nat	R
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	*kiawe*	Nat	C2
LAMIACEAE			
Hyptis pectinata (L.) Poit.	comb hyptis	Nat	U2
Leonotis nepetifolia (L.) R. Br.	lion's ear	Nat	O
MALVACEAE			
Abutilon incanum (Link) Sweet	*ma'o*	**Ind**	A2
Gossypium tomentosum Nutt. ex Seem.	*ma'o*	**End**	C1
Malva parviflora L.	cheese weed	Nat	R
Sida fallax Walp.	*'ilima*	**Ind**	A2
Sida spinosa L.	prickly sida	Nat	R
Waltheria indica L.	*'uhaloa*	**Pol**	C2
PASSIFLORACEAE			
Passiflora suberosa L.	*huehue haole*	Nat	R
PORTULACEAE			
Portulaca oleracea L.	pigweed	Nat	R
FLOWERING PLANTS			
MONOCOTYLEDONES			
POACEAE			
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	Nat	C2
Cenchrus ciliaris L.	buffelgrass	Nat	AA
Chloris barbata (L.) Sw.	swollen fingergrass	Nat	O
Chloris virgate Sw.	feather fingergass	Nat	U
Echinochloa colona (L.) Link	jungle-rice	Nat	U
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	Nat	R1
Urochloa maxima (Jacq.) R. Webster	Guinea grass	Nat	AA

Legend to Table 1

STATUS = distributional status for the Hawaiian Islands:

Ind = indigenous; native to Hawaii, but not unique to the Hawaiian Islands.
End = endemic; native an unique to the Hawaiian Islands
Pol = Polynesian introduction so called (canoe plants)
Nat = naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.
Orn = A cultivated plant; a species not thought to be naturalized (spreading on its own) in Hawaiʻi.

ABUNDANCE = occurrence ratings for plant species:

-- - Species not present in area.
R – Rare - seen in only one or perhaps two locations.
U – Uncommon - seen at most in several locations
O - Occasional - seen with some regularity
C - Common - observed numerous times during the survey
A - Abundant - found in large numbers; may be locally dominant.
AA - Very abundant -abundant and dominant; defining vegetation type.

Numbers (1 – 3) following qualitative rating of abundance indicate localized abundance is greater than occurrence rating. For example, R3 would be a plant encountered only once or twice, but very numerous where encountered.

Avian Survey

A total of 106 individual birds of 18 species, representing 11 separate families, were recorded during station counts. All of the species recorded are alien to the Hawaiian Islands (Table 2). No avian species detected during the course of this survey are protected or proposed for protection under either the federal or State of Hawaiʻi endangered species statutes.

Avian diversity and densities were both low, though in keeping with the habitats present on the site. Three species, House Finch (*Haemorhous mexicanus*), Common Waxbill (*Estrilda astrild*) and Common Myna (*Acridotheres tristis*) accounted for almost 56–percent of all birds recorded during station counts. The most frequently recorded species was House Finch, which accounted for slightly more than 22.5-percent of the total number of individual birds recorded during station point counts.

Table 2 – Avian Species Detected Within the Kahe Photovoltaic Project Site			
Common Name	***Scientific Name***	***ST***	***RA***
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Black Francolin	*Francolinus francolinus*	A	0.14
Erckel's Francolin	*Francolinus erckelii*	A	0.29
	COLUMBIFORMES		
	COLUMBIDAE – Pigeons & Doves		
Rock Pigeon	*Columba livia*	A	1.29
Spotted Dove	*Streptopelia chinensis*	A	0.29
Zebra Dove	*Geopelia striata*	A	0.57
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	2.00
	ZOSTEROPIDAE – White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	1.86
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	A	0.14
	STURNIDAE – Starlings		
Common Myna	*Acridotheres tristis*	A	2.29
	THRAUPIDAE - Tanagers		
Red-crested Cardinal	*Paroaria coronata*	A	0.86
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.71
	FRINGILLIDAE – Fringilline and Carduleline Finches & Allies		
	Carduelidae – Carduline Finches		
House Finch	*Haemorhous mexicanus*	A	3.43
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	A	0.29
	ESTRILDIDAE – Estrildid Finches		
Common Waxbill	*Estrilda astrild*	A	2.71
African Silverbill	*Lonchura cantans*	A	0.14
Chestnut Munia	*Lonchura atricapilla*	A	0.29
Java Sparrow	*Padda oryzivora*	A	0.71

Legend to Table 2

ST	Status
A	Alien – Introduced to the Hawaiian Islands by humans
RA	Relative Abundance - Number of birds detected divided by the number of count stations (7)

Mammalian Survey

Three terrestrial mammalian species were detected adjacent to the site during the course of this survey. Tracks, of dog (*Canis familiaris*), small Indian mongoose (*Herpestes auropunctatus*), and cat (*Felis catus*), were seen in the mud on the storm runoff channel located between the site and the existing Kahe generating station. No mammals were encountered within the site.

No mammalian species currently protected or proposed for protection under either the federal or State of Hawaiʻi endangered species programs were detected during the course of this survey, nor were any expected (DLNR, 1998; USFWS; 2005a, 2005b, 2014).

Discussion

Botanical Resources

The findings of our reconnaissance level botanical survey are in keeping with the xeric, nature of this lowland site. The property does have a slightly higher presence of native species than might be found on typically more disturbed properties along the leeward coast, but only *maʻo* (*Gossypium tomentosum*) is of any special interest, as the other natives are quite common. Hawaiian cotton has been considered for listing in the past (USFWS, 1985; described as "vulnerable" in Wagner, Herbst, & Sohmer, 1990). Presently, this native endemic species is not listed under endangered species statutes. The majority of cotton plants observed on the property occur on slopes above the sites proposed for photovoltaic solar panels.

Avian Resources

The findings of the avian survey are consistent with the habitat and the site's location and with the findings of a previous survey conducted on a portion of the site in 2011 (David, 2011). During the course of this survey, we recorded a total of 106 individual birds representing 18 species; all species detected are alien to the Hawaiian Islands (Table 2).

Although no seabirds were detected during the course of this survey, several seabird species potentially overfly the site on occasion. The primary cause of mortality in resident seabirds is thought to be predation by alien mammalian species at the nesting colonies

(USFWS 1983; Simons and Hodges 1998; Ainley *et al.,* 2001).). As there are no known nesting colonies of any seabird species near the project site, this is not an issue with respect to the proposed project.

Collision with man-made structures is considered to be the second most significant cause of mortality in locally nesting seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds often collide with manmade structures, and if they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals (Hadley 1961; Telfer 1979; Sincock 1981; Reed *et al.*, 1985; Telfer *et al.*, 1987; Cooper and Day, 1998; Podolsky *et al*. 1998; Ainley *et al.,* 2001; Hue *et al.,* 2001; Day *et al* 2003).

The proposed project does not contain any exterior lighting that might attract or disorient fledgling nocturnally seabirds, nor will night-time construction occur. The panels themselves are low-lying (less than 10 feet above the ground) and do not, therefore, constitute a significant avian collision hazard. The few poles that would be installed to carry the proposed new 46 kV circuit from the proposed substation to the existing switchyard within the Kahe Generating Station complex are slightly higher. However, in the absence of substantial known seabird use of the airspace, these do not constitute a substantial new risk.

Mammalian Resources

The findings of the mammalian survey are consistent with the habitat and the sites location. Although mammalian species were detected on the site during this survey, during the 2011 survey of a portion of the site tracks, scat and sign of dog small Indian mongoose, cat and pig (*Sus scrofa*) were encountered. Additionally, no rodents were detected during the course of this survey or the 2011 survey of a portion of the site, it is likely that the four established alien muridae fund on O'ahu, roof rat (*Rattus rattus*), brown rat (*Rattus norvegicus*), European house mouse (*Mus musculus domesticus*) and possibly black rats (*Rattus exulans hawaiiensis*) use various resources found within the general project area on a seasonal basis. All of these introduced mammalian predators are deleterious to native ecosystems and the native faunal species dependent on them.

No Hawaiian hoary bats were detected during the course of this survey. Given the paucity of documented records of this species on O'ahu and the complete lack of suitable roosting vegetation on the site the chance that any use resources on the subject property are extremely low (USFWS, 1998; David, 2013).

Potential Impacts to Protected Species

Botanical

No species of plant listed as threatened or endangered under state or federal statutes was recorded during the survey. Therefore the further modification of the habitat present on

this site is not expected to result in deleterious impacts to any species currently proposed or listed under either the federal or State of Hawaiʻi endangered species statutes.

Seabirds

As neither exterior lighting nor nighttime construction activities are planned for this project, it is not expected that the construction and operation of the proposed photovoltaic system result in deleterious impacts to listed seabird species.

Recommendations

- Hawaiian Electric is developing a native plantings strip along the lower edge of this site. *Maʻo* is an excellent candidate for planting in this area and has the potential to become the dominant shrub in the native restoration project area, easily off-setting the few cotton plants displaced by the Photovoltaic project.

Critical Habitat

There is no federally delineated Critical Habitat present on the property. Thus the development and operation of the proposed PV project will not result in impacts to federally designated Critical Habitat. There is no equivalent statute under state law.

Glossary

Alien – Introduced to Hawaiʻi by humans
Endangered – Listed and protected under the Endangered Species Act of 1973, as amended (ESA) as an endangered species
Endemic – Native to the Hawaiian Islands and unique to Hawaiʻi
Indigenous – Native to the Hawaiian Islands, but also found elsewhere naturally
Mauka - Upslope, towards the mountains
Muridae – Rodents, including rats, mice and voles, one of the most diverse family of mammals
Naturalized – A plant or animal that has become established in an area that it is not indigenous to
Nocturnal – Night-time, after dark
ʻŌpeʻapeʻa – Endemic endangered Hawaiian hoary bat (Lasiurus cinereus semotus)
Pelagic – An animal that spends its life at sea – in this case seabirds that only return to land to nest and rear their young
Phylogenetic – The evolutionary order that organisms are arranged by
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Sign – Biological term referring tracks, scat, rubbing, odor, marks, nests, and other signs created by animals by which their presence may be detected
Threatened – Listed and protected under the ESA as a threatened species
Xeric – Extremely dry conditions or habitat

AC – Alternating Current
DC – Direct Current
DLNR – Hawaiʻi State Department of Land & Natural Resources
DOFAW – Division of Forestry and Wildlife
ESA – Endangered Species Act of 1973, as amended
HE – Hawaiian Electric
kV - Kilovolt
MG- Megawatt
MSL – Mean Sea Level
PV - photovoltaic
USFWS – United State Fish & Wildlife Service
V - Volt

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B. VEGETATION MANAGEMENT PLAN

Vegetation Management Plan

Kahe Utility Scale PV 11.5 MW(AC)
Hawaiian Electric

April 4, 2014

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Table of Contents

1.0 Introduction

Hawaiian Electric (the Company) is constructing an 11.5MW AC (alternating current) renewable photovoltaic electrical generation system (Utility scale PV) on an undeveloped portion of its existing property at the Kahe Generating Station at 92-200 Farrington Highway, Kapolei, Hawaii. All initial clearing of vegetation and construction of this facility will be conducted by SolarCity Corporation (SCC). When construction is complete, the operation and maintenance (O&M) of the Utility scale PV, including routine vegetation management, will be conducted by the Company.

2.0 VMP Purpose

The purpose of this Vegetation Management Plan (VMP) is to define and describe the Company's vegetation management program. This VMP will be implemented to guide vegetation clearance during construction and then maintain and control vegetation during O&M within the Utility scale PV facility site. This document will ensure that vegetation management (VM) operations are planned and performed in an orderly, safe, efficient and effective manner while balancing consideration of environmental impacts, cost containment and aesthetics.

VM (i.e. cutting, mowing, removal and control) is necessary to insure safe, efficient construction of facilities and the safe, cost-effective, reliable delivery of electric service through the Company's Utility scale PV. VM must be conducted to remove and/or control:

- Vegetation that is located where excavation is required to install Utility scale PV facilities.
- Vegetation that obstructs or conflicts with installation of the Utility scale PV facilities.
- Tall growing vegetation that is capable of obstructing sunlight onto the panels and reducing efficient electrical output.
- Vegetation growing near to the Utility scale PV facilities and within access routes that create potential safety hazards for personnel by obstructing visual and/or physical access or otherwise facilitating potentially hazardous conditions (e.g. trips, slips, falls).
- Vegetation that is capable of obstructing visual and physical access for the efficient and effective operation, inspection, maintenance and repair of Utility scale PV facilities.

3.0 Primary Goals and Objectives of the Vegetation Management Plan

The following primary goals and objectives that guide VM activities within the Utility scale PV facility are as follows:

3.1 To cut, mow, remove, or otherwise control all vegetation capable of interfering with safe, effective and efficient construction, operation, inspection, maintenance and repair of Utility scale PV facilities including:

- Obstructs or conflicts with construction or O&M activities;
- Is capable of growing tall enough to obstruct sunlight onto the solar panels;
- May create unsafe construction, operating, inspection, maintenance or repair conditions including, but not limited to tripping, slipping or providing an electrical path to ground;

- Is capable of growing into or falling onto Utility scale PV facilities and damaging or otherwise degrading or accelerating the degradation of their material or physical condition; and
- Is capable of obstructing visual and/or physical access for the construction, operation, inspection, maintenance or repair of Utility scale PV facilities.

3.2 Maintain a sustainable cover of desirable vegetation given natural site conditions.

- Protect and preserve native and desirable plants that naturally establish and thrive and that mature at heights that will not obstruct, interfere, create unsafe conditions or otherwise adversely affect Utility scale PV facility operations.

3.3 Apply best management practices within an Integrated Vegetation Management (IVM) program designed to most safely and cost-effectively manage vegetation considering environmental impacts.

- Identify the optimum VM cycle based on undesirable vegetation growth rate and density.
- Select and apply vegetation control methods based on clearly defined vegetation height and condition action thresholds (section 7.1).
- Monitor vegetation height and conditions at intervals that will permit timely identification of defined vegetation thresholds, and selection and application of appropriate control method(s).
- Select and correctly apply the most cost-effective control method(s).
- Annually review this VMP and make the appropriate amendments to enhance clarity, recognize statutory or regulatory changes, and to implement improved industry standards and practices in order to maintain the highest practical level of efficiency and effectiveness within the VM program.

3.4 Conduct all VM operations in a safe, effective manner and in conformity with all applicable Federal, State, and City & County laws, ordinances, regulations, permit conditions, and this VMP.

- Qualify and utilize only competent personnel to design, implement and provide direction for its VM program.
- Regularly evaluate program performance to ensure conformance with this VMP.

4.0 Site Location

The project site is located immediately adjacent to the Kahe Generating Station (see photo below) and is bounded by Farrington Highway (Hawaii Route 93) on the west and undeveloped lands to the east and north. The site is accessed from the Kahe Generating Station. Based on the current construction plan, the project will utilize approximately 50 acres.

Kahe Utility Scale PV Facility Location

5.0 Existing Vegetation Conditions

Existing vegetation conditions on this site have been described within the "Biological Surveys Conducted for the Hawaiian Electric Kahe Photovoltaic Project, Kahe Valley, Wai'anae District, Island of O'ahu" Prepared by Rana Biological Consulting, Inc. et al, dated February 26, 2014. The pertinent sections of this report that address vegetation conditions are extracted from the subject report and provided in Appendix A.

6.0 Summary of Construction Activities and Components

Vegetation management for construction will consist of clearing the existing vegetation in those areas where Utility scale PV facilities will be installed, and excavation, grading and access routes are required. Removal and control of any tall-growing vegetation on-site that is capable of conflicting with the O&M of the Utility scale PV facilities may also be conducted.

The project area will require some clearing to permit installation of facilities, including solar panels, supporting equipment, and access roads and paths. Because the bottoms of the lower end of the solar modules will be approximately 18 inches above grade, any vegetation taller than 12 inches or expected to exceed 18 inches in height will be cut, mowed, removed, or otherwise controlled to facilitate required construction activities. Active removal of low-growing, desirable shrubs, grass, and groundcover will be avoided under the solar modules.

7.0 Target Vegetation

Target vegetation includes:

- Tall growing vegetation that obstructs sunlight onto solar panels and reduces efficient electrical output or is capable of falling onto Utility scale PV facilities.

- Vegetation growing within Utility scale PV access routes that may create safety hazards such as a trips, slips and/or falls or provide paths for indirect electrical contacts through vegetation.
- Vegetation that obstructs construction activities and installations, and visual and physical obstacles for the efficient and effective operation, inspection, maintenance and repair of Utility scale PV facilities.

7.1 Target Vegetation Thresholds

Thresholds for vegetation vary depending on location, density and species characteristics and site conditions.

As a guide, thresholds that trigger vegetation cutting, mowing, removal, or other control may be defined as follows:

- Vegetation within the array fence exceeds 18 inches in height.
- Access roads and paths:
    - Graveled: Vegetation emerges on the graveled surface and covers greater than 5% of the graveled area.
    - Unimproved (not graveled): Vegetation reaches 4 inches in height.
- Tall-growing tree species (capable of growing up to and taller than 20 feet in height) that do not meet the thresholds above and are within 20 feet of the Utility scale PV facilities:
    - Approximately 25% of the target tree species population is 6 feet in height.
- Tall-growing tree species (capable of growing taller than 20 feet in height) that do not meet the thresholds above and are within 60 feet of the Utility scale PV facilities:
    - Approximately 25% of the target tree species population is 6 feet in height.

Thresholds may be modified according to on-site experience with vegetation and site conditions that justify the amended threshold. Modifications of thresholds shall consider and conform to the IVM factors to be considered to determine the maximum threshold as described within section 8.1 Integrated Vegetation Management (IVM) Program Concept.

7.2 Target Vegetation Identification

Target vegetation will be identified during facility construction and installation activities by SCC.

Target vegetation will be identified for O&M through monitoring of vegetation conditions by the Maintenance Supervisor of the Company's Power Supply, Maintenance Department. The Maintenance Supervisor will identify when vegetation treatment thresholds are attained, determine the appropriate control method(s) according to the Company's VM program described in Section 8.0 Vegetation Management Methods, and will schedule vegetation control work to be conducted before vegetation exceeds thresholds.

When VM is actively conducted, target vegetation will be identified visually, on-site and treated, by trained, experienced vegetation control personnel.

7.3 Native Plant Species

Native plant species will be preserved wherever practical. Native plants located such that they can grow tall enough to obstruct sunlight onto the solar panels, obstruct access, create safety hazards or otherwise conflict with the construction, operation, inspection, maintenance and repair of Utility scale PV facilities will be removed or controlled. However, no threatened or endangered (TE) native species are currently found on this site and will not be affected by VMP operations. Native plants naturally occurring within this site immediately prior to installation of the Utility scale PV were identified as common species and include ’ilima (*Sida fallax)*, hoary abutilon (*Abutilon incanum*), ‘uhaloa (*Waltheria indica*) and Hawaiian cotton (*Gossypium tomentosum*). TE plants that may establish in the future will be managed in conformance with all applicable requirements within the Endangered Species Act.

8.0 Vegetation Management Methods

This section provides procedures and associated best management practices (BMP) to guide the selection of methods to conduct removal and control of target vegetation, and disposal of vegetation cutting debris during construction and O&M.

8.1 Integrated Vegetation Management (IVM) Program Concept

The Company will apply an IVM program concept to control undesirable vegetation near to its Utility scale PV facilities during O&M VM. IVM requires that undesirable target vegetation species be identified, that thresholds are developed that define when control is optimally performed, and that all practical control options are considered, evaluated and appropriately implemented. Control options that will be considered to actively manage vegetation include cultural, biological, mechanical, manual, and chemical, as described within section 8.2 Control Options.

Timing of vegetation controls will be determined through the establishment of maximum height and density thresholds. Factors considered to determine the maximum threshold includes impact on the function or condition of the solar facilities, worker and public safety, control efficacy, environmental sensitivity, site access, cost effectiveness and aesthetics. The ultimate vegetation height and density threshold to define treatment timing will be based on the most restrictive factor for the specific site.

Monitoring of the site and vegetation for O&M VM will be regularly conducted according to an established schedule based on vegetation growth rates to identify when target vegetation reaches the defined threshold that triggers treatments. Initial monitoring frequency should be on a 3 month schedule for the first 3 years after completion of construction to determine the average rate of growth of undesirable species and establish an appropriate monitoring cycle.

8.2 Control Options

The Company’s VM program shall consider all practical vegetation control options - cultural, biological, mechanical, manual, and chemical - to manage target vegetation that meet or exceed defined thresholds. The Company shall implement the most practical

option that the Company determines will best achieve its primary goals and objectives as described in section 3.0 Primary Goals and Objectives of the Vegetation Management Plan.

Cultural Control

Cultural control for the purpose of this VMP consists of the planting and cultivation of desirable vegetation that will not interfere with the construction, operation, maintenance, inspection or repair of the solar facilities. The planting and cultivation of desirable plants is not currently considered efficient or effective for the construction, operation, inspection or maintenance of this Utility scale PV facility. However, in the future, if the Company determines that cultural controls may be cost-effective within portions of this site, this option may be implemented.

Biological Control

Biological control consists of the use of natural agents, to manage target vegetation. For the purpose of this VMP, biological control is implemented by protecting desirable vegetation that are already established or become naturally established on the site. Because of the aggressive nature of many undesirable plant species, chemical control through herbicide applications must be used to facilitate this passive biological control. The challenge is that if the entire undesirable plant is not controlled, including the root system, many species will rapidly resprout and dominate the site, crowding out and killing desirable species or preventing those desirable plant seeds from germinating. Where biological control is desired, herbicide applications will be applied selectively to control undesirable vegetation in a manner that will protect and/or encourage the development of dense communities of low-growing desirable vegetation. Competition for space, light, moisture and nutrients from dense communities of desirable vegetation provides a biological control by inhibiting germination of seeds and the ability of undesirable vegetation to establish and grow. Where effective, this biological control maintains the population of undesirable vegetation at a very low level and significantly reduces long-term conflicts and management requirements.

Biological control will be applied, in conjunction with selective herbicide applications, based on favorable, desirable plant and site conditions, and wherever the manager determines that it may be most cost-effective.

Manual Control

Manual control utilizes hand tools, primarily chain saws, brush saws and weed eaters, to physically cut target vegetation as low to the ground as practical. Manual control quickly removes target vegetation. However, in most cases, it does not control the entire target. The root system is left intact and many species will vigorously resprout requiring retreatments within a relatively short time period. Periodic removal of dense vegetation sometimes results in site disruption and high volumes of debris that creates a negative aesthetic impact, potential fire risk, and access obstacle. Cutting tools have also been documented to expose workers to higher risk of lacerations and high impact injuries when they throw debris. Cutting debris will be managed, removed and disposed as described within section 8.3 considering the risk of fire propagation and spread.

Manual cutting will only be used during initial clearing of woody vegetation for construction and during O&M VM for emergency removal of tall growing trees, shrubs or small clumps of grasses and herbaceous vegetation.

Mechanical Control

Mechanical control utilizes mowing equipment to physically and more quickly cut large areas of target vegetation. Mechanical control quickly removes and mulches target vegetation. However, in most cases, it does not control the entire target. The root system is left intact and many species will resprout requiring retreatments within a relatively short time period. Periodic removal of dense vegetation sometimes results in site disruption that creates a negative aesthetic impact. Mowing machines sometimes throw debris some distance presenting a potential safety hazard to persons and property that may be within the strike zone. Mowing operations are restricted to relatively level terrain with a low amount of potential projectiles. Mowing debris is generally left on site where it lays, but may be removed and disposed as described within section 8.3 if the Company determines that it exposes a high risk of fire propagation and spread.

Mowing will be used primarily for construction clearing of large areas of dense vegetation that must be cleared and O&M clearing and management of large areas with high densities of target vegetation where mowing is the most cost-effective method to quickly knock down and/or maintain the vegetation. In both construction and O&M, the terrain must be favorable for mowing machines. Mowing may also be used to knock down tall, dense vegetation communities to prepare sites for other VM treatments that will provide more environmentally favorable and cost-effective management.

Chemical Control

Chemical control, as utilized within the Company's VM program, consists of the judicious application of small amounts of dilute herbicide solution directly to target vegetation and/or sites. Herbicides are only applied as ground-based applications with low pressure applicators or as topical applications to freshly cut stumps of target vegetation. These types of low-volume applications minimize the risk of off-site movement of herbicide solutions. Low-volume applications result in very low amounts of herbicide application that are rapidly bio-degraded, which minimizes the risk of herbicide movement and adverse impacts to off-site plants or sensitive sites.

Selective use of herbicides provides the Company with the ability to facilitate the biological control method. Because of the aggressive competitiveness of undesirable vegetation, it is necessary to use herbicides to control the total target, including the root system. Herbicides are the only practical, environmentally sound method currently available to provide that total control. This total control provides the less aggressive, desirable plant species with an advantage that may enable them to became established and dominate the site. Subsequent, periodic, selective herbicide applications to remove undesirable plants that are able to establish facilitates expansion and stability of the desirable plant community.

Researchers have determined that herbicides, as used within the Company's VM program, have been demonstrated safe (USDA Forest Service, 1984 and 1997; ECI, 1989). This is

due to the small amount of herbicide applied selectively and that the herbicide formulations used are low in acute toxicity (CALIBRE, 2011; Harrison, 1985; USDA Forest Service, 1997; ECI, 1989), do not bioaccumulate (USDA Forest Service, 1984 and 1997) and, as applied, have a short life-span in the environment with very low soil mobility (CALIBRE, 2011; Deubert, 1985 USDA Forest Service, 1997; Nickerson, 1994). Public exposure could be considered virtually negligible due to the high degree of control of the herbicide solutions inherent in the treatment methods and the behavior of the selected herbicides (ECI, 1989; USDA Forest Service, 1997). The Company's VM program eliminates significant drift from foliar applications by requiring the use of low drift agents and/or low-volume applications, prohibiting applications in high wind conditions and setting maximum target height limits.

Cut Surface Treatments (CST) utilize chain saws and brush saws to cut woody, target vegetation with an immediate follow-up application of an herbicide solution, diluted in mineral oil, to the cut surface of the remaining stump. CST is used for woody species, primarily when target species exceed 12 feet in height and/or are low in density, and/or are visually or environmentally sensitive, and/or maximum containment of the herbicide is desired.

Selective Foliar Application (SFA) utilizes hand-pump or powered backpack applicators to carefully and selectively apply an herbicide solution, diluted from <2% to 5% in water, to the upper stems and foliage of target vegetation. SFA is used when target species are less than 12 feet in height and the site is not visually sensitive to the foliar brownout that would occur on-site.

Broadcast Ground Application (BGA) utilizes hand-pump, powered backpack or truck-mounted applicators to carefully apply an herbicide solution, diluted in water, to the ground surface and/or to dense populations of young vegetation. BGA is only used when bare ground is required or all vegetation must be removed to expose and protect facilities, or high levels of seed banks are present and pre-emergent herbicides will prevent germination and best management of these undesirable species. Often, herbicides that are selective to the target, undesirable vegetation species will be applied to protect desirable vegetation that may be present and enable germination of seeds from desirable vegetation to provide a ground cover of desirable vegetation. Where a vegetative ground cover is desired on a site treated by BGA, future treatments applying cultural or biological control facilitated with CST or SFA may be utilized.

8.3 Cutting Debris Disposal

During construction and O&M, all vegetative cutting debris shall be properly disposed to achieve project VM goals and minimize the risk of fire propagation and spread.

Herbaceous vegetative debris generated by hand cutting and all vegetative debris generated by mowing shall be left on site where it is deposited by the mowing machine to biodegrade unless debris accumulation will present an unreasonable risk of the propagation or spread of fire. Where fire risk must be minimized, debris will be piled or removed and disposed as described below. Debris shall not be permitted to be deposited onto solar panels or equipment during any cutting operation.

Woody vegetation debris generated from manual cutting operations shall be disposed by dicing, piling, chipping or removal and disposal. Woody debris shall not be left in waterways, within trails, roads or within 10 feet of solar facilities or other structures, in such a manner that would permit it to wash or roll into these areas, or will present an unreasonable risk of the propagation or spread of fire.

Dicing: Woody debris shall be cut into small pieces where it falls so that it lies as close to the ground as practical. The diced debris shall be cut into pieces so it does not project greater than 18 inches in height above the ground and does not present an unreasonable risk of the propagation or spread of fire.

Piling: Cutting debris that must be moved away from the area where it was cut may be piled. Debris piles will be placed as close to the cutting site as practical, but outside any areas that may cause access or operations conflicts. Piles shall not exceed 18 inches in height or 10 feet in diameter. Multiple piles shall be separated by a minimum distance of 10 feet. Piles shall be sited in a manner and location that does not present an unreasonable risk of the propagation or spread of fire

Chipping: Where practical and cost-effective, woody debris should be chipped. Where practical, wood chips should be blown onto and left on the site where the vegetation was cut. Chips left on the site shall not be left hanging in standing, woody vegetation or on structures and should be spread to lie as close to the ground as practical, not exceeding 6 inches in depth.

Removal and disposal: The Company may determine that vegetation cutting debris will be removed and disposed at green waste facilities in conformance with all C&C of Honolulu requirements. Removal and disposal may be applied where mowing debris, or dicing or piling vegetation cutting debris conflicts with the function or condition of the Utility scale PV facilities, worker or public safety, site access, cost effectiveness, aesthetics and/or presents an unreasonable risk of the propagation or spread of fire.

9.0 Vegetation Management Personnel

Well-trained, knowledgeable, qualified personnel are essential to the administration of a safe, cost-effective VM program. VM workers who will conduct VM applications shall be:

- Appropriately trained, experienced and qualified for the job to be performed; and
- Have read and understand the intent and strategy of this VMP; and
- Are capable to identify vegetation species within the maintenance area.

VM personnel shall be pre-qualified by the Company prior to commencement of VM operations. Qualification should require production of certifications or other comparable documentation of training and competence in the application of the VM control technique(s) to be applied. To work independently or as a supervisor of other workers, qualification should include, but may not be limited to:

- At least 1 year of documented, successful experience in the application of the VM control technique(s) to be applied;
- Demonstrated understanding of the philosophies, strategies and conduct of VM programs and this VMP.
- Ability to identify the primary, target, vegetation species within the target treatment area.

The Company's Power Supply, Maintenance Department, Maintenance Supervisor shall conduct field audits of VM operations during conduct of applications and immediately afterwards to ensure conformance to all applicable permits, laws, regulations and this VMP.

10.0 Conformance With Laws, Regulations and Permits

All VM operations and work shall comply with all applicable permits, laws and regulations and all work and materials are to comply in every respect with all applicable codes, laws, and regulations.

11.0 Deviations from this VMP

Deviations from this VMP will not be permitted without the written approval of the Manager of the Company's Power Supply, Maintenance Department. This written approval must include a detailed description of the nature and limitations of the deviation.

Appendix A

Biological Surveys Conducted for the Hawaiian Electric Kahe Photovoltaic Project, Kahe Valley, Waiʻanae District, Island of Oʻahu

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General Site Description

The project site is located immediately *mauka* of Farrington Highway and north of the existing Hawaiian Electric Kahe Generating Station, and is bound by the walls of Kahe Valley to the north and east (Figure 1 & 2). The terrain gently slopes north and east from Farrington Highway from an elevation of approximately three meters above mean sea level (MSL) up to a maximum elevation of approximately 50 meters MSL in the northeast corner of the site.

The vegetation present on the site best is characterized as grassland with very scattered trees (Figure 3), except were drainages cross the site and shrubland prevails. In some areas, the vegetation approaches that of a savanna (grassland with an open canopy of trees).

Figure 3 --- Looking down across the middle of site from well upslope of the proposed PV facility site.

Methods

Plant names mostly follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al., 1990, 1999) for native and naturalized flowering plants and *A Tropical Garden Flora* (Staples and Herbst, 2005) for crop and ornamental plants. Some plant species names have been updated following more recently published literature as summarized in Imada (2012). The avian phylogenetic nomenclature used in this report follows the *AOU Check-List of North American Birds* (American Ornithologists' Union, 1998), and the 42nd through the 53rd supplements to the Check-List (American Ornithologists' Union, 2000; Banks et al., 2002, 2003, 2004, 2005, 2006, 2007, 2008; Chesser et al., 2009, 2010, 2011, 2012, 2013). Mammalian species scientific names follow (Wilson and Reeder, 2005). Place names follow (Pukui et al., 1974).

Botanical Survey

The botanical survey was undertaken on January 20, 2014 and entailed a wandering pedestrian transect that traversed primarily those parts of the property proposed for the solar panels and appurtenant structures. A GPS unit (Trimble, GeoXH) was used to record the progress track of the botanist and provide real time feedback on survey coverage. Plant species were identified as they were encountered and notations were recorded and used to develop a qualitative sense of abundance as the survey progressed. The survey period encompassed the wet season and the vegetation appeared generally well watered. For a few species not immediately recognized in the field, photographs were taken and/or material was collected for identification in the laboratory.

Results

Botanical Survey

Vegetation

Vegetation on the proposed PV site is composed mostly of grasses and other herbs. Scattered trees and shrubs are present, although along shallow gulch bottoms. Shrubs dominate the vegetation on the site. The dominant grass here is buffelgrass (*Cenchrus ciliaris*) and in some places, Guinea grass (*Urochloa maxima*). The scrubland along gulch bottoms is mostly short-stature *koa haole* (*Leucaena leucocephala*) with a Guinea grass understory. *Kiawe* (*Prosopis pallida*) trees and *klu* (*Acacia farnesiana*) shrubs are scattered across the area. In a few areas, native cotton plants or *ma'o* (*Gossypium tomentosum*) are moderately abundant. Indeed, in these same areas, several other native shrubs are also abundant: hoary abutilon (*Abutilon incanum*), *'ilima* (*Sida fallax*), and '*uhaloa* (*Watheria indica*). In some cases, the predominance of natives can be associated with recently cleared ground as in Figure 4.

Figure 4– Shallow swale of partially bare soil dominated by *'ilima* with buffelgrass encroaching at the edges.

Flora

"Flora" is the diversity of plant species living in the survey area. A plant checklist (Table 1) was compiled from field observations, with entries arranged alphabetically under plant family names (standard practice). Included in the list are scientific name, common name, and status (for example, whether native or non-native, naturalized or ornamental) for each species observed during the survey.

Qualitative estimates of plant abundance were recorded for each species. Abundance values are coded in the table as explained in the Legend to Table 1. For some species, a two-level system of abundance is used; with a letter-number code indicating a species having a somewhat clustered distribution. For example, a species infrequently encountered but numerous where found would have an abundance rating of "R" indicating a plant encountered only one to three times during the entire survey of the site, but an "R2" to indicate several to many individuals present where encountered. An "R3" would be a plant similarly seldom encountered (i.e., rare), but locally abundant in one or more of the locations where encountered. A species marked "O3" would be one seen with some regularity, usually occurring in patches of numerous individuals (as opposed to "C" for a species seen with regularity throughout the survey area).

A total of 42 species of vascular plants was recorded during our survey of the area. The 42 species are mostly introduced species, but the site does have a smattering of three natives and one early Polynesian introduction (9.5 percent of the species). While this percentage is typical for lowland Oʻahu, not typical is the moderately high abundance of these "native" plants. Three of the species are widespread, especially in dry areas of the island; only native cotton or *maʻo* (*Gossypium tomentosum*) is considered uncommon on Oʻahu. A majority of the cotton plant population on this site is distributed on slopes above the planned PV area.

Table 1 – Plant species identified from January 2014 survey of the Hawaiian Electric Kahe PVC Site, TMK:

Species listed by family	Common name	Status	Abundance
FLOWERING PLANTS			
DICOTYLEDONES			
AIZOACEAE			
Trianthema tetragonioides (Pall.) Kuntze	---	Nat	R
ASTERACEAE (COMPOSITAE)			
Bidens pilosa L.	*kī*	Nat	U
Emilia fosbergii Nicolson	*pualele*	Nat	R
Pluchia carolinensis (Jacq.) G. Don	sourbush	Nat	U2
Sonchus oleraceus L.	sow thistle	Nat	R
ASTERACEAE (COMPOSITAE) Continued			
Tridax procumbens L.	coat buttons	Nat	R
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	Nat	R
BIGNONIACEAE			
Tecoma stans (L.) Juss. ex Kunth	yellow elder	Nat	R
CHENOPODIACEAE			
Atriplex suberecta Verd.	---	Nat	U3
Salsola tragus L.	Russian thistle	Nat	R
CONVOLVULACEAE			
Ipomoea obscura (L.) Ker-Gawl	---	Nat	R
Merremia aegyptica (L.) Urb.	hairy merremia	Nat	C1
CUCURBITACEAE			
Coccinia grandis (L.) Voigt	scarlet-fruited gourd	Nat	R
Momordica charantia L.	wild bitter melon	Nat	R
EUPHORBIACEAE			
Euphorbia hypericifolia L.	graceful spurge	Nat	O
Euphorbia hirta L.	garden spurge	Nat	R
Ricinus communis L.	castor bean	Nat	U1
FABACEAE			
Acacia farnesiana (L.) Willd.	*klu*	Nat	O

Chamaecrista nictitans (L.) Moench	partridge pea	Nat	R
Crotalaria pallida Aiton	smooth rattlepod	Nat	R
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	Nat	A
Leucaena leucocephala (Lam.) deWit	*koa haole*	Nat	C
Macroptilium atropurpureum (DC.) Urb.	---	Nat	U
Macroptilium lathyroides (L.) Urb.	cow pea	Nat	R
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	*kiawe*	Nat	C2
LAMIACEAE			
Hyptis pectinata (L.) Poit.	comb hyptis	Nat	U2
Leonotis nepetifolia (L.) R. Br.	lion's ear	Nat	O
MALVACEAE			
Abutilon incanum (Link) Sweet	*ma'o*	**Ind**	A2
Gossypium tomentosum Nutt. ex Seem.	*ma'o*	**End**	C1
Malva parviflora L.	cheese weed	Nat	R
Sida fallax Walp.	*'ilima*	**Ind**	A2
Sida spinosa L.	prickly sida	Nat	R
Waltheria indica L.	*'uhaloa*	**Pol**	C2
PASSIFLORACEAE			
Passiflora suberosa L.	*huehue haole*	Nat	R
PORTULACEAE			
Portulaca oleracea L.	pigweed	Nat	R
FLOWERING PLANTS			
MONOCOTYLEDONES			
POACEAE			
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	Nat	C2
Cenchrus ciliaris L.	buffelgrass	Nat	AA
Chloris barbata (L.) Sw.	swollen fingergrass	Nat	O
Chloris virgate Sw.	feather fingergass	Nat	U
Echinochloa colona (L.) Link	jungle-rice	Nat	U
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	Nat	R1
Urochloa maxima (Jacq.) R. Webster	Guinea grass	Nat	AA

Legend to Table 1
STATUS = distributional status for the Hawaiian Islands:

Ind = indigenous; native to Hawaii, but not unique to the Hawaiian Islands.
End = endemic; native an unique to the Hawaiian Islands
Pol = Polynesian introduction so called (canoe plants)
Nat = naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.
Orn = A cultivated plant; a species not thought to be naturalized (spreading on its own) in Hawai'i.

ABUNDANCE = occurrence ratings for plant species:

-- - Species not present in area.
R – Rare - seen in only one or perhaps two locations.
U – Uncommon - seen at most in several locations
O - Occasional - seen with some regularity
C - Common - observed numerous times during the survey
A - Abundant - found in large numbers; may be locally dominant.
AA - Very abundant -abundant and dominant; defining vegetation type.

Numbers (1 – 3) following qualitative rating of abundance indicate localized abundance is greater than occurrence rating. For example, R3 would be a plant encountered only once or twice, but very numerous where encountered.

Discussion

Botanical Resources

The findings of our reconnaissance level botanical survey are in keeping with the xeric, nature of this lowland site. The property does have a slightly higher presence of native species than might be found on typically more disturbed properties along the leeward coast, but only *ma‘o* (*Gossypium tomentosum*) is of any special interest, as the other natives are quite common. Hawaiian cotton has been considered for listing in the past (USFWS, 1985; described as “vulnerable” in Wagner, Herbst, & Sohmer, 1990). Presently, this native endemic species is not listed under endangered species statutes. The majority of cotton plants observed on the property occur on slopes above the sites proposed for photovoltaic solar panels.

Potential Impacts to Protected Species

Botanical

No species of plant listed as threatened or endangered under state or federal statutes was recorded during the survey. Therefore the further modification of the habitat present on this site is not expected to result in deleterious impacts to any species currently proposed or listed under either the federal or State of Hawai‘i endangered species statutes.

Recommendations

- Hawaiian Electric is developing a native plantings strip along the lower edge of this site. *Ma‘o* is an excellent candidate for planting in this area and has the potential to become the dominant shrub in the native restoration project area, easily off-setting the few cotton plants displaced by the Photovoltaic project.

Critical Habitat

There is no federally delineated Critical Habitat present on the property. Thus the development and operation of the proposed PV project will not result in impacts to federally designated Critical Habitat. There is no equivalent statute under state law.

Appendix B
Native and Polynesian Plant Buffer Species

Plant Type and Scientific Name	Common Name	% of total plants
Trees		**35.0**
Psydrax odorata	alahe'e	3.0
Morinda citrifolia	Noni	1.0
Pandanus spp.	Hala	4.0
Sapindus oahuensis	Lonomea	5.0
Thespesia populnea	Milo	5.0
Sapindus saponaria	Manele	4.0
Artocarpus altilis	Ulu	1.0
Cocos nucifera	Niu	4.0
Gardenia brighamii	Na'u	4.0
Senna gaudichaudii	Kolomona	1.0
Aleurites moluccana	Kukui	3.0
Shrubs		**40.0**
Dodonaea viscosa	a'ali'i	2.0
Wikstroemia uva-ursi	akia	2.0
Plumbago zylanica	I'lie'e	4.0
Sida fallax	ilima	2.0
Osteomeles anthyllidifolia	ulei	2.0
Sesbania tomentosa	ohai	2.0
Waltheria indica	uhaloa	2.0
Chenopodium oahuense	aweoweo	1.0
Myoporum sandwicense	Naio	5.0
Scaevola sericea	Naupaka	3.0
Bidens spp.	Ko'oko'olau	1.0
Solanum sandwicense	Popolo	2.0
Curcuma longa	Olena	3.0
Gossypium tomentosum	Ma'o	2.0
Hibiscus brackenridgei	Ma'ohauhele	2.0
Cordyline fruticosa	Ki	1.0
Saccharum officinarum	Ko	2.0
Nototrichium sandwicense	Kulu'i	1.0
Piper methysticum	Awa	1.0
Grasses, vines		**25.0**
Heteropogon contortus	pili	2.0
Ipomea batatas	Uala	11.0
Ipomea pes-caprae	pohuehue	12.0
	Total percent:	**100.0**

APPENDIX C
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C. CULTURAL IMPACT ASSESSMENT

Draft

Cultural Impact Assessment for the Kahe Valley Photovoltaic Project, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu TMK: [1] 9-2-003:027 (por.)

Prepared for
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Prefatory Remarks on Language and Style

A Note about Hawaiian and Other Non-English Words:

Cultural Surveys Hawai‘i recognizes that the Hawaiian language is the native language of the State of Hawai‘i, therefore, does not follow the conventional use of italics to identify and highlight all Hawaiian words. Other non-English words, however, are still italicized. CSH parenthetically translates or defines in the text the Hawaiian and non-English words at first mention.

Abbreviations

ABCFM	American Board of Commissioners of Foreign Missions
APE	Area of Potential Effect
AMSL	Above Mean Sea Level
BC	Boundary Certificate Number
BCT	Boundary Commission Testimony
CSH	Cultural Surveys Hawai‘i
DOH/OEQC	Department of Health/Office of Environmental Quality Control
EPC	Ewa Plantation Company
HAR	Hawai‘i Administrative Rules
HECO	Hawai‘i Electric Company
HRS	Hawai‘i Revised Statutes
HSRM	Hawai‘i Survey Registered Maps
LCA	Land Commission Award
LPE	Lualualei Extremely Stony Clay
OEQC	Office of Environmental Quality Control
OHA	Office of Hawaiian Affairs
OIBC	O‘ahu Island Burial Council
OR&L	Oahu Railway and Land Company
RM	Registered Map
rRK	Rock Land
rSY	Stony Steep Land
SIHP	State Inventory of Historic Properties
SHPD	State Historic Preservation Division
TCP	Traditional Cultural Property
TMK	Tax Map Key
UH	University of Hawai‘i
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WWII	World War II

Management Summary

Reference	Cultural Impact Assessment (CIA) for the Kahe Valley Photovoltaic Project, Honouliuli Ahupua‘a, Ewa District, O‘ahu, TMK: [1] 9-2-003:027 (por.) (Fa‘anunu and Hammatt 2014)
Date	February 2014
Project Number	CSH (Cultural Surveys Hawai‘i) Job Code: HONOULIULI 89
Agencies	State of Hawai‘i Department of Health/Office of Environmental Quality Control (DOH/OEQC)
Project Location	This study is located in the ahupua‘a of Honouliuli in ‘Ewa, on O‘ahu Island on portions of TMK: [1]-9-2-003:027
Land Jurisdiction	Private
Project Description	This project consists of the construction and installation of a photovoltaic system to generate energy from solar panels on approximately 50 acres of the 454 acres of Kahe Valley owned by Hawaiian Electric Company, Inc. (HECO). The project intends to clear approximately 10 acres of land as the site for proposed inverters and transformer pads and the remaining 40 acres will be mowed. Approximately 8,000 linear ft of access road will be constructed throughout the project area and 2,250 linear ft of access gravel will be constructed. All site preparation will incorporate a 100-ft setback from Farrington Highway. Solar modules will be mounted to an estimated 4,927 posts that will be pile driven to a depth of approximately 8 ft. Depending on conditions at a particular post location, a poured concrete footing or an additional driver pier may be installed as necessary. The solar panels will be set at a 20 degree tilt to the sun and will be oriented facing south. The height of the solar module racking units will be approximately 6 ft above the finish grade of the highest point
Project Acreage	The total project acreage is approximately 50 acres.
Area of Potential Effect (APE) and Survey Acreage	The APE is defined as the approximately 50 acres in total. While this investigation focuses on the project APE, this study considered the whole ahupua‘a of Honouliuli.

Document Purpose	This CIA was prepared to comply with Hawai‘i State’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 on cultural beliefs, practices, and resources (per the *Office of Environmental Quality Control’s Guidelines for Assessing Cultural Impacts*) which may include Traditional Cultural Properties (TCPs) of ongoing cultural significance that may be eligible for inclusion on the State Register of Historic Places. The document is intended to support the Project’s environmental review and may also serve to support the Project’s historic preservation review under HRS §6E-42 and Hawai‘i Administrative Rules (HAR) §13-284
Results of Background Research	Background research for this study yielded the following results which are presented in approximate chronological order: The project area is located along the western coast of Honouliuli Ahupua‘a, the largest and Western-most ahupua‘a in ‘Ewa. Honouliuli translates literally as “dark water,” “dark bay,” or “blue harbor,” named thus 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). Numerous wahi pana (storied places), ‘ōlelo no‘eau (proverbs), ‘oli (chants), and mo‘olelo (stories) come from Honouliuli which suggests the ahupua‘a’s historical significance, abundance of natural resources, and the presence of a viable Native Hawaiian population. Many mo‘olelo took place along the plains of Honouliuli, such as the story of the demi-god Kamapua‘a and his grandmother; Pele’s sister, Hi‘iaka, on the plains of Kaupe‘a and Keahumoa; the wondering ghosts of Kaupe‘a, Pu‘uokapolei, and Kanēhili; the demi-god Maui and his stolen wife; the pōhaku of Pukaua; the hero Pikoi and his arrow-shooting skills; the warrior Palila and his supernatural war club; and the hero Nāmakaokapao‘o. Mo‘olelo and ‘ōlelo no‘eau associated with the natural resources of Honouliuli include the many shark stories of Pu‘uloa and the guardian shark Ka‘ahupāhau; the pipi and ‘ānae-holo of Pu‘uloa; the kāī-koi kalo of ‘Ewa; the fishponds of Pu‘uloa involving the gods Kane and Kū, Kaihuopala‘ai, and Ihuopala‘ai; and the planting of the first breadfruit from Kahiki. Mo‘olelo also tell of the ōlohe people who were humans with dog tails who dwelled in caves in Honouliuli.

	Early historical accounts and the presence of permanent habitation sites, fishing shrines, and subsistence-related features along the coast also suggest ‘Ewa was once widely inhabited and home to many ali‘i (chiefs, royalty) during the pre-Contact period. Successful coastal settlement was likely supported by a plethora of marine resources, particularly the lochs of Pearl Harbor; irrigated lowlands suitable for wetland taro, banana, and sugarcane cultivation seen nowhere else in O‘ahu (Meyen 1981:63); and forest resources along the slopes of the Wai‘ānae Range, likely utilized as a subsistence alternative in times of famine (Handy 1940:211; Handy and Handy 1972:469-470). Accounts by missionaries in 1823-24, suggest the lands farther from the coast or the plains of ‘Ewa were largely uncultivated and habitation was scarce (Ellis 1963:7). Ten historic properties were found within the project area of which four are recommended for preservation. These include State Inventory of History Places (SIHP) #s 50-80-12-6647, -7137, -7139, and -7140. These sites were associated with Native Hawaiian habitation and agricultural sites and WWW II military activity. Honouliuli was the most populous ahupua‘a on O‘ahu at Contact with the majority of the population centered around Pearl Harbor. The inland area of ‘Ewa was likely abandoned by the mid-nineteenth century due to population decline from disease and consolidation of the remaining people in the towns of Honouliuli, Waipahu, and Waiawa. Today, Honouliuli is among the most rapidly growing ahupua‘a in O‘ahu. A heiau (altar, shrine) was once located on Pu‘uokapolei, a hill in Honouliuli thought to have been named after “beloved Kapo,” the sister of the volcano goddess, Pele, but it had been destroyed by the time of McAllister’s (1933:108) survey of O‘ahu Island in the early 1930s. Pu‘uokapolei was a place for astronomical observations and it may have been regarded as the gate of the setting sun, just as the eastern gate of Kumukahi in Puna is regarded as the rising sun (Fornander 1919:VI:292). ‘Ewa was known for the many limestone caves formed in the uplifted coral called the “Ewa Karst” (Mylroie and Carew 1995). Some of these caves, called “ka-lua-ōlohe” were inhabited by the “ōlohe,” a type of people that looked like 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, lived in Līhu‘e in upland Honouliuli, and he was an “ōlohe.” Several historic trails traversed ‘Ewa including a lateral trail that connected Honolulu to the Wai‘ānae District and is likely located in

	the vicinity of the project area. This trail is described by ‘Ī‘ī (1959:96) as dipping down “toward the coast towards . . . Pu‘uokapolei [and] . . . crossed into Wai‘ānae at the coast near Pili o Kahe.” The boundaries of Honouliuli were often contested with the people of Wai‘ānae. However, the boundaries of these two districts are said to be marked by a stone known as Pili-o- Kahe which translates literally as “clinging to flow” and refers to the female or Wai‘ānae side of the hill (told to E.S. by Simeon Nawaa, 22 March 1954 in Sterling and Summers 1978:1). Many battles took place in ‘Ewa, including in Honouliuli, dating back to at least the twelfth century. Many ali‘i came from ‘Ewa and chiefs from Līhu‘e, Wahiawā, and Halemano were called lō‘āli‘i (from whom a guaranteed chief might be obtained, loa‘a) because they lived there continually and guarded their kapu. The lō‘āli‘i were regarded as being “like gods, unseen, resembling men” (Kamakau 1991a:40). The supremacy of the ‘Ewa chiefs ended with the Battle of Nu‘uanu against Kamehameha I. In 1795, Honouliuli Ahupua‘a was given by Kamehameha I to Kalanimōkū, an early supporter (Kame‘eleihiwa 1992:58, 112). The ahupua‘a was inherited by Kalanimōkū’s sister, Wahinepi‘o. During the Māhele of 1848, 96 land claims were made and 72 claims were awarded to commoners. Claims ranged in size from 0.1 to 5.5 acres and almost all of them were adjacent to Honouliuli Gulch and contained fishponds and irrigated taro fields (Tuggle and Tomonari-Tuggle 1997:34). In 1855, the Land Commission awarded all 43,250 acres of unclaimed land in Honouliuli to Miriam Ke‘ahikuni Kekau‘ōnohi, a granddaughter of Kamehameha I, and the heir of Kalanimōkū (Indices of Awards 1929; Kame‘eleihiwa 1992). The property passed through a series of heirs until 1877 when James Campbell purchased most of Honouliuli Ahupua‘a, except the ‘ili of Pu‘uloa, for a total of $95,000. James Campbell started the Honouliuli Ranch, which was used almost exclusively for cattle. Cattle ranching continued into modern times and Honouliuli Ranch was considered the “fattening” area for the other ranches (Frierson 1972:15). Though Honouliuli Ranch was not in operation until the 1870s, a longhorn cattle ranch was reported to exist in nearby Wai‘ānae by at least 1840 (Frierson 1972:10). The grazing of animals from ranching, as well as the logging of the sandalwood forests, disturbed the ecosystem of the ‘Ewa plains allowing exotic vegetation to thrive which further changed the landscape of the district. Rice cultivation occurred in Honouliuli around the 1880s and in 1885, 200 acres of rice replaced much of the former taro lands in the lowland areas surrounding Pearl Harbor (Coulter and Chun 1937:21). The

	ancient taro lo‘i (irrigated terrace, especially for taro but also for rice) and ‘auwai (irrigation ditches) were modified and expanded to support rice cultivation which was dominated by the Chinese. By the early twentieth century, rice farming declined and was succeeded by sugar. Sisal, a plant used to make fibers for rope and other material, was also experimented with between 1898 to the 1920s, mainly on the coastal plain of Honouliuli in Kānehili (Frierson 1972:16). Sugar cane became a dominant industry in the 1800s and in 1879, the first artesian well was drilled in ‘Ewa allowing great irrigation possibilities (Ellis 1995:22). Three sugar companies were established in the district including the Ewa Plantation Company (EPC), which was located in Honouliuli (Nedbalek 1984:13). The EPC started in 1890 and by the 1930s, it encompassed much of the eastern half of Honouliuli Ahupua‘a. EPC was once termed the “richest sugar plantation in the world” (*Paradise of the Pacific,* December 1902:19-22 in Kelly 1985:171). The Oahu Sugar Company took over the EPC in 1970 and continued operations until 1995 (Dorrance and Morgan 2000:45, 50). Plantation villages to house a growing immigrant labor force developed in Honouliuli but by the 1930s and 1940s, World War II (WWII) took many of the plantations’ workers. Railroads built by Oahu Railway and Land Company (OR&L) extended from Honolulu to Pearl City in 1890 and to Wai‘anae in 1895, eventually running across the center of the ‘Ewa plains (Kuykendall 1967:3:100). To attract business to the new railroad system, much land in Honouliuli was subleased to the sugar plantations. The U.S. military also used the sugar cane rail system to “haul large quantities of ammunition” and in 1947, the U.S. Navy took over a section of the OR&L track for their own use (Condé and Best 1973:315; Treiber 2005:25-26). After WWII, 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. Though Pearl Harbor is located east of the project area, U.S. military development on Pearl Harbor and the events of WWII significantly changed the history of Honouliuli and Hawai‘i at large beginning in 1876 with the Reciprocity Treaty. Since then, the U.S. military has acquired much of coastal ‘Ewa for its naval and air force bases, and developed the surrounding areas of ‘Ewa with infrastructure to support its operation. By 1943, the military attracted over 24,000 people who worked at Pearl Harbor and naval housing areas had grown large enough to be considered separate cities. Barracks and temporary housing for workers were built for miles between Pearl Harbor and the outskirts of Honolulu (Downes 1953).

	Following the bombing of Pearl Harbor on 7 December 1941, the strategic vantage point of Kahe Point was chosen as a potential site to house one of the two 14-inch gun turrets that could be recovered from the sunken battleship USS *Arizona*.
Results of Community Consultation	Community consultations for this study yielded the following results which are presented in approximate chronological order: According to Mr. Kila and Mr. Oliveira, the project area was traditionally part of Wai‘ānae Moku (district) when O‘ahu originally had three moku before political boundaries changed in 1909. During that time, Wai‘ānae Moku was composed of Wai‘ānae Makai and Wai‘ānae Uka. The project area was part of Wai‘ānae Makai which included the coastal area of Nānākuli, Wai‘anae, Lualualei, Makaha, all the way to Ka‘ena Point. Wai‘ānae Uka included portions of Wai‘ānae, Wahiawā, and parts of existing Honouliuli. Thus, the project area has historical ties to Wai‘ānae. Mr. Kila described the project area as part of Kahe but the general area is also known as Ko‘olina, in the ahupua‘a of Honouliuli. He explained that Honouliuli is one of the largest ahupua‘a in O‘ahu but Honouliuli is generally understood to refer to the part of the ahupua‘a in the vicinity of Pearl Harbor. The coastal area fronting the project area is also known as Keana‘ō‘io, the caves of the ‘ō‘io (*Albula vulpes*) fish which Mr. Oliveira said is common to the area. The place name Keone‘ō‘io, the sand of the ‘ō‘io, appears on a U.S. Geological Survey (USGS) map of the area which he speculated refers to the larger coastal area in the vicinity of the project area and that Keana‘ō‘io refers more specifically to the area immediately near the project area. Mr. Enos pointed out that Wai‘ānae lands were very important because they had access to deep sea fisheries combined with an abundance of spices such as salt, limu (seaweed), and ‘inamona. He referenced the mo‘olelo of Maui pulling up the islands and explained that the story was not just about pulling islands out of the ocean but acknowledging the deep sea where the ‘ahi (*Thunnus albacares*) and aku (*Katsuwonus pelamis*) come from, both valuable resources for the livelihood of the people. Mr. Kila explained that the project area was not a place of permanent settlement due to lack of water and fertile soil for cultivation. Instead, it was a place where people passed through to and from ‘Ewa, or to the fishing and surfing for which the coastal area of the project property is most known for. According to Mr. Kila and Mr. Oliveira, petroglyphs also indicate places of previous settlement usually near water sources where people could drink water and refresh themselves before traveling. Petroglyphs

	exist north and south but not within the project area. According to Mr. Kila, stick figure petroglyphs that date back to over 1,000 years old are found by Kahe Point near Pili-o-Kahe by Black Rocks. Thus, given the lack of water, Mr. Kila and Mr. Oliveira were puzzled by a large gulch area on the project property, just mauka (mountain side) of the bridge along Farrington Highway. Attracted to the good surf and fishing along the coast, Mr. Kila stated that ali‘i like King Kakuihewa and Ka‘ihikapu loved and frequented the area. They lived at Lanikuhonua by Ko‘olina because of water at Waimānalo. Mr. Enos added that the area in nearby Līhu‘e, now known as Schofield, at the birthing stones of Kūkaniloko, was the birthing place of the O‘ahu ali‘i. From Līhu‘e, the ali‘i could look down to the rich lands of Pu‘uloa in Honouliuli and command the limu, salt, and large fish from that area. According to Mr. Kila, there are two types of fishing ko‘a (shrine): 1) kū‘ula (any stone god used to attract fish) and 2) kane ko‘a. Ku‘ula are usually located near the ocean and made of lava rock or coral while kane ko‘a are usually near waterways for fish like ‘o‘opu (families *Eleotridae, Gobiidae,* and *Blennidae*), in lo‘i (irrigated taro terrace) or for birds. Therefore, he believes a structure on the property, identified by archaeologists as a possible fishing shrine, is unlikely because of its location further inland from the ocean and its structural composition is uncharacteristic of fishing ko‘a. Instead, Mr. Kila and Mr. Oliveira speculated the structure may have burials beneath it. Mr. Enos explained that ko‘a were built to align with the mountain peaks and acted as transects for indicating fishing grounds particularly for ‘ōpelu (*Decapterus pinnulatus* and *D. maruadsi*) and akule (*Trachurops crumenophthalmus*). Mr. Kila and Mr. Oliveira discussed that cave burials are common to the Wai‘ānae region and that Native Hawaiian burials are most likely found along the coast. Mr. Kila recalled iwi (bones) were found in a cave, SIHP # 50-80-12-7139, along the Pili-o-Kahe ridge on the northern boundary of the project area. The iwi did not seem like a burial but more like bones that had fallen from higher ground. Though family members spoke of some cattle ranching in the area previously, Mr. Kila and Mr. Oliveira were skeptical that a rock wall along the gulch within the project area was for cattle, as indicated by archaeologists. Numerous mo‘olelo (stories) are associated with the general area of Kahe which include Kāne and Kanaloa, Hi‘iaka at Mauna Kapu, Pili-o-Kahe landmark that marks the boundary between Kahe and Nānākuli, and the birth place of Maui Akalana across from Pili-o-Kahe. Though located far from the project area, the first breadfruit is said to have

	been brought by the Tahitian/Hawaiian navigator Kaha‘i, the grandson of Mo‘ikeha, and it was planted in a village near Pearl Harbor in Honouliuli Ahupua‘a. The predominance of Kāne, the god of the sun, to the western part of O‘ahu, speaks to the significance of the sun to these areas, explained Mr. Kila and Mr. Oliveira. In addition, the setting of the sun in the west where the project area directly faces, is also associated with the spirit world and night marchers. Therefore, Mr. Kila and Mr. Oliveira felt the proposed project is in line with the cultural significance of Kāne and the sun to the region. The three participants pointed out that native plants grow throughout the project area, such as ma‘o (*Gossypium sandvicense*), ‘ilima (species of *Sida,* especially *S. fallax*), and ‘uhaloa (*Waltheria indica* var. *Americana*). Mr. Kila stated that Hawaiian cotton, ma‘o, is important because there used to be acres of Hawaiian cotton in the area and the other plants are used in lā‘au lapa‘au (traditional medicine). Military remnants, such as a World War II historic site up along the hillside of the project area, as well as a pill box in the flat area of the property currently exist on the project property. Mr. Kila acknowledged the importance of these structures to the history of the 1920s and 1930s. Mr. Kila recounted that during the 1920s to 1930s during plantation times, a railroad station used to be located on the ocean-side of the coast before Nānākuli. Plantation workers would get off there and go swimming at the sandy beaches nearby so a railroad used to pass through along the coastal area in front of the project area. According to all three participants, historic trails came through the coast, most likely where the current Farrington Highway runs adjacent to the project area. Mr. Enos pointed out that inland trails are only in Lualualei, Kolekole and the other one is the famous Pohakea Pass where Hi‘iaka rested at Pohakea and climbed up Mauna Kapu. In sharing their knowledge on the cultural resources and practices of the area, Mr. Kila and Mr. Oliveira also emphasized and discussed the important Hawaiian value of Ka‘ananiau which means “managing the beauty of time.” Ka‘ananiau is central to managing natural resources particularly of a place like the project area with limited resources.
Impacts and Recommendations	The following cultural impacts and recommendations are based on a synthesis of all information gathered during preparation of the CIA. Recommendations are dichotomized to differentiate between community recommendations provided by participants of this study for the proposed project and the CSH recommendations formulated to consider the restrictions of existing rules and regulations of land use

	and access. The findings indicate several historical features, a cave with iwi, and native plants that exist on the project property. To help mitigate the potential adverse impacts of the proposed project on Native Hawaiian cultural beliefs, practices, and resources, recommendations should be faithfully considered and appropriate measures to address each concern should be developed. **Burials** **Community Recommendations**: Community participants acknowledge that a cave along the northern boundary of the project property contained iwi. Mr. Kila recommended preserving the cave. Mr. Kila and Mr. Oliveira also speculated that the structure on the property thought to be a fishing shrine, may contain burials underneath it. They recommend this structure to be preserved. **CSH Recommendations:** CSH recommends the cave and also the possible fishing structure be preserved. In the State of Hawai‘i, burials are protected through HRS §13-300, HRS §6E, and Hawai‘i State Constitution Article 12 Section 7: 1) The treatment of burial sites and human remains is under the jurisdiction of the SHPD and OIBC; therefore, should burial sites be discovered, CSH recommends all work immediately cease and the above agencies be notified; 2) Requests to preserve or relocate human remains must be submitted to the OIBC for Native Hawaiian human remains and the SHPD for non-Native Hawaiian human remains in the form of a Burial Treatment Plan, therefore, should such requests be necessary, CSH recommends a Burial Treatment Plan be developed pursuant to the guidelines established in HRS §13-300; 3) In developing this plan, CSH recommends identifying and consulting with cultural and lineal descendants of the ahupua‘a where human remains are found, as required by law. Thus, recommendations provided by community participants regarding burials stated above, should be considered in the preparation of a Burial Treatment Plan; 4) Furthermore, CSH recommends archaeological monitoring and consultations with recognized descendants of corresponding ahupua‘a during ground-disturbing phases of development. **Historic Properties** **Community Recommendations**: Mr. Kila recommends military remnants on the property that were house sites and the names associated with them be preserved. He acknowledged those structures are important to the history of the 1920s and 1930s. A World War II historic site along the hillside of the project area, as well as a pill box existing in the flats are also recommended for preservation. Regarding the rock wall with basalt on the property, Mr. Kila and Mr. Oliveira suggested that if the rocks are removed, they be donated to the

	community center, Marae Ha‘a Koa, where children can learn how to build replicate cultural strucutres. **CSH Short-Term Recommendations:** CSH recommends that 1) historic property boundaries be located by a licensed land surveyor and indicated on all construction plans; 2) the establishment of a 20-ft (6.1-m) preserve buffer for each historic property as indicated in the preservation plan; 3) the addition of preserve buffers on all construction plans; 4) installation of a continuous barrier of orange web fencing or similar highly visible material around the preserve buffer for SIHP #s -6647 and -7140; 5) passive preservation of SIHP #s -7137 and -7139; and 6) a preconstruction meeting between project personnel and monitoring archaeologist(s). **CSH Long-Term Recommendations:** CSH recommends 1) establishment of a 20-ft (6.1-m) preserve buffer for each historic property as indicated in the preservation plan; 2) physical buffers be installed around SIHP #s -6647 and -7140 Feature A and B using permanent fencing and/or boulder barriers to be determined in consultation with community members and installed with the supervision of an archaeologist; 3) preservation in place of the iwi at SIHP # -7139 to include the reburial of the iwi within the underlying previously excavated and backfilled test unit to be conducted in consultation with community members; and 4) passive preservation for SIHP #s -7137 and -7139. **Native Plants** **Community Recommendations:** Participants emphasized the project area is a habitat for native plants such as ma‘o, ‘ilima, and ‘uhaloa. Mr. Kila and Mr. Oliveira recommend the plants be preserved. Mr. Oliveira prefers the facility serve multi-purposes in addition to providing clean energy, such as preserving the native plants of the area, educating the public about them, and beautifying the area. He recommends ma‘o be incorporated into the landscaping of the project and that part of the ma‘o currently growing on the property be left as is or as a garden amongst the solar panels. Other native plants like naio (*Myoporum sandwicense*), ‘uhaloa, ‘a‘ali‘i (*Dodonaea species*), iliahi (*Santalum* species), ‘ilima, and coconut trees were also recommended to be included in the landscaping. **CSH Recommendations**: Native plant populations within the project area, particularly of ma‘o, should be inventoried and protected as they are important cultural and natural resources in Hawai‘i and beyond, due to their endemic nature and their uses in traditional medicine. **Cultural Monitoring** **Community Recommendations**: Mr. Kila recommends cultural monitoring particularly for the historic sites within the property, such as the possible fishing shrine, to prevent any desecration of cultural

	resources. “We do not want to stop the project because the project should go on but to make sure it’s pono (goodness),” he said. **CSH Recommendations**: Developing and maintaining positive relationships with the Kahe and Ko‘olina communities is important in ensuring proper cultural protocols are respected and unanticipated adverse cultural impacts are minimized. To achieve this process, CSH recommends recognized descendants and Native Hawaiian organizations be consulted as the project design progresses.

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Section 1 Introduction

1.1 Project Background

At the request of Hawaiian Electric Company (HECO), CSH has prepared a CIA for a photovoltaic project in Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu, on portions of TMK: [1] 9-2-003:027. The project area is depicted in Figure 1 through Figure 3.

The project includes construction and installation of a photovoltaic system to generate energy from solar panels on approximately 50 acres of the 454 acres of Kahe Valley owned by HECO. The project intends to clear approximately 10 acres of land as the site for proposed inverters and transformer pads and the remaining 40 acres will be mowed. Approximately 8,000 linear ft of access road will be constructed throughout the project area and 2,250 linear ft of access gravel will be constructed. All site preparation will incorporate a 100-ft setback from Farrington Highway. Solar modules will be mounted to an estimated 4,927 posts that will be pile driven to a depth of approximately 8 ft. Depending on conditions at a particular post location, a concrete poured footing or an additional driver pier may be installed, as necessary. The solar panels will be set at a 20 degree tilt to the sun and will be oriented facing south. The height of the solar module racking units will be approximately 6 ft above the finish grade of the highest point.

1.2 Document Purpose

The project requires compliance with the Hawai‘i State environmental review process (Hawai‘i Revised Statutes [HRS] §343), which requires consideration of a proposed Project’s effect on cultural practices. Through document research and ongoing cultural consultation efforts, this report provides information pertinent to the assessment of the proposed Project’s impacts to cultural practices and resources (per the *Office of Environmental Quality Control’s Guidelines for Assessing Cultural Impacts*) which may include Traditional Cultural Properties (TCPs) of ongoing cultural significance that may be eligible for inclusion on the State Register of Historic Places. In accordance with Hawai‘i State Historic Preservation Statute HRS §6E guidelines for significance criteria and in the Hawai‘i Administrative Rules (HAR) §13–275 under Criterion “e,” any historic property determined to be significant shall:

> 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.

The document is intended to support the Project’s environmental review and may also serve to support the Project’s historic preservation review under HRS §6E and HAR §13–275.

1.3 Scope of Work

The scope of work for this CIA includes the following:

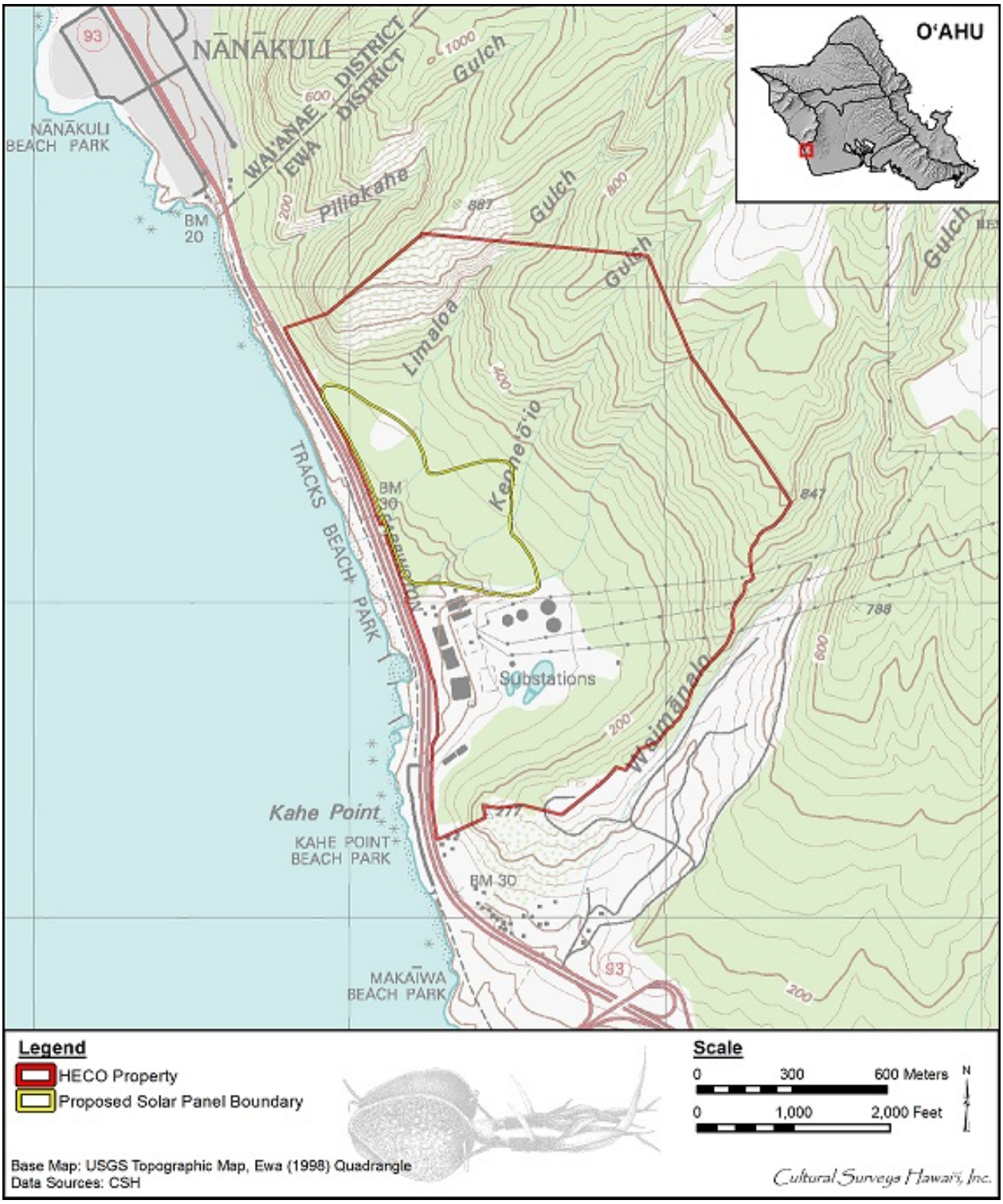

Figure 1. 1998 Ewa USGS 7.5-minute topographic quadrangle (portion) showing the proposed project area

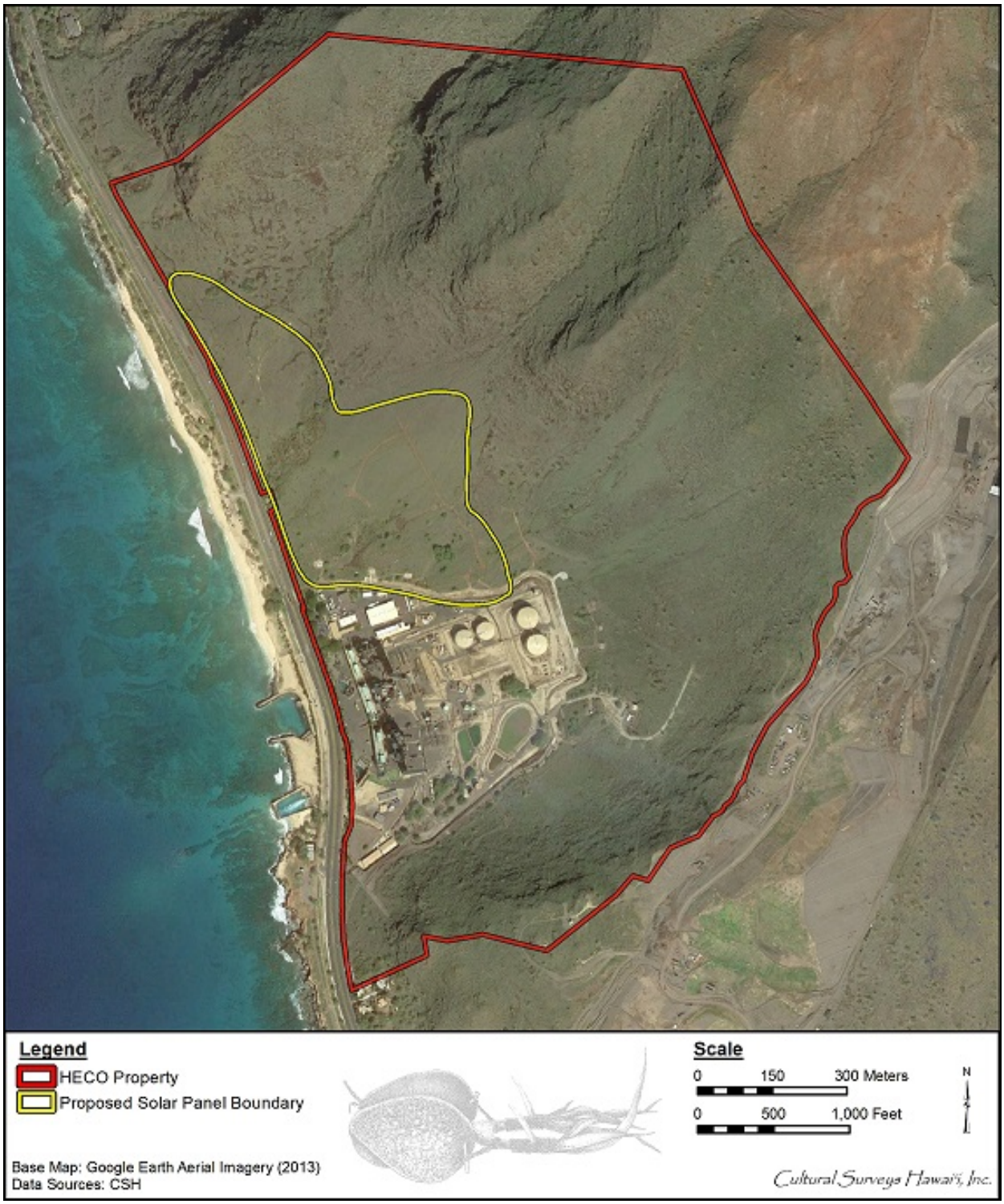

Figure 2. Aerial phototgraph showing the project area (Google Earth 2013)

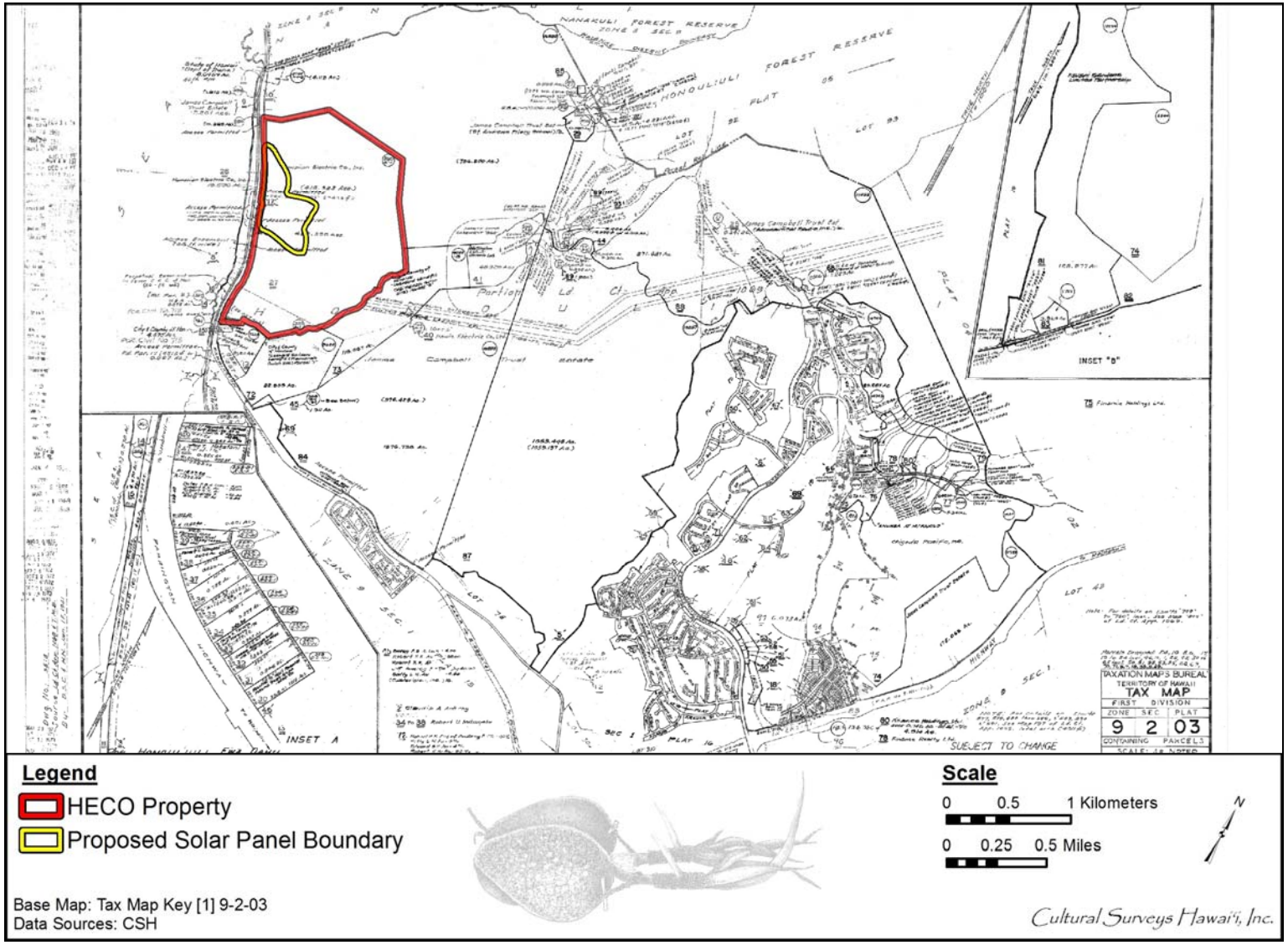

Figure 3. TMK map of the proposed project (Hawai‘i TMK Service 2014)

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 Natural Environment

In Honouliuli Ahupua‘a, the land immediately mauka of the shoreline consists of a flat karstic raised limestone reef forming a level plain marked by a thin or non-existent soil mantle. The micro-topography is notable in containing countless sinkholes caused by chemical weathering (dissolution) of the limestone shelf. Proceeding mauka from this limestone plain, this shelf is overlain by alluvium deposited through a series of gulches draining the Wai‘ānae Mountains. The largest of these is Honouliuli Gulch towards the east side of the plain which drains into West Loch. To the west are fairly steep gradient gulches forming a more linear than dendritic drainage pattern. The major gulches from east to west are 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 as such 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 of the base of Honouliuli Gulch.

Located in the dry, leeward area of O‘ahu, the project area receives an average of less than 600 mm (24 inches) of annual rainfall (Giambelluca et al. 1986). Elevations within the project area range from approximately 4 to 66 m (13 to 216 ft) above mean sea level (AMSL). The land surface slopes down from east (mauka) to west (makai) at the border with Farrington Highway. Two small gulches called Limaloa and Keone‘ō‘io also extend to within the northern portion of the property. The steep, nearly vertical gulch faces were found to be cut into the limestone shelf. A dry streambed extends from the base of each gulch to within the project area.

Within the project area, the U.S. Department of Agriculture (USDA) Soil Survey (Foote et al. 1972) classifies the sediments of Survey Areas A and B as Lualualei Extremely Stony Clay, 3 to 35% slopes (LPE), Stony Steep Land (rSY), and Rock Land (rRK) (Figure 4). Soils of the

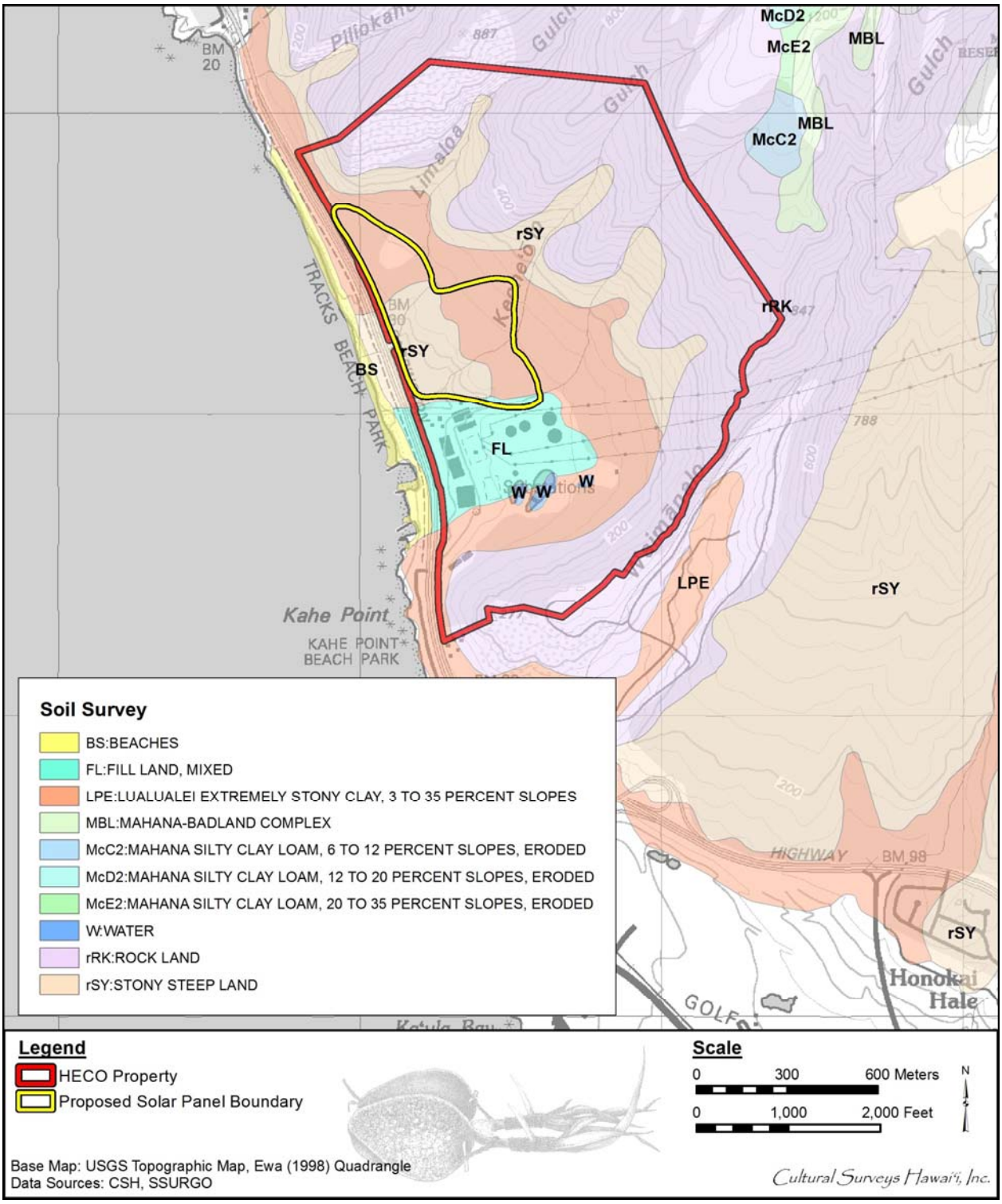

Figure 4. Soil map of the proposed project area (base map: USGS 1998)

Lualualei Series are described as “well-drained soils on the coastal plains, alluvial fans, and on talus slopes . . . developed in alluvium and colluviums” (Foote et al. 1972:84). Stony Steep Land is described as “a mass of boulders and stones deposited by water and gravity on the side slopes of drainageways” (Foote et al. 1972:121). Rock Land is described as “areas where exposed rock covers 25 to 90 percent of the surface” (Foote et al. 1972:119). Also observed was the emerged Pleistocene limestone reef.

Before the introduction of exotic species at Contact in 1778, the native ecosystem of the dry coastal areas of O‘ahu consisted of lowland dry and mesic forests, lowland dry shrub lands, and grasslands. Early historic accounts suggest the lowland zone on the leeward side of O‘ahu was composed of pili grass (*Heteropogon contortus*), kākonakona (*Panicum torridum*), and ‘ilima (*Sida fallax*) around the time of Contact (Rock 1913:7-17). Vegetation within the proposed project area currently consists predominantly of introduced perennial grasses and weeds, along with kiawe (*Prosopis pallida*) and koa haole (*Leucaena leucocephala*) near gulches and drainages.

1.5 Built Environment

The project area is located adjacent to Farrington Highway, on the mauka (mountain) side of the road between Pili-o-Kahe Ridge and the existing HECO Power Plant. The nearest commercial development to the project area is the HECO Power Plant and the Ko‘olina Resort further south. Immediately to the east of the project area is the Waimānalo Gulch Landfill. No residential areas are visible from the project area with the nearest settlements being north of the project area in the ahupua‘a of Nānākuli and south of the HECO Power Plant towards Ko‘olina.

Section 2 Methods

2.1 Archival Research

Historical documents, maps, and existing archaeological information pertaining to the project area were researched at the CSH library and other archives including the University of Hawai‘i at Mānoa’s Hamilton Library, the State Historic Preservation Division (SHPD) library, the Hawai‘i State Archives, the State Land Survey Division, and the Bishop Museum Archives. Previous archaeological reports for the area were reviewed, as were historic maps and photographs and primary and secondary historical sources. Information on Land Commission Awards (LCAs) was accessed through Waihona ‘Aina Corporation’s Māhele Database (Waihona Aina 2002) as well as a selection of CSH library references.

For cultural studies, research for the Traditional Background section centered on Hawaiian activities including religious and ceremonial knowledge and practices; traditional subsistence land use and settlement patterns; gathering practices and agricultural pursuits; as well as Hawaiian place names and mo‘olelo, mele (songs), oli, ‘ōlelo no‘eau and more. For the Historic Background section, research focuses on land transformation, development and population changes beginning in the early post–Western Contact era to the present day (see Scope of Work above).

2.2 Community Consultation

2.2.1 Sampling and Recruitment

A combination of qualitative methods, including purposive, snowball, and expert (or judgment) sampling, were used to identify and invite potential participants to the study. These methods are used for intensive case studies such as CIAs, to recruit people who are hard to identify, or are members of elite groups (Bernard 2006:190). Our purpose is not to establish a representative or random sample. It is to “identify specific groups of people who either possess characteristics or live in circumstances relevant to the social phenomenon being studied . . . This approach to sampling allows the researcher deliberately to include a wide range of types of informants and also to select key informants with access to important sources of knowledge” (Mays and Pope 1995:110).

We began with purposive sampling informed by referrals from known specialists and relevant agencies. For example, we contacted the SHPD, Office of Hawaiian Affairs (OHA), O‘ahu Island Burial Council (OIBC), and community and cultural organizations in the ‘Ewa District for their brief response/review of the project and to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the study area and vicinity, cultural and lineal descendants of the study area, and other appropriate community representatives and members. Based on their in-depth knowledge and experiences, these key respondents then referred CSH to additional potential participants who were added to the pool of invited participants. This is snowball sampling, a chain referral method that entails asking a few key individuals (including agency and organization representatives) to provide their comments and referrals to other locally recognized experts or stakeholders who would be likely candidates for the study (Bernard

2006:192). CSH also employs expert or judgment sampling which involves assembling a group of people with recognized experience and expertise in a specific area (Bernard 2006:189–191). CSH maintains a database that draws on over two decades of established relationships with community consultants including cultural practitioners and specialists, community representatives and cultural and lineal descendants. The names of new potential contacts were also provided by colleagues at CSH and from the researchers' familiarity with people who live in or around the study area. Researchers often attend public forums (e.g., Neighborhood Board, Burial Council and Civic Club meetings) in (or near) the study area to recruit participants. Please refer to Table 3, Section 6, for a complete list of individuals and organizations contacted for this CIA.

CSH focuses on obtaining in-depth information with a high level of validity from a targeted group of relevant stakeholders and local experts. Our qualitative methods do not aim to survey an entire population or subgroup. A depth of understanding about complex issues cannot be gained through comprehensive surveying. Our qualitative methodologies do not include quantitative (statistical) analyses, yet they are recognized as rigorous and thorough. Bernard (2006:25) describes the qualitative methods as "a kind of measurement, an integral part of the complex whole that comprises scientific research." Depending on the size and complexity of the project, CSH reports include in-depth contributions from about one-third of all participating respondents. Typically this means three to 12 interviews.

2.2.2 Informed Consent Protocol

An informed consent process was conducted as follows: 1) before beginning the interview the CSH researcher explained to the participant how the consent process works, the project purpose, the intent of the study and how his/her information will be used; 2) the researcher gave him/her a copy of the Authorization and Release Form to read and sign (Appendix A); 3) if the person agreed to participate by way of signing the consent form or providing oral consent, the researcher started the interview; 4) the interviewee received a copy of the Authorization and Release Form for his/her records, while the original was stored at CSH; 5) after the interview was summarized at CSH (and possibly transcribed in full), the study participant was afforded an opportunity to review the interview notes (or transcription) and summary and to make any corrections, deletions or additions to the substance of their testimony/oral history interview; this was accomplished either via phone, post or email or through a follow-up visit with the participant; 6) the participant received the final approved interview and any photographs taken for the study for their records. If the participant was interested in receiving a copy of the full transcript of the interview (if there was one, as not all interviews are audio-recorded and transcribed), a copy was provided. Participants were also given information on how to view the report on the OEQC website and offered a hardcopy of the report once the report is a public document.

If an interviewee agreed to participate on the condition that his/her name is withheld, procedures were taken to maintain his/her confidentiality (see Protection of Sensitive Information below).

2.2.3 Interview Techniques

To assist in discussion of natural and cultural resources and cultural practices specific to the study area, CSH initiated semi-structured interviews (as described by Bernard 2006), asking

questions from the following broad categories: gathering practices and mauka and makai resources, burials, trails, historic properties, and wahi pana. The interview protocol is tailored to the specific natural and cultural features of the landscape in the study area, identified through archival research and community consultation. For example, for this study fishing, ala hele (trails), and salt gathering were emphasized over other categories less salient to project participants. These interviews and oral histories supplement and provide depth to consultations with government agencies and community organizations that may provide brief responses, reviews and/or referrals gathered via phone, email, and occasionally face-to-face commentary.

2.2.3.1 In-depth Interviews and Oral Histories

Interviews were conducted initially at a place of the study participant’s choosing (usually at the participant’s home or at a public meeting place) and/or—whenever feasible—during site visits to the project area. Generally, CSH’s preference is to interview a participant individually or in small groups (two–four); occasionally participants are interviewed in focus groups (six–eight). Following the consent protocol outlined above, interviews may be recorded on tape and in handwritten notes, and the participant photographed. The interview typically lasts one to four hours, and records the who, what, when, and where of the interview. In addition to questions outlined above, the interviewee is asked to provide biographical information (e.g., connection to the study area, genealogy, professional and volunteer affiliations, etc.).

2.2.3.2 Field Interviews

Field interviews are conducted with individuals or in focus groups comprised of with kūpuna and kama‘āina who have a similar experience or background (e.g., the members of an area club, elders, fishermen, hula dancers) who are physically able and interested in visiting the project area. In some cases, field visits are preceded with an off-site interview to gather basic biographical, affiliation and other information about the participant. Initially, CSH researchers usually visit the project area to become familiar with the land and recognized (or potential) cultural places and historic properties in preparation for field interviews. All field activities are performed in a manner to minimize impact to the natural and cultural environment in the project area. Where appropriate, Hawaiian protocol may be used before going on to the study area and may include the ho‘okupu (offering) of pule (blessing) and oli. All participants on field visits are asked to respect the integrity of natural and cultural features of the landscape and not remove any cultural artifacts or other resources from the area.

2.2.4 Study Limitations

Cultural impact assessments are limited by the time frame and costs of the study as well as community participation. Often, researchers have little control over the time frame or budget available for a project but may have more discretion over study design and the methodologies employed to illicit public participation. Various factors may affect participation, such as the availability of contact information for community members during the recruitment process, the interest of the community in the project, and the commitment of participants through several phases of the interview process. For example, once an interview is scheduled and conducted, CSH engages the interviewee at least one more time (in person or by emails or phone calls) to gain their approval of the interview transcript or summary and to incorporate any changes they

make. The voluntary nature of community participation in this process, combined with restraints on time and costs, often limits the number of interviews and the depth of information gathered during the interviews.

2.3 Compensation and Contributions to Community

Many individuals and communities have generously worked with CSH over the years to identify and document the rich natural and cultural resources of these islands for cultural impact, ethno-historical and, more recently, TCP studies. CSH makes every effort to provide some form of compensation to individuals and communities who contribute to cultural studies. This is done in a variety of ways. Individual interview participants are compensated for their time in the form of a small honorarium and/or other makana (gift); community organization representatives (who may not be allowed to receive a gift) are asked if they would like a donation to a Hawaiian charter school or nonprofit of their choice to be made anonymously or in the name of the individual or organization participating in the study; contributors are provided their transcripts, interview summaries, photographs and—when possible—a copy of the CIA report; CSH is working to identify a public repository for all cultural studies that will allow easy access to current and past reports; CSH staff do volunteer work for community initiatives that serve to preserve and protect historic and cultural resources (for example in Lāna‘i and Kaho‘olawe). Generally our goal is to provide educational opportunities to students through internships, share our knowledge of historic preservation and cultural resources and the State and Federal laws that guide the historic preservation process, and through involvement in an ongoing working group of public and private stakeholders collaborating to improve and strengthen the §343 environmental review process.

Section 3 Traditional Background

3.1 Overview

This section focuses on the traditional background of the study area which includes the ahupua‘a of Honouliuli located in the ‘Ewa District of O‘ahu Island. The moku of ‘Ewa is traditionally made up of 12 ahupua‘a. Honouliuli Ahupua‘a is the largest traditional land unit on O‘ahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupua‘a at Pili-o-Kahe in the west. Honouliuli Ahupua‘a includes approximately 12 miles of open coastline from One‘ula westward to Pili-o-Kahe. The ahupua‘a extends mauka from West Loch nearly to Schofield Barracks in Wahiawā; the western boundary is the Wai‘ānae Mountain crest running north as far as Pu‘u Hapapa or to the top of Ka‘ala Mountain according to some.

The following sub-sections provide information specific to Honouliuli.

3.2 Wahi Pana

A Hawaiian wahi pana, also referred to as a place name, “physically and poetically describes an area while revealing its historical or legendary significance” (Landgraf 1994:v). Wahi pana can refer to natural geographic locations, such as streams, peaks, rock formations, ridges, and offshore islands and reefs, or they can refer to Hawaiian divisions such as ahupua‘a and ‘ili (land section, usually a subdivision of an ahupua‘a), and man-made structures such as fishponds. In this way, the wahi pana of ‘Ewa and the study area tangibly link the kama‘āina (native) of ‘Ewa to their past.

The primary compilation source for place names in this section is the online database compiled by Lloyd Soehren (2010), Hawaiian Place Names. Soehren compiled all names from mid-nineteenth century land documents such as Land Commission Awards (LCA) and Boundary Commission Testimony (BCT) reports. The BCT lists boundary points for many of the ahupua‘a. The names of ‘ili ‘āina (land units within an ahupua‘a) and ‘ili kū (land units rewarded separately from a specific ahupua‘a) are compiled from the testimony in Māhele Land Commission Awards, from both awards successfully claimed and from those rejected. Place names found by authors on USGS maps and Hawai‘i Survey Registered Maps (HSRM) were also added to the database. The Soehren database includes place name meanings from the definitive book on Hawaiian place names, *Place Names of Hawaii* (Pukui et al. 1974). For cases in which Pukui et al. (1974) did not provide a meaning, Soehren suggested meanings for simple names from the *Hawaiian Dictionary* (Pukui and Elbert 1986). Thomas Thrum (1922) also compiled a list of place names in the 1922 edition of Lorrin Andrews’s *A Dictionary of the Hawaiian Language*, although these meanings are considered less reliable than those from Pukui et al. (1974). The meanings from Thrum’s work are presented here as possible, but not definitive, translations.

Due to numerous place names available for the ahupua‘a in the study area, most place names will be presented in table format under each ahupua‘a (Table 1). Each row within a table shows the place name, the corresponding type of place name, the meaning of the name, and the source from which that meaning was extracted. For some place names, information is unavailable. Other place names gathered from consultations with kūpuna and kama‘āina for this study will also be presented in narrative form if they are available.

Table 1. Place Names of Honouliuli

Place	Type	Meaning	Source
Akupu	peak, spring		
Anianikū	cove		
Awanui	gulch	big harbor, or big kawa plant	Pukui and Elbert 1986
‘Ēkahanui	gulch	large bird’s nest fern	Pukui et al. 1974
Hāpapa, Pu‘u	peak	rock stratum hill; a shallow	Thrum 1922
Hoakalei	spring	lei reflection	Pukui et al. 1974
Honouliuli	stream, gulch	dark bay; blue harbor	Thrum 1922
Huliwai	gulch	water search	Pukui et al. 1974
Hunehune	gulch	tiny	Pukui et al. 1974
Ka‘ākau	‘ili ‘āina	the right, or the north	Pukui and Elbert 1986
Ka‘aikukui	gulch	the candlenut root	Pukui et al. 1974
Ka‘aimanō	pond	possibly, the shark food	Pukui and Elbert 1986
Ka‘aumakua	pu‘u (peak), ‘ili ‘āina	the family god	Pukui et al. 1974
Kahe	point	flow	Pukui et al. 1974
Kahe, Pu‘u		flow	Pukui et al. 1974
Kaihuopala‘ai	West Loch	the nose of Pala‘ai	Pukui et al. 1974
Kaihuopala‘ai	‘ili ‘āina	the nose of Pala‘ai	Pukui et al. 1974
Kā‘ilikahi	‘ili ‘āina	snatch once	Pukui et al. 1974
Kalaeloa	‘ili ‘āina	the long point	Pukui et al. 1974
Kalaeloa	point	the long point	Pukui et al. 1974
Kalahu	pond		
Kalo‘i	gulch	the taro patch	Pukui et al. 1974
Kalua‘a	gulch		
Kaluamo‘oiki	‘ili ‘āina		
Kama‘ipipipi	‘ili ‘āina		
Kamilomilo	‘ili ‘āina	to twist	Thrum 1922
Kamoku	‘ili ‘āina	the district, or the cut-off portion	Pukui et al. 1974
Kānehili	plain		
Kānehoa, Pu‘u	peak	a native shrub; Kāne’s friend	Thrum 1922
Kanukuopu‘uloa	point	the entrance of Pearl Harbor	
Kapākule	loko (pond)	the akule fish enclosure	Pukui et al. 1974
Kapāmuku	loko	the short wall	Pukui and Elbert 1986

Place	Type	Meaning	Source
Kapapapuhi	point, ‘ili ‘āina	the numerous eels	Thrum 1922
Kapolei	gulch	beloved Kapo, a sister of Pele	Pukui et al. 1974
Kapolei, Pu‘u o	hill	beloved Kapo, a sister of Pele	Pukui et al. 1974
Kapuai, Pu‘u	pu‘u	footstep	Thrum 1922
Kaua, Pu‘u	pu‘u	war hill or fort hill	Pukui et al. 1974
Kaula	Bay		
Kaulaula	‘ili ‘āina	the red one	Thrum 1922
Kaupe‘a	plain		
Keahi	point	the fire	Pukui et al. 1974
Keka‘a	point	the rumble	Pukui et al. 1974
Keon‘ō‘io	gulch	the sandy place with bonefish (‘ō‘io)	Pukui et al. 1974
Kepoe	‘ili ‘āina		
Kīhewamakawalu	loko		
Kolekole	pass	raw, scarred	Pukui et al. 1974
Ko‘olina	village		
Kualaka‘i	village, ‘ili ‘āina	*Tethys* sp.	Pukui et al. 1974
Ku‘ina, Pu‘u	pu‘u, heiau		
Kunia	‘ili ‘āina	burned	Pukui and Elbert 1986
Kupaka‘akahi	beach		
Ku‘ua, Pu‘u	pu‘u, heiau	relinquished hill	Pukui et al. 1974
Laulaunui	islet	large leaf package	Pukui et al. 1974
Līhe‘e	‘ili ‘āina	cold chill	Pukui et al. 1974
Limaloa	gulch	long arm	Pukui et al. 1974
Loloulu	‘ili ‘āina		
Makai‘i	‘ili ‘āina		
Makaīwa	gulch	mother of pearl eyes	Pukui et al. 1974
Makakilo, Pu‘u	pu‘u	observing eyes	Pukui et al. 1974
Makalapa	gulch	ridge features	Pukui et al. 1974
Manawahua, Pu‘u	pu‘u	great grief hill, or nausea hill	Pukui et al. 1974
Manawaiahu	gulch	bird water pool	Pukui et al. 1974
Manawai‘elelū	gulch	cockroach water branch	Pukui and Elbert 1986
Manuwaikealae	gulch		
Maui	‘ili ‘āina		
Maunakapu	peak	sacred mountain	Pukui et al. 1974

Place	Type	Meaning	Source
Maunauna	pu‘u, gulch	mountain sent on errands	Pukui et al. 1974
Ma‘ūakapua‘a	‘ili ‘āina		
Mo‘opunea Pu‘u	pu‘u	grandchild hill	
Nalowale	heiau	lost, forgotten	Pukui and Elbert 1986
Nāmo‘opuna	gulch	the grandchildren	Pukui and Elbert 1986
Nāpepeiao‘ōlelo	‘ili ‘āina		Pukui and Elbert 1986
Niuke‘e	‘ili ‘āina	bent coconut tree	
‘Oki‘okilepe	loko	cut strips	Pukui et al. 1974
One‘ula	village, beach	red sand	Pukui et al. 1974
Pālailai	gulch	young lai fish	Pukui et al. 1974
Pālailai, Pu‘u	pu‘u	young lai fish hill	Pukui et al. 1974
Pālāwai	gulch	kind of sea moss	Thrum 1922
Pālehua	pu‘u	lehua flower enclosure	Pukui et al. 1974
Palikea	pu‘u, ridge	white cliff	Pukui et al. 1974
Pāmoku	loko		
Paupauwela (Poupouwela)	‘ili ‘āina	an angry person	Thrum 1922
Pili o Kahe	point	clinging to Kahe	Pukui et al. 1974
Pilo o Koe	gulch		
Pōhākea	pass	white stone	Pukui et al. 1974
Pōhaku Palaha	pōhaku	broad rock	Thrum 1922
Pō‘aiwaikele	‘ili ‘āina	(spelling from Soehren 2009)	
Polapola	‘ili ‘āina	improved in health	Pukui et al. 1974
Poliwai	gulch	water bosom	Pukui et al. 1974
Po‘ohilo	‘ili ‘āina		
Poulihale	gulch	dark house	Pukui et al. 1974
Pouilihale, Pu‘u	pu‘u	dark house hill	Pukui et al. 1974
Puali‘i	gulch	small flower	Pukui and Elbert 1986
Pua‘alu‘u	‘ili ‘āina	diving pig	Pukui et al. 1974
Pu‘uloa	‘ili ‘āina, beach	long hill	Pukui et al. 1974
Pu‘umai‘alau	gulch	hill of many bananas, or many banana stalks	Pukui and Elbert 1986
Wai‘eli	gulch	dug water	Pukui et al. 1974
Waimānalo	gulch	potable water	Pukui et al. 1974
Waimanana	‘ili ‘āina	extended water	Pukui and Elbert 1986

Honouliuli is the largest and western-most ahupua‘a in ‘Ewa District. Honouliuli is defined as “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. In the the “Mo‘olelo of Lepeamoa,” the chicken-girl of Pālama, **Honouliuli** is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa (Westervelt 1923:164-184). Honouliuli also translates as “unequal” (*Saturday Press*, 11 August 1883).

‘**Ewa** literally translates as “crooked” or “unequal” (Pukui and Elbert 1986:42). An alternative interpretation of ‘Ewa is “strayed” in association with a story about the gods Kāne and Kanaloa, who threw a stone to determine the boundary of the district, as shown in the following excerpt:

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

Pearl Harbor, a prominent feature of the ‘Ewa District, was called **Pu‘uloa** which translates literally as “long hill.” Pu‘uloa was also known as **Keawalau-o-Pu‘uloa**, “the many harbored-sea of Pu‘uloa” (Pukui 1983:182). An alternate name was **Awawalei**, or “garland (lei) of harbors” (Handy and Handy 1972:469). Pukui (1983:120) uses the name **Awalau** for Pearl Harbor, as in the saying “Huhui na ‘ōpua i Awalau; ‘The clouds met at Pearl Harbor’” which refers to the mating of two people. Emerson (1993:167) interprets Awalau as “leaf-shaped lagoon.”

The boundaries of the western-most ahupua‘a of ‘Ewa were often contested with the people of Wai‘ānae, however, the boundaries of these two districts are said to be marked by a stone known as **Pili o Kahe**:

> The ancient Hawaiians said the hill on the ‘Ewa side was the male and the hill on the Wai‘ānae side was female. The stone was found on the Waianae side hill and the place is known as **Pili o Kahe** (Pili=cling to, Kahe=flow). The name refers, therefore, to the female or Waianae side hill. And that is where the boundary between the two districts runs. [Told to E.S. by Simeon Nawaa, 22 March 1954 in Sterling and Summers 1978:1]

Pu‘uokapolei was the primary landmark for travelers on a historical lateral trail that ran from Pearl Harbor in the east to Wai‘ānae in the west through Honouliuli (Section 3.11.1) (‘Ī‘ī 1959:27, 29; Nakuina 1992:54; E.M. Nakuina 1904 in Sterling and Summers 1978:34). The plain southwest of the hill was called **Kaupe‘a**. These two names appear in many mo‘olelo of Honouliuli.

Honouliuli consists of numerous topographic features such as peaks, streams, gulches, coastal points, and a number of ancient villages with specific place names. These place names are listed with their associated features, meanings, and locations in Table 1. In addition, 21 ‘ili names listed in Māhele documents are also included. It is possible more ‘ili existed in Honouliuli on lands not claimed or awarded during the Māhele, therefore, were not captured or recorded. The 21 ‘ili in Honouliuli were all ‘ili ‘āina—land in which the chief of the ‘ili owed tribute to the chief of the ahupua‘a. Another type of common ‘ili in other ahupua‘a, called an ‘ili kū, short for ‘ili kūpono which was nearly independent of any specific ahupua‘a although it was usually within the boundary of a specific ahupua‘a. Tribute for ‘ili kūpono was usually owed directly to the king or a high ali‘i, but not to the chief of the ahupua‘a.

3.3 Mo‘olelo (Stories)

3.3.1 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, south of the HECO property:

> Ko‘olina is in Waimānalo near the boundary of ‘Ewa and Wai‘ānae. This was a vacationing place for chief Kākuhihewa and the priest Napuaikamao was the caretaker of the place. Remember reader, this Ko‘olina is not situated in the Waimānalo on the Ko‘olau side of the island but the Waimānalo in ‘Ewa. It is a lovely and delightful place and the chief, Kākuhihewa loved this home of his. [Sterling and Summers 1978:41]

3.3.2 Pu‘uokapolei

Pu‘ukapolei is a hill in Honouliuli thought to have been named after “beloved Kapo,” the sister of the volcano goddess, Pele. Pu‘ukapolei is associated with being a place for astronomy, a heiau, home to the grandmother of Kamapua‘a, the pig god, and also the realm of the ao kuewa, or wandering homeless souls. Several mo‘olelo are associated with this hill which are described in the following subsections.

3.3.2.1 Astronomical Marker and Heiau

The hill was used as a point of solar reference or as a place for making astronomical observations. 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 gate of the rising sun; both places are associated with the goddess Kapo (Emerson 1993:41). This somewhat contradicts some Hawaiian cosmologies, in which Kū was the god of the rising sun, and Hina, the mother of Kamapua‘a, was associated with the setting sun. Fornander (1919:292) states Pu‘uokapolei may have been a jumping off place (also connected with the setting sun) and associated with the wandering souls who roamed the plains of Kaupe‘a and Kānehili, makai of the hill.

Samuel Kamakau (1976) writes that ancient Hawaiians used Pu‘uokapolei as an astronomical marker to designate the seasons:

> the O‘ahu people who reckoned the time (*Oahu pō‘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 heiau was once on Pu‘uokapolei, but had been destroyed by the time of McAllister’s (1933:108) survey of the island in the early 1930s.

3.3.2.2 Kamapua‘a

Pu‘uokapolei was the home of Kamaunuaniho, the grandmother of Kamapua‘a, the Hawaiian pig-god. She was one of the three migrants from Kahiki who were ancestors to the people of O‘ahu. The following excerpt tells of taking his grandmother to Pu‘uokapolei (Fornander 1919:V:318; Kahiolo 1978:81, 107).

> Kamapua‘a subsequently conquered most of the island of O‘ahu, and, installing his grandmother [Kamaunuaniho] as queen, took her to Pu‘uokapolei, the lesser of the two hillocks forming the southeastern spur of the Wai‘ānae 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 notes, “A very short time ago [prior to 1904] the foundations of Kamaunuaniho’s house could still be seen at Pu‘uokapolei.” Another account (*Ka Loea Kālai‘āina,* 13 January 1900 in Sterling and Summers 1978:34) speaks of Kekeleaiku, the older brother of Kamapua‘a, who also lived on Pu‘uokapolei. Kamapua‘a once lived in Kaluanui on the windward side of O‘ahu but he escaped to ‘Ewa when he was pursued by the chief Olopana.

3.3.2.3 Hi‘iaka

Hi‘iaka sang this bitter chant addressed to Lohiau 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 1993:162-163]

Several other Honouliuli places are mentioned in this chant, including Pe‘e-kaua, which may be a variation of Kau-pe‘e or Kaupe‘a, and the plains of Kānehili, the last of which again refers to wandering, as the word "hili" means "to go astray" (Emerson 1993:162). In the chant, Hi‘iaka moves downhill from Kaupe‘a, probably the plains adjacent to Pu‘uokapolei, toward the coast, the plain of Kānehili.

3.3.2.4 The Plains of Kaupe‘a and Pu‘uokapolei, and the Realm of Homeless Souls

There are several places on the ‘Ewa coastal plain associated with "ao kuewa," the realm of the homeless souls. Samuel Kamakau (1991b) explains the Hawaiian beliefs in the afterlife:

> There were three realms (*ao*) for the spirits of the dead. . . . There were, first, the realm of the homeless souls, the *ao kuewa*; second, the realm of the ancestral spirits, the *ao ‘aumakua*; and third, the 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* realm (*kanaka kuleana ‘ole*), 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 he would find the breadfruit tree of Leiwalo, *ka‘ulu o Leiwalo*. If it was not found by an *‘aumakua* soul who knew it (*i ma‘a mau iaia*), or one who would help it, the soul would leap upon the decayed branch of the breadfruit tree and fall down into endless night, *the pō pau ‘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*. . . . [Kamakau 1991b:47]
>
> On the plain of Kaupe‘a beside Pu‘uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by *‘aumakua* souls, and be helped to escape. [Kamakau 1991b:49]

The breadfruit tree Leilono was said to have been located on the ‘Ewa-Kona border, above Āliamanu. In another section of his account of the dead, Kamakau (1991b:29) calls the plain of wandering souls the "plain at Pu‘uokapolei." Kamakau also writes,

> There are many who have died and have returned to say that they had no claim to an *‘aumakua* [realm] (*kuleana‘ole*). These are the souls, it is said, who only

> wander upon the plain of Kama‘oma‘o on Maui or on the plain at Pu‘uokapolei on Oahu. Spiders and moths are their food. [Kamakau 1991b:29]

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

3.3.2.5 Kanehili

The association of Pu‘uokapolei and Kanehili with wandering souls is also illustrated in a lament on the death of Kahahana, the paramount chief of O‘ahu, who was killed by his foster father, the Maui chief Kahekili, after Kahahana became treacherous and killed the high priest Ka‘opulupulu.

E newa ai o hea make i ka la,	Go carefully lest you fall dead in the sun,
Akua noho la i Puuokapolei.	The god that dwells on Kapolei hill
E hanehane mai ana ka la i na wahine o Kamao,	The sun is wailing on account of the women of Kamao,
Akua pee, 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 wast spoken of by the *oo*—
E ka manu o Kanehili.	By the bird of Kanehili.
[Fornander 1919:VI:297]	

Fornander provides some notes on this lament. The god dwelling at Kapolei is Kahahana, stating that this is where his soul has gone. Kamao is one of the names of the door to the underworld. This lament draws an association with wandering souls and the place where the first breadfruit tree was planted by Kaha‘i at Pu‘uloa.

3.3.3 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 Kualaka‘i [near Barbers Point] in the evening, they caught these things, *‘a‘ama* crabs, *pipipi* shellfish, and whatever they could get with their hands. As they were returning to the plain from the shore and thinking of getting home while it was yet

> dark, they failed for they met a one-eyed person [bad omen]. It became light as they came near to the plain, so that passing people were distinguishable. They were still below the road and became frightened lest they be seen by men. They began to run—running, leaping, falling, sprawling, rising up and running on, without a thought of the *‘a‘ama* crabs and seaweeds that dropped on the way, so long as they would reach the upper side of the road. They did not go far for by then it was broad daylight. One woman said to the other, ‘Let us hide lest people see us,’ and so they hid. Their bodies turned into stone and that is one of the famous things on this plain to this day, the stone body. This is the end of these strange women. When one visits the plain, it will do no harm to glance on the upper side of the road and see them standing on the plain. [*Ka Loea Kālai‘āina*, 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 (supernatural beings) and were afraid that Hi‘iaka would kill them, so they changed into their lizard form. One of the lizards hid in a little space on a stone beside the coastal trail, and the other hid nearby (*Ka Hōkū o Hawai‘i*, 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 grove on the hill. These women were named Pu‘uokapolei and Nāwaineokama‘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:

Ku‘u kāne i ke awa lau o Pu‘uloa	My man on the many harbored sea of Pu‘uloa
Mai ke kula o Pe‘ekāua ke noho	As seen from the plain of Pe‘ekāua
E noho kāua i ke kaha o ka ‘ōhai	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 Kānehili la	Descending along Kānehili
Ua hili ho‘i au-e	I am winding along.

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

3.3.4 The Plains of Keahumoa

3.3.4.1 Hi‘iaka and the Plains of Keahumoa

In several mo‘olelo of ‘Ewa, mention is made of the “plain of Keahumoa.” John Papa ‘Ī‘ī (1959:96) has this plain opposite the trail to Pōhākea Pass, stretching across the ahupua‘a of Honouliuli and Hō‘ae‘ae. McAllister (1933:107) states the plain was west of Kīpapa Gulch in Waikele; it is also mentioned in mo‘olelo 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.

The goddess Hi‘iaka, sister of the volcano goddess Pele, passed through ‘Ewa and met women stringing ma‘o flowers to make lei (garland). Hi‘iaka offered a chant, making known her wish for a lei around her own neck which mentions Keahumoa:

E lei ana ke kula o Ke‘ahumoa i ka ma‘o	The plains of Keahumoa are garlanded with *ma‘o*

‘Ohu‘ohu wale nā wāhine kui lei o ka nahele	The lei-stringing women of the forest are festively adorned

[Ho‘oulumahiehie 2006a:287; 2006b:268]

3.3.4.2 Nāmakaokapao‘o

Nāmakaokapao‘o was a Hawaiian hero of powerful 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 1919:V:274–276).

3.3.4.3 The Demi-god Maui

In the stories of the demi-god Maui, Keahumoa is the home of Maui‘s grandfather, Kuolokele (Kū-honeycreeper). One day, Maui’s wife, Kumulama, was stolen by the chief Peapeamakawalu, called eight-eyed-Pea-Pea, who is identified in the creation chant *Kumulipo* as the octopus god (Beckwith 1940:136). The chief disappeared with Kumulama in the sky beyond the sea, and escaped so quickly that Maui could not catch him. To recover his wife, Maui’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]

Kuolokele made a moku-manu or “bird-ship” for Maui, who entered the body of the bird and flew to Moanaliha, the land of the chief Peapeamakawalu. 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 Maui’s wife. When Peapeamakawalu fell asleep, Maui 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).

A man named Kaopele, born in Waipi‘o, had a tendency to fall into deep trances for months at a time. While awake, he would create plantations of supernatural proportions. However, he was never able to enjoy the fruits of his labors because he would always fall into another deep sleep. During one profound slumber, Kaopele was believed to be dead; he was taken to Wailua, Kaua‘i to be offered as a sacrifice. Upon awakening, he married a woman named Makalani and stayed on Kaua‘i. They had a son named Kalelealuaka, who was also blessed with supernatural powers. Kaopele instructed the boy in the arts of war and combat, which Kalelealuaka exhibited during two challenges with kings of Kaua‘i. One day, Kalelealuaka decided to travel to O‘ahu. A boy, Kaluhe, accompanied him and they paddled to Wai‘ānae. There, he met another companion who

he later named Keinoho‘omanawanui, the sloven. The three traveled toward the old plantation called Keahumoe (Keahumoa), in the *mauka* regions of Waipi‘o, formerly planted by Kaopele.

> . . . the three turned inland and journeyed till they reached a plain of soft, whitish rock, where they all refreshed themselves with food. They kept on ascending, until Keahumoe lay before them, dripping with hoary moisture from the mist of the mountain, yet as if smiling through its tears. Here were standing bananas with ripened, yellow fruit, upland *kalo*, and sugar cane, rusty and crooked with age, while the sweet potatoes had crawled out of the earth and were cracked and dry. [Emerson 1998:86-87]

To determine the best settlement location, Kalelealuaka shot an arrow to see where it would land. He then built a mountain house and called it “Lelepua” (meaning “arrow flight”), after his magic arrows.

One night, Kalelealuaka made known his wish:

> The beautiful daughters of Kakuhihewa to be my wives; his fatted pigs and dogs to be baked for us; his choice *kalo*, sugar cane, and bananas to be served up for us; that Kakuhihewa himself send and get timber and build a house for us; that he pull the famous *awa* of Kahuone; that the King send and fetch us to him; that he chew the *awa* for us in his own mouth, strain and pour it for us, and give us to drink until we are happy, and then take us to our house. [Emerson 1998:89]

Upon hearing such a request, the mō‘ī (king, monarch) Kākuhihewa conferred with his priests and instead of killing Kalelealuaka, decided to test him in battle with Kūali‘i. Kalelealuaka proved worthy in battle and was given charge of Kākuhihewa’s kingdom.

3.3.4.4 Pikoi

Pikoi was a 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 1917:450–463). Pikoi’s skill was commemorated in a saying that mentions the plains of Keahumoa (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.

3.3.5 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‘ānae, and from there east across the district of ‘Ewa. Fornander writes,

> *Ha‘alele keia ia Ka‘ena, hele mai la a Kalena, a Pōhākea, Maunauna, Kānehoa, a ke kula o Keahumoa, nana ia ‘Ewa. Kū kēia i laila nānā i ke kū a ka ea o ka lepo i nā kānaka, e pahu aku ana kēia i ka la‘au palau aia nei i kai o Honouliuli,*

> *kū ka ea o ka lepo, nu lalo o ka honua, me he olai la, makau nā kānaka holo a hiki i Waikele. A hiki o Palila, i laila, e pa‘apu ana nā kānaka i ka nānā lealea a ke ‘li‘i o O‘ahu nei, oai o Ahuapau.*
>
> After leaving Ka‘ena, he came to Kalena, then on to Pōhākea, then to Manuauna [a peak in Honouliuli], then to Kānehoa [a peak in Honouliuli], then to the plain of Keahumoa [upland plain from Honouliuli to Waipi‘o] and looked 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 O‘ahu, Ahupau by name. [Fornander 1918:142–143]

3.3.6 Ka-lua-ōlohe (Caves) of Honouliuli

Ewa was famous for the many limestone caves formed in the uplifted coral, called the “Ewa Karst.” Some of these caves, called “ka-lua-ōlohe” were inhabited by the “ōlohe,” a type of people who 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, lived in Līhu‘e in upland Honouliuli, and he was an “ōlohe.”

3.3.7 The First Breadfruit Brought from Kahiki

The chief Kaha‘i left from Kalaeloa, a coastal area in Honouliuli Ahupua‘a, for a trip to Kahiki. On his return to the Hawaiian Islands, he brought back the first breadfruit (Kamakau 1991a:110) and planted it near the waters of Pu‘uloa or “long hill,” now known as Pearl Harbor (Beckwith 1940:97).

3.3.8 Shark Mo‘olelo

3.3.8.1 Ka‘ahupāhau

Pu‘uloa is closely associated with shark ‘aumakua (family or personal gods, deified ancestors who might assume the shape of sharks). Pukui (1943:56) claims the sharks of Pearl Harbor were so tame that people used to ride on their backs, and that their human relatives would feed them with ‘awa (*Piper methysticum*). The most famous guardian shark was Ka‘ahupāhau, the queen shark of O‘ahu, who lived in Pu‘uloa, now called Pearl Harbor. Her name means “cloak well cared for” (Pukui 1943:56), or “well cared-for feather cloak.” The feather cloak was a symbol of royalty.

Ka‘ahupāhau and her brother, Kahi‘uka, had been born as humans and were turned into sharks (told by Mary Kawena Pukui, 29 March 1954 in Sterling and Summers 1978:56).

> The mother, who was a chiefess, of Ka‘ahupahau was gathering limu [seaweed] in the waters of Pearl Harbor when she had a miscarriage. Thinking the baby dead she left it in the water to be washed away. Later she went again to gather limu and was bitten by a shark. She went to a kahuna [priest] who told her that the shark

> was Ka‘ahupahau who was her own daughter, the baby she thought was dead. The kahuna advised her to go to the place and build an ahu (heap) of hau a sort of landing from which she could feed the shark and care for it. It was from that time by command of the mother that all people of Ewa were to be always be protected from sharks whether in Pearl Harbor or outside. (Simeon Nawaa, 22 March 1954, in Sterling and Summers 1978:56)

This explains the meaning of the shark’s name Ka‘ahupāhau, “the mound (ahu) of hau” (*Hibiscus tiliaceus*). Koihala, the grandmother of Ka‘ahupāhau and her brother, lived in Honouliuli. One day she was making lei for her shark grandchildren. A young girl named Pāpio rudely begged for one of the lei, but Koihala refused. On her way to her favorite surfing spot at Keahi Point in Honouliuli, Pāpio snatched up one of the lei, and laughingly went surfing. She swam across the narrow Pearl River channel to the east side in Hālawa and basked on a rock near the water. Koihala angrily told Ka‘ahupāhau about the stolen lei, and the shark killed the girl, grabbing her from a rock in the sea where she was resting. The blood spewed everywhere, staining the soil of Hālawa red, the same color as it is today. Pukui (1943) recounts how the people of ‘Ewa became protected by sharks:

> Ka‘ahupahau soon recovered from her anger and became very sorry. She declared that from hence forth all sharks in her domain should not destroy, but protect the people round about. As flowers were the cause of the trouble she forbade their being carried or worn on the water of Pu‘uloa. From that time all the people of that locality and the sharks in the lochs were the best of friends. [Pukui 1943:56]

In a second version of this story, the shark gods Kānehunamoku and Kamohoali‘i were the ones that had placed a kanawai (decree) against the attack of men by all sharks around O‘ahu. As the result of the attack of the chiefess Pāpio, Ka‘ahupāhau was put on trial and tried at Uluka‘a, the realm of the gods. She escaped the punishment of death, but was placed in confinement. Kamakau writes,

> After her confinement ended several years later Ka‘ahupahau was very weak. She went on a sightseeing trip, got into trouble, and was almost killed. But she received great help from Kupiapia and Laukahi‘u, sons of Kuhaimoana, when their enemies were all slain the *kanawai* was firmly established. This law—that no shark must bite or attempt to eat a person in Oahu waters—is well known from Pu‘uloa to the Ewa. Anyone who doubts my work must be a *malihini* [recent resident] there. Only in recent times have sharks been known to bite people in Oahu waters or to have devoured them; it was not so in old times. [Kamakau 1991b:73]

This information on the protective nature of Ka‘ahupāhau is somewhat contradicted by the writings of the Russian explorer Otto Von Kotzebue, who walked to Pearl Harbor in 1821, but was unable to actually sail on the waters. He was told that people were thrown into the water as sacrifices to the sharks. However, it is uncertain whether the person who relayed the story was an actual resident of ‘Ewa who may not have known the correct mo‘olelo. Kotzebue’s account is as follows:

> In the Pearl River there are sharks of remarkable size, and there have made on the banks an artificial pond of coral stones, in which a large shark is kept, to which, I was told, they often threw grown-up people, but more frequently children, as victims. [Kotzebue 1821:338-348]

3.3.8.2 Mikololou, the Man-Eating Shark

The protection of Ka‘ahupāhau is emphasized in many other Hawaiian traditions. One time, a man-eating shark called Mikololou from the Ka‘ū district of the island of Hawai‘i came visiting at Pearl Harbor with other sharks, some man-eating, some not. Mikololou remarked, “What fine, fat crabs you have here,” from which Ka‘ahupāhau knew that some of the sharks were man-eaters, since sharks referred to fishermen as “fat crabs.” She directed the fishermen to place a barrier of nets across the entrance to the harbor, and when the sharks left her home, they could not get back out to the ocean. Pukui (1943) writes of Mikololou:

> The sharks of the lochs attacked the man-eaters from outside and beat them unmercifully. A shark from Ka‘u, Hawaii, who was not a man-eater, threw his weight over the nets and pressed them down. His sons changed themselves into pao‘o [blennies] fishes and leaped where the net was forced down, thus escaping from the place where the battle of sharks was raging. Mikololou was caught fast in the nets and dragged ashore where his head was cut off and his body burned. [Pukui 1943:56]

In another version of this story, Mikololou is accompanied to Pearl Harbor with his shark friends Kua, Keali‘ikauaoka‘ū, Pākaiea, and Kalani; Mikololou was the only man-eater. To escape the nets,

> Keali‘ikauaoka‘ū changed himself into a pao‘o fish, which lives among the rocks, and leapt out of the net. Kua changed into a lupe, as the spotted stingray is called, and weighted down the net on one side, helping his son Kalani and nephew Pākaiea, who were half human, to escape. [Pukui and Green 1995:40]

Only Mikololou was caught in the nets, and his body was tossed on shore to rot, until only the tongue was left. In some versions of this story, the tongue immediately jumps into the water and then becomes a shark again (Pukui and Green 1995:41). In other versions (Pukui 1943:56), the tongue is eaten by a dog, which then jumps into the water, turns into a shark, and escapes. In both versions, Mikololou returns to Ka‘ū, never to bother Ka‘ahupāhau again.

3.3.8.3 Kahi‘ukā, a Brother of Ka‘ahupāhau

There were other guardian sharks in Pearl Harbor including a brother of Ka‘ahupāhau named Kahi‘ukā (the smiting tail) and a son named Kūpīpī (Pukui 1943:57), or, in some versions, twin sons named Kūpīpī and Kūmaninini (Pukui and Green 1995:41). The following excerpt describes Kahi‘ukā’s kuleana (responsibility):

> Kahi‘ukā was the brother of Ka‘ahupahau. The name means ‘smiting tail.’ This shark was called by this name because it was his duty to warn the people of Ewa of the presence of strange and unfriendly sharks in these waters and he did so by nudging them or striking at them with his tail. Whenever anyone was fishing and

> felt a nudge they would know it was Kahi‘uka, warning them and they would leave the water immediately. [Simeon Nawaa, 22 March 1954 in Sterling and Summers 1978:56]

There are two different accounts of the home of this shark brother. The above reference says that Kahi‘ukā lived at the site of the old dry dock. Mary Pukui disagrees, and says the site of the old dry dock was the home of the son, not the brother of Ka‘ahupāhau. Mary Pukui says Kahi‘ukā lived in a cavern underwater off Moku‘ume‘ume (Ford Island) near Keanapua‘a Point; he had a stone form in deep water some distance from the cave that could be seen from the surface (Mary Kawena Pukui, 29 March 1954 in Sterling and Summers 1978:56). J.S. Emerson (1892:11) wrote in the late nineteenth century that Kahi‘ukā’s keeper, Kimona, would often find fish nets missing and knew that Kahi‘ukā had carried them up shore to a place of safety. Pukui also relates that the shark was named “smiting tail” because one side was longer than the other, and the shark would use his tail to smite unfriendly sharks.

Others have placed a home for Kahi‘ukā at a cave above the old Ewa Protestant Church in Waiawa (*Ke Au Hou* 1910a in Sterling and Summers 1978:18). Kuhialoko, a fishpond on the Waiawa coastline, was named for Kuhia, a servant or retainer to Kahi‘ukā (*Saturday Press* 12 January 1884 in Sterling and Summers 1978:17).

3.3.8.4 Ka‘ehu, the Little Yellow Shark

One of the shark ‘aumakua associated with Pearl Harbor was the little yellow shark called Ka‘ehu, who was born on the Big Island but later traveled to O‘ahu and settled at Pu‘uloa. His ancestor was Kama‘ili‘ili, the Hawaiian shark god, brother of the Hawaiian volcano goddess, Pele. Ka‘ehu was a guardian of the Hawaiian people and once saved several surf riders at Waikīkī from a man-eating shark called Pehu (Knudsen 1946:9-13; Westervelt 1963:55-58).

In Thrum’s translation of this mo‘olelo, the shark’s name is Ka-ehu-iki-manō-o-Pu‘uloa, meaning “the small, blonde shark of Pu‘uloa.” He was born in Puna, Hawai‘i, but soon left on a tour of all of the islands, so that he could call and pay respects to all of the king-sharks of Hawai‘i:

> Puuloa, Oahu, was the next objective. Reaching its entrance they visited the pit of Komoawa, where Kaahupahau’s watcher lived. Here the young shark made himself known, as usual; the object of the journey, and the desire to meet the famous queen-shark protector of Oahu‘s water . . . Welcome greetings were sent by the messenger, who was bid entertain the visitors in the outer cave, and on the morrow the party could come up the lochs to meet the queen . . . The company then reported to the royal cave at Honouliuli, where the visitors were supplied with soft coconut and *awa*, their home food and beverage. [Thrum 1923:301-302]

According to Thrum’s version (Thrum 1923:301), Ka‘ehu found Ka‘ahupāhau and her entourage at Waiawa. Other references associating the Ka‘ahupāhau shark royal court with Waiawa include the naming of a fishpond at Pearl Harbor “Kuhialoko” after the name of a butler or purveyor to the shark queen (*Saturday Press,* 12 January 1884). Ka‘ahupāhau’s brother Kahi‘uka was said to have a cave in Waiawa below the former home of the Reverend Bishop, who was the pastor in ‘Ewa (*Ke Au Hou,* 14 December 1910, translation in Sterling and Summers 1978:18).

The cave of Komoawa may be the Hawaiian words for “channel” or harbor” entrance (Pukui and Elbert 1986:164). In 1823, the missionary Hiram Bingham accompanied Liholiho (King Kamehameha II) and his company to the royal compound at Pu‘uloa, where he was shown a cave that was home to a shark god. Although Bingham stated in 1823 that no one any longer believed these stories, there were some who kept the beliefs of the guardian sharks alive. In 1912, dredging in Pearl Harbor was completed and a large dry-dock was built, but collapsed the very next year. The Native Hawaiians believed the dock had collapsed because it had been built over the home of Kūpīpī the shark son of Ka‘ahupāhau, who lived in a cavern near the harbor entrance at Pu‘uloa. “Angered by the violation of his home, the shark prince destroyed the imposing structure” (Clark 1977:69-70). The dock was rebuilt in the same year, but this time only after a blessing of the construction was made by Hawaiian traditional practioners.

3.3.9 Loko I‘a Mo‘olelo

3.3.9.1 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).

Mary Pukui (1943:56-57), who visited Kapākule Fishpond when she was young, writes that the pond was built by the menehune under the direction of the gods Kāne and Kanaloa. Pukui describes several unique aspects of this pond:

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

The fishpond contained many fish, especially the akule, thus its name, “the enclosure for *akule* fish” (Pukui 1943:56-57). The pond was destroyed when the channel to Pearl Harbor was dredged in the early twentieth century. The caretaker of the pond took the stones Kū and Hina to a deep place in the ocean and sunk them so “none would harm or defile them.” Cobb (1903:733) writes that the pond was used to catch the larger akule (goggler), ‘ōpelu, weke (goat fish), kawakawa (bonito), 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).

3.3.9.2 Kaihuopala‘ai

Fornander (1919:270–271) recorded a mo‘olelo of Maikohā, a deified hairy man who became the god of kapa (tapa cloth) makers. This mo‘olelo describes Maikohā’s sister, Kaihuopala‘ai, who journeyed to O‘ahu and fell in love with Kapapaapuhi, a man from Honouliuili:

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

The name of Maikohā’s sister, Kaihuopala‘ai, which means “the nose of Pala‘ai” (Pukui et al. 1974:68), is also the name the Hawaiians used for the West Loch of Pu‘uloa. Yet, McAllister (1933:108) recorded that some Hawaiians claim there never was a fishpond by that name. Beckwith (1918:354) writes that Kaihuopala‘ai changed into the fishpond near the place called Kapapapūhi (the eel flats). This fishpond is identified on old maps as the peninsula that juts into the west side of West Loch (and sometimes spelled Kapapa‘apūhi).

3.3.9.3 Ihuopala‘ai and the ‘Anae-holo (traveling mullet)

Kaihuopala‘ai, also known as Ihuopala‘ai, is also associated with the ‘anae-holo, the traveling mullet of Pearl Harbor. Nakuina (1998:270-272) writes that Ihuopala‘ai was a place in Honouliuli and the home of the ‘anae-holo.

> 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]

In Nakuina’s account, Ihupala‘ai was a male who possessed a kū‘ula (fish god) that supplied the large mullet known as ‘anae. His sister lived in Lā‘ie and there came a time when there were no fish to be had. She sent her husband to visit Ihupala‘ai, who was kind enough to send the fish following his brother-in-law on his trip back to Lā‘ie. This story is associated with a proverb or poetical saying identified with Honouliuli, “Ka i‘a hali a ka makani, The fish fetched by the wind.”

Pukui et al. (1974:68) call the husband in this story Lā‘ie and the name of the wife is Pala‘ai, which ties into the name of the west loch of Pearl Harbor, called Kaihu o Pala‘ai (the nose of Pala‘ai). Another version has a woman named Awawalei, another wahi pana of Pearl Harbor,

who had a brother named Laniloa (the point on Lā‘ie at which the mullet stops its migration and makes its way back to Pearl Harbor), and another brother (a mullet) who lived with an eel named Papapūhi (*Ka Loea Kālai‘āina* 21 October 1899, translated in Sterling and Summers 1978:34).

There is also a famous pōhaku called Pōhaku Anae, 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* 1908, translation from Sterling and Summers 1978:53]

3.3.10 Pipi of Pu‘uloa

Pearl Harbor, originally called 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 the pearl oysters of the family Pteriidae (mainly *Pinctada radiata*), which were once abundant on the harbor reefs. This oyster was supposedly brought from the Hawaiian ancestral land of Kahiki by a mo‘o (lizard or water spirit) named Kānekua‘ana (Handy and Handy 1972:470).

Kānekua‘ana was the kia‘i (food guardian) for ‘Ewa. When food was scarce, the descendants of Kua‘ana built Waihau heiau (a heiau for mo‘o) for her and lit fires to plead for her blessings, as shown below:

> Kanekua‘ana guarded all the district of Ewa and the natives from Halawa to Honouliuli had faith in her. She cared specially for those related to her but the blessings that came to them were shared by all. The people of Ewa depended upon her as their guardian to bless them. When their children were suffering from a scarcity of fish, the relatives of Kanekua‘ana from Halawa to Honouliuli erected waihau [a heiau with food offerings] for Kanekua‘ana and lighted fires to bring blessings upon the whole people. [translation of story by S.M. Kamakau in Sterling and Summers 1978:51]

A clarification of the mo‘olelo of Kānekua‘ana and the pearl oysters of Pearl Harbor tells that an overseer had set a ban on the pipi for several months a year so that they could increase. A poor widow, a relation of the mo‘o, took some of the pipi and hid them in a basket. The konohiki found the hidden shells, and took them from her, emptying them back into the sea, which was proper. However, after this he followed the woman home and also demanded that she pay a stiff fine in cash, which she did not have. The mo‘o thought this was unjust and the next night she took possession of a neighbor who was a medium. Angered by the greed of the konohiki, it is said that Kānekua‘ana took the pipi back to Kahiki as shown in the following excerpt:

> After the overseer had gone back to Palea the lizard goddess possessed her aged keeper [a woman of Ewa] and said to those in the house, ‘I am taking the pipi back to Kahiki and they will not return until all the descendants of this man are dead. I go to sleep. Do not awaken my medium until she wakes of her own accord.’ The command was obeyed and she slept four days and four nights before she awoke. During the time that she slept the pearl oysters vanished from the

> places where they were found in great numbers, as far as the shore. The few found today are merely nothing. [*Ka Loea Kālai‘āina*, 3 June 1899, translation in Sterling and Summers 1978:49-50]

3.4 ‘Ōlelo No‘eau (Proverbs)

Many ‘ōlelo no‘eau specific to Honouliuli, derived from the natural resources that were important to the people of the ahupua‘a or unique to that place, mo‘olelo, and practices specific to Honouliuli illustrate the way of life and physical landscape in Hono‘uliuli. For example, many ‘ōlelo no‘eau are about sharks, the pipi oyster of Pearl Harbor, the ‘anae-holo or travelling mullet, taro, and wandering souls of the dead. This section describes some of these ‘ōlelo no‘eau and also shows their English translations and interpretation by Pukui (1983).

3.4.1 Concerning Sharks

The eastern coast of Honouliuli Ahupua‘a 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.

3.4.1.1 **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)

3.4.1.2 **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)

3.4.1.3 **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)

3.4.1.4 **Make o Mikololou a ola i ke ale lo**
Mikololou died and came to life again through his tongue

> Said of one who talks himself out of a predicament. (Pukui 1983:229)

3.4.2 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‘ea were generated.

3.4.2.1 **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 1983:144)

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.

3.4.2.2 **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)

3.4.2.3 **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)

3.4.2.4 **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)

3.4.3 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]

3.4.3.1 **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)

3.4.4 Concerning Taro

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:

3.4.4.1 **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)

3.4.5 Concerning “Ao Kuewa,” the Realm of the Homeless Souls

3.4.5.1 **Ka wiliwili of Kaupe‘a**
The *wiliwili* grove of Kaupe‘a

> 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.

3.5 Oli

3.5.1 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—Waikele;
Ka hale pio i Kauamoa—o Waipio;	The arched house at Kauamoa—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.
[Fornander 1917:400–401]	

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.

3.5.2 Hi‘iaka and the Plains of Pu‘uokapolei

Hi‘iaka sang this bitter chant addressed to Lohiau 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 1993:162-163]

Several other Honouliuli places are mentioned in this chant, including Pe‘e-kaua, which may be a variation of Kau-pe‘e or Kaupe‘a, and the plains of Kānehili, the last of which again refers to wandering, as the word “hili” means “to go astray” (Emerson 1993:162). In the chant, Hi‘iaka moves downhill from Kaupe‘a, probably the plains adjacent to Pu‘uokapolei, toward the coast, the plain of Kānehili.

3.5.3 Hi‘iaka and the Plains of Keahumoa

The goddess, Hi‘iaka, sister of the volcano goddess Pele, passed through ‘Ewa and met women stringing ma‘o flowers to make lei. Hi‘iaka offered a chant, making known her wish for a lei around her own neck:

E lei ana ke kula o Ke‘ahumoa i ka ma‘o	The plains of Keahumoa are garlanded with *ma‘o*
‘Ohu‘ohu wale nā wāhine kui lei o ka nahele	The lei-stringing women of the forest are festively adorned

[Ho‘oumāhiehiemalie 2006a:287; 2006b:268]

In the chant, she mentions the plains of Keahumoa of which McAllister (1933:107) references as west of Kīpapa Gulch in Waikele. It is possible that Keahumoa was a general name for the flat plain mauka of the productive floodplain area directly adjacent to Pearl Harbor.

3.6 Traditional Settlement and Agricultural Patterns

Various Hawaiian mo‘olelo and early historical accounts suggest ‘Ewa was once widely inhabited, including by 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 district 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 part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the ‘awa for which the area was famous. [Handy and Handy 1972:429]

In addition, breadfruit, coconuts, wauke (paper mulberry, *Broussonetia papyrifera,* used to make kapa for clothing), bananas, olonā (*Touchardia latifoli*, used to make cordage), 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 (*Pipterus* spp., used to make kapa for clothing). 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” (Pukui 1983:305).

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

3.7 Marine Resources

3.7.1 Pearl Oysters (Pipi)

The pipi, or pearl oyster, was the chief i‘a (marine food) of ‘Ewa. Samuel Kamakau describes the pipi of Honouliuli:

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

Sereno Bishop, an early resident of O‘ahu, wrote of his time in the area around 1836, of the pearl oyster, the pipi, and another edible clam (probably *Lioconcha heiroglyphica)*.

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

Older Hawaiians believed the pipi disappeared around the time of the smallpox epidemic of 1850-1853 because Kānekua‘ana became displeased at the greed of some konohiki (overseer). According to Sterling and Summer (1978),

> The people of the place believe that the lizard was angry because the konohikis imposed kapus [bans], were cross with the women and seized their catch of oysters. So this ‘fish’ was removed to Tahiti and other lands. When it vanished a white, toothed thing grew everywhere in the sea, of ‘Ewa, which the natives of ‘Ewa had named the pahikaua (sword). It is sharp edged and had come from Kauai-helanai, according to this legend. [Manu 1885 in Sterling and Summer 1978:50]

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

3.7.2 Fishponds

3.7.2.1 Kapākule Fishpond

Kamakau mentions two fishponds at Pu‘uloa, “Kapakule and Kepoolala.” He describes Kapākule in the following excerpt:

> At Pu‘uloa on Oahu were two unusual ponds [fish traps]—Kapakule and Kepoolala. Kapakule was the better one. The rocks of its walls, *kuapa*, could be seen protruding at high tide, but the interlocking stone walls (*pae niho pohaku*) of the other pond were still under water at high tide. . . . It [Kapakule] was said to have been built by the *‘e‘epa* people [mysterious people; often associated with menehune] at the command of Kane. [Kamakau 1976:88]

As described in Section 3.3.3.1, Kapākule Fishpond is associated with the gods Kāne and Kanaloa. Mary Kawena Pukui (1943:56-57), who visited Kapākule Fishpond when she was young, writes that the pond was built by the menehune under the direction of the two gods. 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 the fish swam up the channel and then inside of this wall, they invariably found themselves in the pond. A short distance from the spot where the pond touched the shore was a small koa or altar composed of coral rock. It was here that the first fish caught in the pond was laid as an offering to the gods. [Pukui 1943:56]

The fishpond contained many fish, especially the akule (scad fish, *Trachurops crumenophthalmus*), thus its name, “the enclosure for *akule* fish” (Pukui 1943:56-57). The pond was destroyed when the channel to Pearl Harbor was dredged in the early twentieth century. The caretaker of the pond took the stones Kū and Hina to a deep place in the ocean and sunk them so “none would harm or defile them.” Cobb (1903:733) writes that the pond was used to catch the larger akule (goggler), ‘ōpelu (mackerel scad), weke (goat fish), kawakawa (bonito), 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 one called Kepo‘okala.

> This is how the fish entered the pond. At high tide many fish would go past the mauka side of the pond, and when they returned they would become frightened by the projecting shadows of the trunks, and would go into the opening. The fish that went along the edge of the sand reached the seaward wall, then turned back

> toward the middle and entered the anapuna (the arched portion of the trap) A man ran out and placed a ‘cut-off’ seine net (‘omuku lau) in the opening, and the fish shoved and crowded into it. The fish that were caught in the net were dumped out, and those not caught in the net were attacked with sharp sticks and tossed out, or were seized by those who were strong. [Kamakau 1976:88]

3.7.2.2 Kaihuopala‘ai, Kapapapūhi, or Kapapa‘apūhi Fishpond

Kapapaapuhi was a man from Honouliuili with whom Kaihuopala‘ai fell in love. She was the sister of Maikohā, a deified hairy man who became the god of kapa makers. Fornander (1919:V: 270–271) records the following mo‘olelo which tells of Kaihuopala‘ai changing into a fishpond for mullet.

> Kaihuopala‘ai saw a goodly man by the name of Kapapaapuhi who was living at Honouliuli, ‘Ewa; she fell in love with him and they were united, so Kaihuopala‘ai has remained in ‘Ewa to this day. She was changed into that fishpond in which mullet are kept and fattened, and that fish pond is used for that purpose to this day. [Fornander 1919:V:270]

According to Pukui et al. (1974:68), Kaihuopala‘ai, which means “the nose of Pala‘ai,” is also the name the Native Hawaiians used for the West Loch of Pu‘uloa. However, McAllister (1933:108) recorded that some Hawaiians claim there never was a fishpond by that name. Beckwith (1918:354) writes that Kaihuopala‘ai changed into the fishpond near the place called Kapapapūhi (the eel flats). This fishpond is identified on old maps as the peninsula that juts into the west side of West Loch and is sometimes spelled Kapapa‘apūhi.

3.8 Heiau

3.8.1 Pu‘uokapolei, Astronomical Marker and Heiau

A heiau was once on Pu‘uokapolei, but 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 making astronomical observations (Fornander 1919:292). Pu‘uokapolei may have been regarded as the gate of the setting sun, just as the eastern gate of Kumukahi in Puna is regarded as the gate of the rising sun; both places are associated with the Hawaiian goddess Kapo (Emerson 1993:41). This somewhat contradicts some Hawaiian cosmologies, in which Kū was the god of the rising sun, and Hina, the mother of Kamapua‘a, was associated with the setting sun. More detailed mo‘olelo on Pu‘uokapolei follow.

3.8.2 Waihau Heiau

Kānekua‘ana was the kia‘i (food guardian) for ‘Ewa. When food was scarce, the descendants of Kua‘ana built Waihau heiau (a heiau for mo‘o) for her and lit fires to plead for her blessings, as shown below:

> Kanekua‘ana guarded all the district of Ewa and the natives from Halawa to Honouliuli had faith in her. She cared specially for those related to her but the blessings that came to them were shared by all. The people of Ewa depended upon her as their guardian to bless them. When their children were suffering from

> a scarcity of fish, the relatives of Kanekua‘ana from Halawa to Honouliuli erected waihau [a heiau with food offerings] for Kanekua‘ana and lighted fires to bring blessings upon the whole people. [translation by S.M. Kamakau in Sterling and Summers 1978:51]

3.9 Caves

‘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 1998). These pit caves 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 who 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, lived in Līhu‘e in upland Honouliuli, and he was an “ōlohe.”

The caves of Pu‘uloa were also used for burials as described in Section 3.10.

3.10 Burials

The caves of Pu‘uloa were 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 ex-husband at sea. According to Alexander,

> 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 1908:27]

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.

3.11 Ala Hele (Trails)

3.11.1 Historic Trails through ‘Ewa District

Several historic trails traversed ‘Ewa including a lateral trail that connected Honolulu to Wai‘ānae District; a mauka-makai trail that branched off from the lateral trail, following the boundary between Honouliuli and Hō‘ae‘ae to the Pōhākea Pass and to Wai‘ānae; and a second mauka-makai trail that generally followed the path of Waikele Stream in Waikele Ahupua‘a. This mauka-makai trail eventually led through the Kolekole Pass to Wahiawā and to Waialua District on the windward side of the island as shown in Figure 5.

‘Ī‘ī describes the main lateral trail from west to east, beginning with the boundary of the Kona and ‘Ewa Districts at the Moanalua/Hālawa border. This trail was just mauka of the floodplains near Pearl Harbor, skirting the inland edges of the productive taro fields. The trail then dipped down toward the coast and a prominent hill and landmark, Pu‘uokapolei. The trail crossed into Wai‘ānae at the coast near Pili o Kahe, the stone that marked the boundary of the ‘Ewa and Wai‘ānae districts. The following passage highlights place names along the trails and describes the wahi pana of some names:

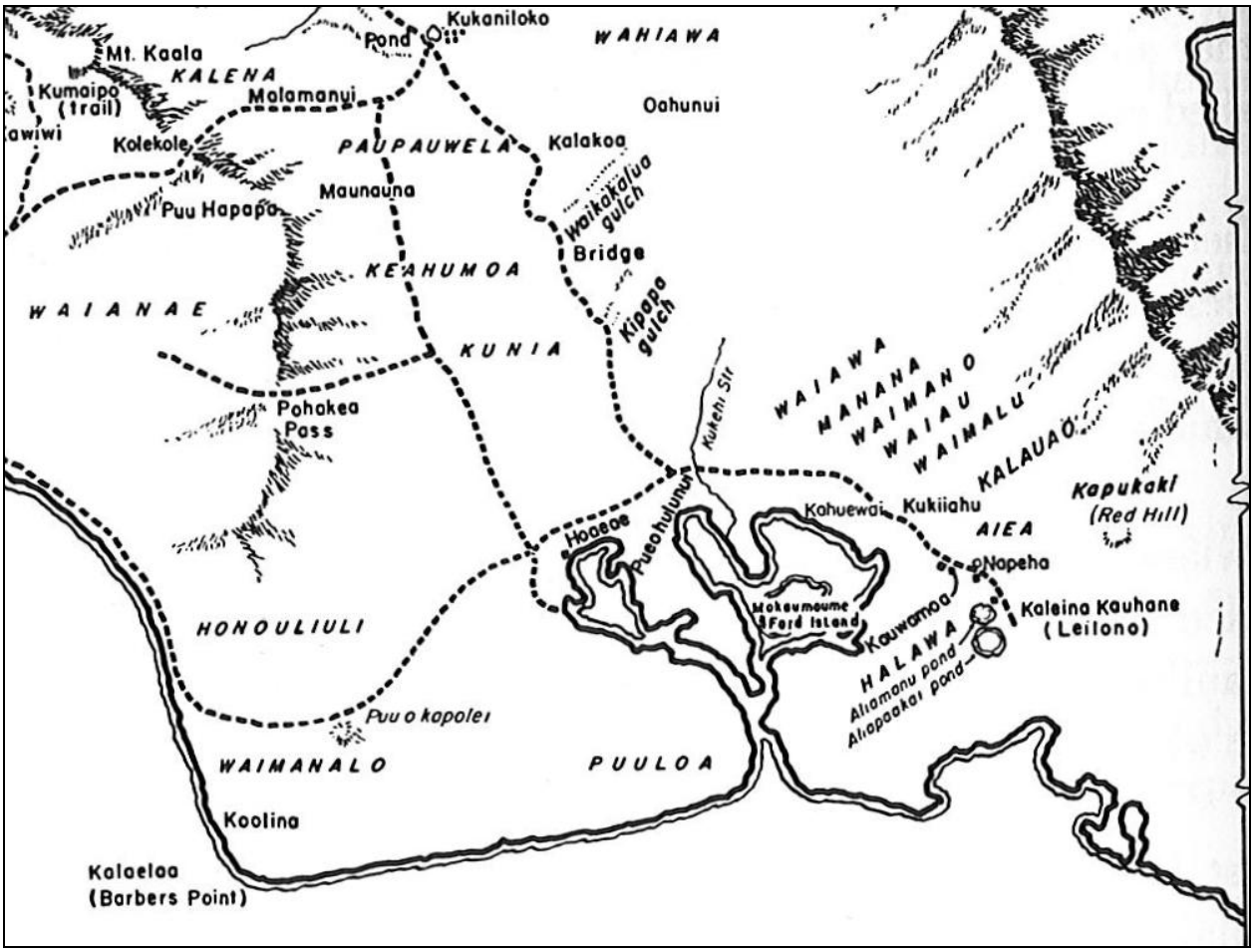

Figure 5. Map of trails in ‘Ewa by Paul Rockwood (not to scale) ca. 1810, as described by John Papa ‘Ī‘ī (1959:96)

> From there the trail went to Kaleinakauhane [Moanalua Ahupua‘a in the Kona District], then to **Kapukaki** [Red Hill on the Moanalua / Hālawa boundary], from where one could see the irregular sea of Ewa [Pearl Harbor]; then down the ridge to **Napeha** [in Hālawa], a resting place for the multitude that went diving there at a deep pool. This pool was named Napeha (Lean Over), so it is said, because Kauli‘i a chief of ancient Oahu, went there and leaned over the pool to drink water.
>
> The trail began again on the opposite side of the pool and went to the lowland of **Hālawa**, on to **Kauwamoa**, a diving place and a much-liked gathering place. It was said to be the diving place of Peapea, son of Kamehamehanui of Maui who was swift in running and leaping. The place from which he dove into the water was 5 to 10 fathoms above the pool.
>
> There the trail led to the taro patches in **Aiea** and up the plain of **Kukiiahu**. Just below the trail was the spot where Kaeo, chief of Kaua‘i, was killed by Kalanikupule. From there the trail went along the taro patches to the upper part of **Kohokoho** and on to **Kahuewai** [in Kalauao], a small waterfall. On the high ground above, a little way on, was a spring, also a favorite gathering place for travelers. From there it continued over a small plain down the small hill of **Waimalu**, and along the taro patches that lay in the center of the land . . .
>
> The trail went down to the stream and up again, then went above the taro patches of **Waiau**, up to a *maika* [game with rolling stones] field, to **Waimano**, to **Manana** and to **Waiawa**; then to the stream of **Kukehi** and up to two other *maika* fields, **Pueohulunui** and **Haupuu** [in Waiawa]. At Pueohulunui [on the border of Waiawa and Waikele] was the place where a trail branched off to go to Waialua and down to Honouliuli and on to Waianae. [‘Ī‘ī 1959:95, 97]

Of the first mauka-makai trail located in Honouliuli, ‘Ī‘ī (1959:97) noted “From **Kunia** the trail went to the plain of **Keahumoa**, on to **Maunauna** [peak], and along **Paupauwela** (‘ili), which met with the trails from Wahiawā [District] and Waialua [District].” ‘Ī‘ī places the area called Kunia east of Pōhākea Pass in the ahupua‘a of Honouliuli and Hō‘ae‘ae, makai of the modern town of Kunia, and places the plain of Keahumoa between Kunia and Paupauwela, the most mauka portion of Honouliuli. The trail passed near the peak called Maunauna in upper Honouliuli.

Section 4 Historical Background

4.1 Overview

The following section provides a summary of the history of Honouliuli Ahupua‘a from the time of the arrival of Captain Cook, the first explorer to visit Hawai‘i, in 1778, until present day.

4.2 Early Post-Contact 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 Kualaka‘i and the arid Honouliuli coast:

> The point is low flat land, with a reef round it . . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen’s huts. [Vancouver 1798:1:167]
>
> . . . from the commencement of the high land to the westward of Opooroah [Pu‘uloa], was composed of one very barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island. [Vancouver 1798:2:217]
>
> 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]

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‘ānae, he stopped at Waimānalo, an ‘ili in Honouliuli, on the western border of ‘Ewa. At around eleven o’clock the next day, on a Saturday, Chamberlain and his companions set out towards 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 trail across the ‘Ewa District.

4.2.3 Battles and Chiefly Claims over Territory

4.2.3.1 Māweke and Overview of the Reign of Ali‘ i in ‘Ewa

‘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 1991a: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 1991a:54). 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 in the ahupua‘a immediately north 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.

4.2.3.2 Mā‘ilikūkahi and the Battle of Kīpapa

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.

Mā‘ilikūkahi, who was born ali‘i kapu (sacred chief) at the birthing stones of Kūkaniloko (Kamakau 1991a:53), became mō‘ī of O‘ahu between 1520-1540 (Cordy 2002:19). Mā‘ilikūkahi was popular during his reign and was remembered for initiating land reforms, which brought about peace, and for encouraging agricultural production, which brought about prosperity. He also prohibited the chiefs from plundering the maka‘āinana (common people), a prohibition that was punishable by death (Kamakau 1991a:55).

Upon consenting to become mō‘ī at the age of 29, Mā‘ilikūkahi was taken to Kapukapuākea Heiau at Pa‘ala‘akai in Wai‘alua 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 Wai‘alua 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‘ukea [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 1991a: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 Kīpapa 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 ‘Kīpapa,’ 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]

4.2.3.3 Makaioulu

Kalanikūpule was defeated the following year at the battle of Nu‘uanu when the Hawaiian chief, Kamehameha, invaded O‘ahu and conquered the opposing forces. Kamehameha distributed the O‘ahu lands among his favorite followers, which resulted in the displacement of many families: “Land belonging to the old chiefs was given to strange chiefs and that of old residents on the land to their companies of soldiers, leaving the old settled families destitute” (Kamakau 1992:376-377).

The main battle was fought from the Honolulu shore past the forts of Pūowaina (Punchbowl) and into the valley of Nu‘uanu. By tradition, one warrior with Kamehameha fought a series of one-man battles from Honolulu to Wai‘ānae. This individual, Makaioulu, killed a champion of O‘ahu in Waikīkī by standing in front of his companion who threw a spear at him, then dodging at the last second so the spear killed his opponent instead. In Kalauao, he met a party of men, and shamed them into fighting him one at a time rather than as a group. He defeated and killed each

warrior. He then killed a robber at Kapolei in Honouliuli and two women famed for bone-breaking in Makua in the moku of Wai‘ānae (Fornander 1919:488).

4.3 Mid-Nineteenth Century to Present

4.3.1 The Great Māhele (1848)

Prior to 1848, all land belonged to the akua (gods), held in trust for them by the paramount chief and managed by subordinate chiefs. In the mid-1800s, Kamehameha III decreed a division of lands called the Māhele, which divided land for private land ownership in Hawaiian society (Chinen 1958). In 1848, lands were divided into three portions, crown lands, government lands, and lands set aside for the chiefs. Individual plots, called kuleana (Native Hawaiian land rights) awards, were granted within these divided lands to native inhabitants who lived on and farmed these plots and came forward to claim them. The chiefs and konohiki were required to pay a commutation fee for their lands, usually about one-third the value of any unimproved lands. Awardees usually "returned" a portion of the lands awarded to pay the commutation fee for the lands they "retained." The returned lands usually became government lands (Chinen 1958:13).

The Kuleana Act legislated in 1850 allowed maka‘āinana (commoners) to own land parcels which they were currently and actively cultivating and/or using for residence. In theory, this "set aside" hundreds of thousands of acres as potential kuleana parcels which led to about 10,000 claimants obtaining approximately 30,000 acres. The konohiki, 252 chiefs, divided up about a million acres. Many Hawaiians were disenfranchised by these acts (Cordy et al. 1991). Land Commission Award (LCA) records generated during the Māhele provide the first specific documentation of life in ‘Ewa.

In AD 1795, seventeen years after Captain James Cook made the first Western Contact with Hawai‘i, the great Hawaiian warrior Kamehameha completed his conquest of the island of O‘ahu and then went on to consolidate his rule over all of the Hawaiian Islands. He gave the ahupua‘a of Honouliuli to Kalanimōkū, an early supporter, as part of the panalā‘au, or conquered lands, with the right to pass the land on to his heirs rather than having it revert to Kamehameha (Kame‘eleihiwa 1992:58, 112). Kalanimōkū subsequently gave the ahupua‘a to his sister, Wahinepi‘o.

In 1855 the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke‘ahikuni Kekau‘ōnohi (LCA 11218), a granddaughter of Kamehameha I, and the heir of Kalanimōkū (Indices of Awards 1929; Kame‘eleihiwa 1992). Kekau‘ōnohi was one of Liholiho's (Kamehameha II's) wives, and after his death, she lived with her half-brother, Luanu‘u Kahalai‘a, governor of Kaua‘i (Kelly 1985:21). Subsequently, Kekau‘ōnohi ran away with Queen Ka‘ahumanu's stepson, Keli‘iahonui, and then became the wife of Chief Levi Ha‘alelea. Upon her death on 2 June 1851, all her property was passed on to her husband and his heirs. In 1863, the owners of the kuleana lands deeded their lands back to Ha‘alelea to pay off debts owed to him (Frierson 1972:12). In 1864, Ha‘alelea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband John Coney.

During the Māhele of 1848, 96 individual claims were made and 72 individual claims in the ahupua‘a of Honouliuli were registered and awarded by King Kamehameha III to commoners (Tuggle and Tomonari-Tuggle 1997:34). The 72 kuleana awards were almost all made adjacent

Table 2. Land Commission Awards in Honouliuli

*LCA	Awardee	‘Ili		LCA	Awardee	‘Ili
748	Kalauhala	Panahaha, Kaaumakua		906	Kanoho	Kamoku
749	Mahina	Kaulaula		907	Luana	Kamaipipipi, Niukee
751	Kalauli	Kamoku, Polapola, Kalihikahi		910	Nunu	Kaaumakua
752	Haae	Kailikahi, Kailihai		911	Kauhailepa	Poohilo
753	Manuwa	Kamoku		914	Kamaala	Niukee, Kapapahi
754	Kaunahi	Niukee		916	Kama	Loloulu, Makau
755	Keinohana-nui	Niukee, Kailikahi, Kaakau		917	Kaulu	Kamilomilo, Kaaumakua
756	Kauouo	Kaaumakua		947	Kaopala	Loloulu, Kaulaula
758	Nihua	Niukee		960	Poopuu	Loloulu
760	Kuhemu	Kamaipipipi, Niukee, Naopala, Kailikahi		1565	Kaalauahi	Niukee, Kapapahi
761	Kinolua	Niukee, Kailikahi, Ilikahi, Palahemo		1570	Kekua	Poohilo
762	Kalama	Kaaumakua		1570-B	Paekane	Kaaumakua
763	Keliiaa, Solomona	Hiwa, Poohilo, Mauakapuoa, Uani / Maui, Polapola		1570-C	Naholowaa	Kaaumakua
765	Kamalae	Niukee, Kailikahi, Palahemo		1573	Kawahamana	Niukee, Kapapapuhi
766	Paele	Niukee, Kaluamooiki, Kailikahi		1580	Kanahuna	Kamilomilo
767	Hapauea	Niukee, Kapapahi		1580-B	Kapioho	Polapola, Kahiwapalaai
768	Pio	Kahaumakua, Niukee, Waioha		1598	Kekua	Loloulu, Kapapahi
827	Kauakahilau	Poohilo		1605-B	Nakai	Mahuna, Niukee
828	Kawahaea	Poohilo		1666	Mauwele	Poohilo
831	Kaekuna	Poohilo		1666-B	Kuahilo	Poohilo
832	Opiopio	Poohilo		1670	Moano	Loloulu, Kaaumakua
834	Oni	Poohilo, Kailikahi		1672	Makue	Kamoku, Kapapapuhi

*LCA	Awardee	‘Ili		LCA	Awardee	‘Ili
839	Kaaiawaawa	Kamilomilo, Kailikahi, Haole, Poohilo		1699	Leleiaupa	Maui, Poaiwaikele
845	Kekukahiko	Kapapahi, Niukee		1701	Alaluka	Pohilo
847	Hinaa	Poohilo		1703	Aimaikai	Kamilomilo
848	Kapule	Poohilo		1713	Healani	Niukee, Kapapuhi
869	Pue	Maui		1719	Hilea	Kaaumakua
872	Kahakuliilii	Loloulu, Paakai, Papaioua		1720	Hilinae	Polapola
874	Laamaikahiki	Polapola, Hiwa		5204	Kalama 2	Polapola
876	Nohunohu	Niukee, Nukee		5653	Kua	Maui, Polapola, Kahui
881	Kikala	Polapola		5654	Kuhiena	Maui, Poohilo
886	Kahalewai	Kamoku, Manuwa		5653-B	Kanehikili	Poohilo
892	Aoao, Samuela	Kapapahi, Niukee		5670-B	Kaohai	Kaihuopalaai, Polapola
898	Kaneaola	Polapola		5670-C	Kumupopo	Poohili, Kepoe, Loloulu, Puaaluu
901	Kuahine	Nukee / Niukee,		5950	Pihana	Kamoku
902	Haakue	Waimanalo		10933	Uia	Niukee
905	Kaimuena	Kaaumakua		11218	Kekau‘ōnohi	ahupua‘a award

to Honouliuli Gulch, which contained fishponds and irrigated taro fields. The awards ranged in size from 0.1 to 5.5 acres in size.

4.3.2 Early Ranching

4.3.2.1 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 inFigure 6. 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.

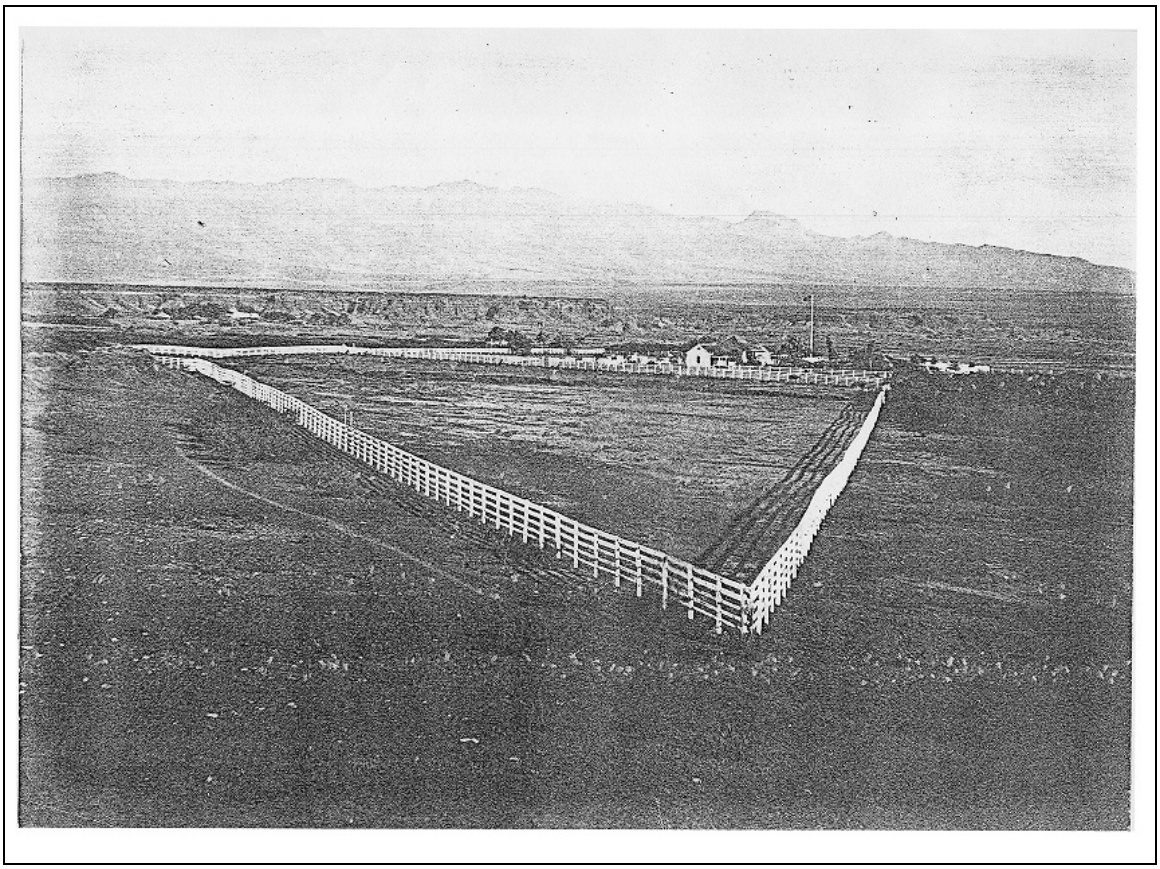

Figure 6. 1880s photograph of James Campbell’s residence on the ‘Ewa Plain (Hawai‘i State Archives)

> 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.

Following Western Contact, the landscape of the ‘Ewa plains was adversely affected by the removal of the sandalwood forest, and the introduction of domesticated animals and new vegetation species. Domesticated animals, such as goats, sheep, and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s, and allowed to graze freely about the land. It is unclear when the domesticated animals were brought to O‘ahu; however, L.A. Henke reports the existence of a longhorn cattle ranch in Wai‘ānae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing.

4.3.3 Rice Cultivation

As the sugar industry throughout the Hawaiian kingdom expanded in the second half of the nineteenth century, the need for increased numbers of field laborers prompted passage of contract labor laws. In 1852 the first Chinese contract laborers arrived in the Islands. Contracts were for five years, and pay was $3 a month plus room and board. Following the completion of their plantation labor contracts, some Chinese immigrants began rice farming, to which they were accustomed in their native land (Figure 7). Chinese rice farmers acquired lands by leasing small plots of land for individual farms, or by forming hui (partnerships) with other farmers and acquiring large tracts of land (Coulter and Chun 1937:17-18). During the height of rice cultivation (ca. 1880-1920), the industry was dominated by Chinese firms that controlled the growing and milling of rice (Devaney et al. 1982:49).

The Hawaiian Islands were well-positioned for rice cultivation. A market for rice in California had developed as increasing numbers of Chinese laborers immigrated there since the mid-nineteenth century. Similarly, as Chinese immigration to the Islands also accelerated, a domestic market opened. The following excerpt describes the views of a missionary on rice cultivation at the time:

> Considerable effort has been made to induce the natives to be more industrious to cultivate the soil and particularly to try to [sic] the cultivation of rice . . . Foreigners too have begun the culture of rice in this district extensively and it was

Figure 7. Waikele Rice Fields below the Oahu Sugar Company Mill (Hawai‘i State Archives n.d.)

> hoped their example would stimulate the natives to cultivate their own lands, but most of them choose to hire themselves to the foreigners at low wages and put their lands in the hands of the foreigners for a few dollars rather than cultivate or improve it themselves. [Mission Station Report 1862:1 in Devaney et al. 1982:49]

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

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

Rice cultivation replaced much of the former taro lands and became widespread in the lowlands surrounding Pearl Harbor (Coulter and Chun 1937:21). The ancient taro lo‘i and ‘auwai (irrigation ditches) were modified and expanded to support rice cultivation.

> The great demand for rice land brought disused taro patches into requisition–especially because water rights attached to them. Such was the desire of the Chinese to use every piece of land to its fullest extent for paddy that they cut

> away the paths which the Hawaiians had used between taro patches to strips so narrow that a man could walk along them only with difficulty . . . As the demand for rice continued, it became profitable to bring into use land hitherto unused. The land most easily rendered fit for rice cultivation was swamp or marsh land of which there was a large amount in the islands. Most of such land was at or near sea level-undrained areas at the mouths of streams: lowlands, which could be reclaimed without great expense . . . lands hitherto unused became fields of waving grain. [Coulter and Chun 1937:11]

The following account describes a visit to the rice fields of ‘Aiea, north of the project area, ca. 1904:

> On the morning of June 2nd, for instance, our destination was Aiea. At ten minutes past seven we boarded the first passenger train going towards Honolulu. For a distance of eight miles the road skirts the shore and then turns landwards or mauka through rice and sugar plantations, Ewa Mill, Waipahu, Pearl City. We reached Aiea at eleven minutes past eight. Like all rice fields in Hawaii, this one is worked entirely by Chinamen, they alone being able to endure the conditions of location and climate necessary for the cultivation of this cereal. On one side of the railroad track was the broad, muddy inland lake or bay of salt water, Pearl Harbor; on the other side were the terraced plots or fields, flooded to a depth of several inches with water and separated by narrow raised earthen ridges on which the careful Chinaman doubtless succeeded in walking, but which many times proved treacherous to our unsteady feet. A rice plantation, laid out as it generally is on the low flats at the foot of a valley, where mountain streams empty into the sea, is an ideal collecting ground for certain kinds of algae. [Tilden 1905:134]

By the early decades of the twentieth century rice farming in the Hawaiian Islands was in decline, beset by crop diseases and cheaper prices for mainland-grown rice. Commercial agriculture in ‘Ewa became dominated by sugar with the development of the three sugar companies of ‘Ewa (Nedbalek 1984:13).

4.3.4 Pineapple

In the early decades of the twentieth century, lands in the mauka portion of the central and eastern sections of ‘Ewa were being acquired for pineapple cultivation. There is a record of attempted pineapple irrigation utilizing water from shallow wells in Waiawa Gulch in 1893. Later attempts were made in Waiawa and Honouliuli (Figure 8). James Dole founded the Hawaiian Pineapple Company in 1901. The previous year, Dole had purchased 61 acres of land in Wahiawa for growing pineapple. Prior to 1913, most of the upland plateau areas in Waiawa were planted in pineapple (Goodman and Nees 1991:59) and small plots along gullies; those not appropriate for sugar cane cultivation in several ‘Ewa ahupua‘a were planted in cane. Many of these small plots were cultivated by independent farmers, who sold the crops at markets or to larger companies. In 1901, the Hawaiian Pineapple Company obtained 61 acres in Waiawa through public auction. Initially, most pineapple was shipped to California for packing. In an attempt to speed up processing, save money, and produce a fresher product, a cannery was constructed in Waiawa. This cannery was constructed by the Pearl City Fruit Company but

Figure 8. First pineapple plantation in Kunia in Honouliuli ca. 1900 (University of Hawai‘i at Mānoa)

became a part of the Hawaiian Pineapple Company operations after the Pearl City Fruit Company went bankrupt. The cannery was in operation from 1905 to 1935.

4.3.5 Other Agricultural Enterprises

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

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

Besides sisal, cotton, and pineapples, other crops were grown in central ‘Ewa, such as macadamia nuts. In spite of these many introduced crops, some Hawaiian families continued to live in ‘Ewa and preserve the traditional lifestyle into the early twentieth century, including at the fishing village of Kualaka‘i in Honouliuli. One resident, Mrs. Eli Williamson, recalled,

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

4.3.6 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 B. Franklin 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 9). To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly formed Ewa Plantation Company (Frierson 1972:15). Dillingham’s Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company. Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch, established by Dillingham, was the “fattening” area for the other ranches (Frierson 1972:15).

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.

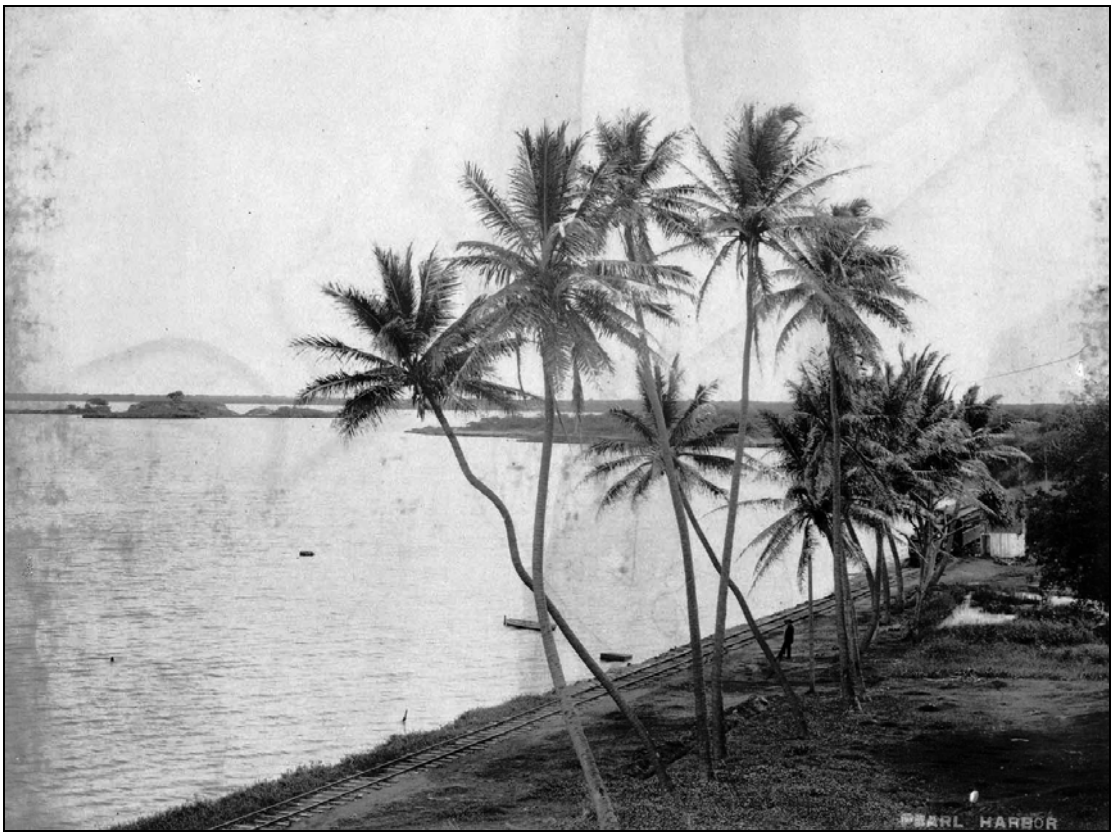

Figure 9. 1890 photograph of Pearl Harbor with OR&L railroad tracks along the coast (Honolulu Advertiser Archives)

> 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 Water 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 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 scraped. 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.

4.3.7 The Sugar Plantations of ‘Ewa

Although sugar cane 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 sugar cane production.

Agricultural field systems, railroads, and residential areas in ‘Ewa were developed by three sugar cane companies, the Ewa Plantation Company, located largely in the ahupua‘a of Honouliuli and Hō‘ae‘ae in the western section of the ‘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 the ‘Ewa.

4.3.7.1 The Ewa Plantation Company

The Ewa Plantation Company was incorporated in 1890 for sugar cane cultivation (Figure 10). The first crop, 2,849 tons of sugar, was harvested in 1892. Ewa was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967: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).

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, 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 Company lands in 1970 and continued operations until 1995, when sugar cane production was shut down in the combined plantation areas (Dorrance and Morgan 2000:45, 50).

Figure 10. Ewa Plantation Company sugar cane fields, Filipino Camp area, ca. 1925 (University of Hawai‘i atMānoa)

4.4 The U.S. Military Development of ‘Ewa

4.4.1.1 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 11). 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

Figure 11. Dredging in Pearl Harbor ca. 1908 (Hawai‘i State Archives)

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 that it had bought from the Campbell Estate. Construction of a new depot in Lualualei Valley and at West Loch Harbor began in 1931.

In the early 1930s, the U.S. Navy leased 700 acres of the Campbell Estate to build Ewa Field 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.

In the 1930s an Army Air Corps airfield was established to the west of Rodgers Airport. The Hickam Air Force Base website offers the following brief history of this military base’s early development:

> In 1934, the Army Air Corps saw the need for another airfield in Hawaii and assigned the Quartermaster Corps the job of constructing a modern airdrome from tangled brush and sugar cane fields adjacent to Pearl Harbor on the island of Oahu. The site consisted of 2,200 acres of ancient coral reef, covered by a thin layer of soil, located between Oahu’s Waianae and Koolau mountain ranges, with the Pearl Harbor channel and naval reservation marking its western and northern boundaries, John Rodgers Airport to the east, and Fort Kamehameha on the south. The new airfield was dedicated May 31, 1935 and named in honor of Lt. Col.

> Horace Meek Hickam, a distinguished aviation pioneer killed Nov. 5, 1934, at Fort Crockett in Galveston, Texas.
>
> Hickam AFB now consists of 2,850 acres of land and facilities valued at more than $444 million. [Hickam Air Force Base 2010]

4.4.1.2 World War II and the U.S. Military in ‘Ewa

By 1941, Pacific Naval Air Bases expenditures for new construction at Pearl Harbor were in the hundreds of millions of dollars. The Japanese attack on Pearl Harbor on 7 December 1941 damaged or destroyed much of the new construction. Reconstruction was instituted to double the Pearl Harbor’s war capacity. Military planners approved a new ammunition depot in the mountainside of Waipahu, a large new hospital in ‘Aiea, and thousands of additional changes to the Navy Yard to accommodate the new aircraft carrier task forces (Woodbury 1946:342-343). During World War II, the military used the sugar cane rail system to “haul large quantities of ammunition” (Condé and Best 1973:315).

By 1943, over 24,000 people were working at Pearl Harbor. Navy Housing Areas 1 and 2 and Civilian Housing Area 3 had grown large enough to be considered separate cities. Barracks and temporary housing for workers filled every available piece of land for miles between Pearl Harbor and the outskirts of Honolulu. A ring of huge barrage balloons was set up for the protection of the once-quiet waters of Waimomi [Pearl Harbor], which had since become one of the greatest Navy bases in the world (Downes 1953).

Before the war, the main Pearl Harbor naval yard was sufficient for a staging and storage area for the Pacific fleet, but after the Japanese attack and the beginning of World War II, additional areas were needed for supply depots and warehouses. The government procured additional land after the beginning of World War II to expand the functionality of the military bases. The Navy took all of the coastline area in eastern ‘Ewa District from the coast inland of the OR&L railroad tracks (Ching 1996:24). Waipi‘o Point, Waiawa Gulch, Pearl City (Mānana) Peninsula, Iroquois Point in Hālawa, and small areas in Honouliuli and Hō‘ae‘ae were taken over as supply depots and storage areas. The OR&L railroad had built a spur from the coast to Wahiawa in 1905, to haul cane and pineapples down to the coast and later to haul men and supplies from Pearl Harbor to Schofield Barracks in Wahiawa through Waikakalaua Gulch in Waikele. During the war, the military built a “secret railroad” from the railroad terminus at Waikakalaua Gulch to join the OR&L railroad coming around Ka‘ena Point at Hale‘iwa, thus providing a short cut from Pearl Harbor to Army facilities at Kahuku on the north shore of O‘ahu (Kneiss 1957:11-12). By 1944, the Navy had claimed close to 2,400 acres of land in the Pearl Harbor and Pearl City areas within Mānana, Waiawa, and Hālawa for use as military staging areas in the war effort (Allen 1999:234).

To this day, much of the Pearl City peninsula remains in the custody of the U.S. Navy; however, in the late 1990s, much of the rest of the previous Pearl City regions were released to the State for public use (Allen 1999:239).

4.4.1.3 Military Land Use in Kahe Valley

Major land use changes came to western Honouliuli Ahupua‘a when the U.S. military began development in the area. Prior to U.S. involvement in World War II (WWII), Kahe Point was identified by the U.S. military as a strategic defensive location. Bennett (2005) states:

> The Hawaiian Dept. had selected the Kahe Point area in February 1941 as a ‘strong point’ to defend against an enemy landing on the West Shore and attacking toward Pearl Harbor and Honolulu from the Waianae Pocket. The coastal plain narrowed at the point, forming a choke point; to thwart any enemy advances down the Nanakuli coast, pre-war plans were drawn up for the Second Battalion, thirty-fifth Infantry Regiment, to man rifle trenches, machine gun emplacements, and other defensive works at the point. The Kahe Strong Point was situated in the South Sector of Oahu’s two World War Two defense sectors and assigned to the twenty-fifth Infantry Division from its organization in October 1941 until it was relieved by the 27th Infantry Division in November 1942. [Bennett 2005:65]

Following the bombing of Pearl Harbor on 7 December 1941, the strategic vantage point of Kahe Point was chosen as a potential site to house one of the two 14-inch gun turrets that could be recovered from the sunken battleship USS *Arizona* (Figure 12). Lewis and Kirchner (1992) describe:

> One turret-to be known as Battery Arizona-was originally to be placed on Puu Mailiilii, just south of Waianae, on the west shore. In December, 1942, however, its proposed location was shifted southward to Kahe Point, from which its three 14-inch guns could command the entire west and south coasts from Kaena Point to Diamond Head, and add considerable firepower to the existing pair of pre-war 16-inch batteries. [Lewis and Kirchner 1992:282]

Kahe Point and the surrounding land including Kahe Valley was taken over by the U.S. military to become the Kahe Military Reservation. “The Kahe Military Reservation eventually comprised 955 acres. The lands were commandeered by the theater commander and occupied as of October 26, 1942” (Bennett 2005:65). On 21 October 1942, Battery Arizona was named and by May 1943 a final layout design of Battery Arizona on Kahe Point was completed (Bennett 2005). Numerous complications arose through the process of constructing the battery and converting a naval gun turret into a terrestrial defensive armament. The majority of the Battery Arizona infrastructure would be subterranean, and two parallel tunnels were drilled into the slope of Kahe Ridge, lined with thick, reinforced concrete, and equipped with all of the machinery and equipment required for self-sustained operation (Bennett 2005).

With the design of the battery completed, the piece-by-piece transfer of the Arizona’s 14-inch gun components from Pearl Harbor to the Wai‘ānae Coast was initiated in late summer 1943. Moving the gun components from Kahe Beach to the newly constructed barbette on Kahe Point required intensive effort and planning. Participants in the project document that “special roads were built along which the turret components were moved on rollers, and that the 71-ton tubes were parbuckled from the beaches to the emplacements high above” (Lewis and Kirchner 1992:288).

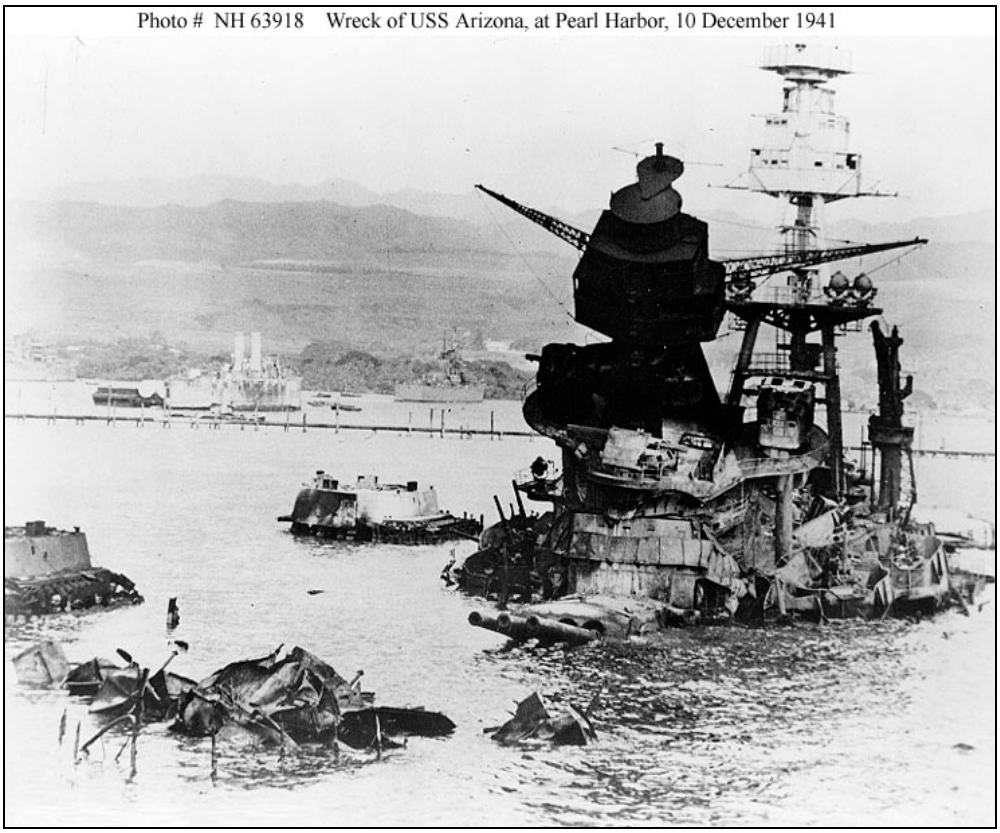

Figure 12. Wreck of the USS *Arizona* showing one of the 14-inch gun turrets partially submerged (source: Naval History and Heritage Command)

Construction of Battery Arizona was halted on 1 August 1945. The battery was nearly completed with the exception of some components of its SCR-296A radar (Bennett 2005:77). The emplacement of the 14-inch guns of the USS *Arizona* at the barbette on Kahe Point was completed with an access road encircling the barbette and continuing down the southern slope of Kahe Ridge. Lewis and Kirchner (1992) summarize:

> Battery Arizona, named after the ship from which its armament had come, was evidently never finished, but remained instead in a state of suspended construction during the immediate post-war years until, in the late 1940s, its guns, along with all other American seacoast weapons, were cut up for scrap. Where the Oahu turrets once stood, there remain today only concrete-lined holes in the ground. [Lewis and Kirchner 1992:299]

Battery Arizona was abandoned by the U.S. military in 1948. Immediately following WWII, the battery was used for some time as a command post and evacuation shelter by civil defense authorities. A 1991 inspection of Battery Arizona conducted by the Corps of Engineers documented that sometime prior to 1991 vandals had broken into the subterranean tunnels and started a fire in the battery's power room (Bennett 2005:78).

In addition to the Kahe Strong Point and the Battery Arizona described above, Kahe Point was also selected as an alternate position for four 155-mm *Grande Puissance Filloux* (GPF)

guns. The alternate position was named Battery Kahe on 12 June 1942 and manned by Battery B, Fifty-fifth Coast Artillery Regiment until 1943 (Bennett 2005:77). The exact location and extent of Battery Kahe is unclear.

Section 5 Archaeology

5.1 Archaeological Inventory Survey

An archaeological inventory survey (AIS) of the project area was conducted in 2012 within areas designated as Survey Areas A and B, as shown in Figure 13. The AIS was a 100% coverage pedestrian survey which identified ten historic properties. Four of the ten historic properties, identified as SIHP #s 50-80-12-6647 through -6650, were previously identified and documented during an AIS conducted by CSH in 2004 (Tulchin and Hammatt 2004). The remaining six historic properties (SIHP #s -7137 through -7142) were newly identified. Seven historic properties (SIHP #s -6647 through -6650 and -7140 through -7142) were located within or immediately adjacent to Survey Area A, and two historic properties (SIHP #s -7137 and -7139) were located within Survey Area B. SIHP # -7138 extended within Survey Areas A and B. Historic properties included traditional pre- and/or early post-Contact Native Hawaiian sites, historic ranching or agricultural sites, and military fortifications.

Of the ten historic properties found, four are recommended for preservation and are described below. More detailed information on the archaeological study for this project and on the historic properties in the project area is provided in *Preservation Plan for SIHP # 50-80-12-6647, SIHP # 50-80-12-7137, SIHP # 50-80-12-7139, and SIHP # 50-80-12-7140 at Kahe Valley, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu TMK: [1] 9-2-003:027 por.* (Yucha and Hallett 2013).

5.2 3.2 Description of Historic Properties Recommended for Preservation

5.2.1 SIHP # 50-80-12-6647

Site Type: Complex
No. of Features: Three
Functional Interpretation: Agricultural/Ceremonial
Probable Age: Pre- and/or early post-Contact to historic
Overall Dimensions: 33.0 m (108.3 ft) N/S by 49.8 m (163.4 ft) E/W
Topography: Level to moderately sloping edges of a gulch (Keone‘ō‘io Gulch)
Elevation: 4 to 9 m (13 to 30 ft) AMSL
Location: Survey Area A
Description:

SIHP # -6647 is a complex consisting of three features (Features A–C) located within Keone‘ō‘io Gulch, near the southern boundary of Survey Area A (Tulchin and Hammatt 2004).

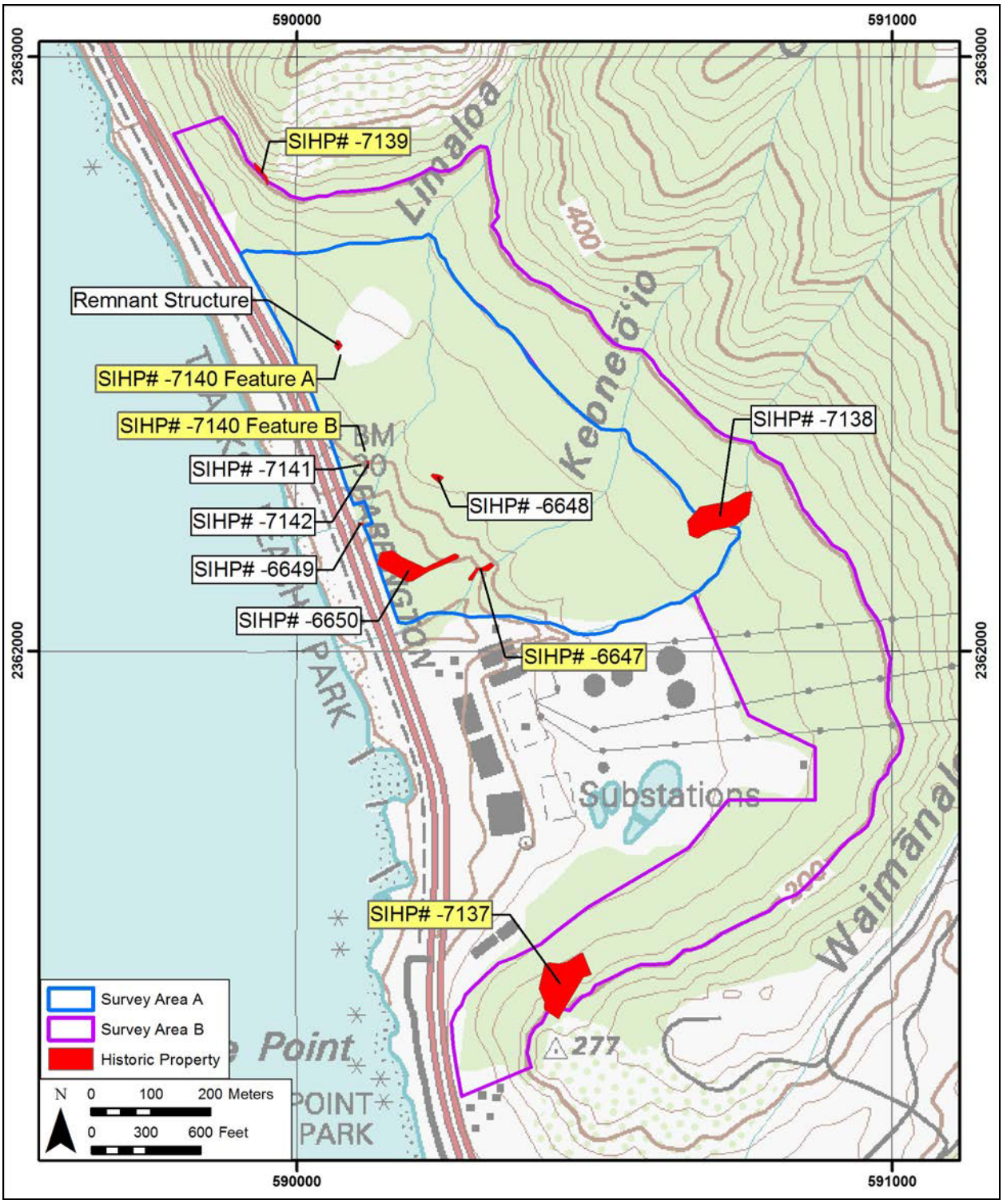

Figure 13. Historic properties found in the project area

5.2.2 SIHP # 50-80-12-7137

Site Type: Complex
No. of Features: 15
Functional Interpretation: Defensive position/observation post
Probable Age: Historic (military)
Overall Dimensions: 94.6 m (310.4 ft) N/S by 82.4 m (270.3 ft) E/W
Topography: Steep talus slope
Elevation: 36 to 71 m (118 to 232 ft) AMSL
Location: Survey Area B
Description:

SIHP # -7137 is a complex consisting of 15 features (Features A–O) located along a portion of the northern talus slope of Kahe Point within Survey Area B (see Figure 13). The talus slope is comprised of exposed basalt faces scattered with basalt boulders and cobbles (talus) and intermittent, natural bedrock terraces that support minimal soil formation. Vegetation in the area consists of koa haole, kiawe, and exotic grasses. The area affords a commanding view plane of the coast north to Pu‘u-o-Hulu. The road that encircles the barbette at Battery Arizona is located approximately 165 m (541 ft) southeast of SIHP # -7137. A National Geodetic Survey (NDS) triangulation station is located approximately 53 m (174 ft) south of SIHP # -7137 on Kahe Point. The 15 archaeological features of SIHP # -7137 include five formal structures, eight enclosures, one inscription, and one refuse scatter. In addition to the 15 features of SIHP # -7137, barbed wire fence lines as well as unused coiled barbed wire and T-posts were observed in the immediate vicinity.

5.2.3 SIHP # 50-80-12-7139

Site Type: Complex
No. of Features: Two
Functional Interpretation: Temporary habitation/activity area
Probable Age: Pre- and/or early post-Contact
Overall Dimensions: 31.6 m (103.7 ft) N/S by 14.7 m (48.2 ft) E/W
Topography: Relatively level area between a vertical cliff face and a steep talus slope
Elevation: 47 to 65 m (154 to 213 ft) AMSL
Location: Survey Area B
Description:

SIHP # -7139 is a complex consisting of two features (Features A and B) located on the western end of the ridge, between Pili-o-Kahe Gulch and Limaloa Gulch. SIHP # -7139 comprises a narrow, relatively level corridor of bare soil inside the dripline at the base of a vertical cliff face of exposed basalt outcrop. The level corridor is bordered to the east by a steep talus slope that extends eastward to the edge of Farrington Highway. SIHP # -7139 is located along the outer boundary of Survey Area B and extends partially within Survey Area B to the south. The area affords a commanding view plane of the coast and ocean resources from Kahe Point to Pu‘u-o-Hulu. Vegetation in the area consists of koa haole, kiawe, and exotic grasses. SIHP # -7139 includes an overhang shelter (Feature A) and a culturally enriched silt A horizon (Feature B).

One disassociated human skeletal element (radius) was identified on the surface of SIHP # -7139 Feature B. SIHP # -7139 is interpreted as a temporary habitation shelter and activity area.

5.2.4 SIHP # 50-80-12-7140

Site Type: Complex
No. of Features: Two
Functional Interpretation: Defensive position
Probable Age: Historic (military–WWII)
Overall Dimensions: Feature A: 2.4 m (7.9 ft) N/S by 2.4 m (7.9 ft) E/W; Feature B: 3.1 m (10.2 ft) N/S by 2.5 m (8.2 ft) E/W
Topography: Leveled (bulldozed) to slightly sloping
Elevation: 16 m (53 ft) AMSL
Location: Survey Area A
Description:

SIHP # -7140 is a complex consisting of two features (Features A and B) located within Survey Area A, 60.0 to 90.0 m (196.9 to 295.3 ft) west of Farrington Highway. The area surrounding SIHP # -7140 is relatively level with clear signs of grading and land modification including linear bulldozer pushpiles and mounds and remnant bulldozed road alignments. Sediment within the area consists of sandy clay with 30 to 70% limestone/coral cobble and pebble inclusions. Vegetation in the area predominately consists of exotic grasses with few scattered koa haole and kiawe trees.

Section 6 Community Consultation

Throughout the course of this assessment, an effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of and/or concerns about traditional cultural practices specifically related to the study area. This effort was made by letter, email, telephone, and in-person contact. The initial outreach effort began 30 October 2013, and community consultation was completed in February 2014.

In the majority of cases, a letter (Appendix B), map, and an aerial photograph of the project area were mailed. In most cases, one to multiple attempts were made to contact individuals, organizations, and agencies apposite to the CIA for the project. The results of the community consultation process are presented in Table 3. Written statements from organizations, agencies, and community members are presented in Sections 6.1–6.3 below and summaries of interviews with individuals are presented in Section 7.

Table 3. Results of Community Consultation

Name	Affiliation, Background	Comments
Aila, William	Cultural Practitioner and Chairperson, DLNR	CSH mailed letter and figures 30 October 2013
Alaka‘i, Robert	Cultural Practitioner	CSH emailed letter and figures 5 November 2013
Amaral, Annelle	Member, ‘Ahahui Siwila Hawai‘i ‘O Kapolei Civic Club	CSH mailed letter and figures 30 October 2013
Awana, Karen	House District 43 Representative	CSH emailed letter and figures 6 November 2013
Ayau, Halealoha	Hui Mālama i Nā Kūpuna ‘O Hawai‘i Nei	CSH emailed letter and figures 6 November 2013
Cayan, Phyllis “Coochie”	Hui Kako‘o	CSH emailed letter and figures 6 November 2013
Cope, Auntie Aggie Kalanihookaha	Founder, Wai‘anae Coast Culture and Arts	CSH mailed letter and figures 30 October 2013
Crabbe, Dr. Kamana‘opono	CEO, Office of Hawaiian Affairs	CSH mailed letter and figures 30 October 2013
Eaton, Arlene	Kūpuna, Hale O Na‘auao	CSH mailed letter and figures 30 October 2013; letter was returned 4 November 2013

Name	Affiliation, Background	Comments
Enos, Eric	Cultural Practitioner; Director, Ka‘ala Farm	CSH emailed letter and figures to Mr. Enos 25 October 2013. CSH emailed Mr. Enos 5 November 2013 to set up an interview on 8 November 2013. Mr. Enos responded on the same day and organized an interview for 8 November 2013 at Ka‘ala Farms. Mr. Enos was interviewed 8 Novermber 2013. Mr. Enos sent CSH an email 10 November 2013 giving thanks for meeting and also sent along an ‘oli awa. CSH responded via email and thanked Mr. Enos. Mr. Enos approved his interview 25 January 2014.
Greenwood, Alice Auntie	Nani ‘O Waianae LCC-Wai‘anae	CSH mailed letter and figures 30 October 2013; letter was returned 4 November 2013
Ho‘ohuli, Josiah “Black”	Cultural Practitioner; Vice President, Auamo I Na Alaka‘i (AINA)	CSH mailed letter and figures 30 October 2013
Jordan, Georgette “Jo”	House District 44 Representative	CSH emailed letter and figures 6 November 2013
Kanahele, Kamaki	DHHL Nānākuli homesteads, State Council of Hawaiian Homestead Associations	CSH mailed letter and figures 30 October 2013
Kane, Shad	Member, O‘ahu Island Burial Council	CSH emailed letter and figures 6 November 2013
Kila, Glen	Kumu, Program Director of Marae Ha‘a Koa (Hawaiian Cultural Center)	CSH emailed Mr. Kila 25 and 30 October and 5 November 2013. Mr. Kila wrote CSH on 1 and 5 November 2013. CSH met with Mr. Kila and his nephew, Mr. Christian Oliveira, on 7 November 2013. Mr. Kila approved his interview summary 4 Febuary 2014.
Maunakea, Ruby	President, Nānāikapono Hawaiian Civic Club	CSH mailed letter and figures 30 October 2013
McKeague, Kawika	Cultural Practitioner, Honouliuli historian and longtime resident	CSH emailed letter and figures 6 November 2013
Philpotts, Douglas	Descendant of Campbell family	CSH mailed letter and figures 30 October 2013

Name	Affiliation, Background	Comments
Rodenhurst, Roda	President, ‘Ahahui Siwila Hawai‘i O Kapolei Hawai‘i Civic Club	CSH emailed letter and figures 6 November 2013
Shimabukuro, Maile	Senator, District 21	CSH emailed letter and figures 6 November 2013
Tiffany, Nettie	Kahu, Lanikuhonua	CSH mailed letter and figures 30 October 2013; letter came back 5 November 2013; CSH emailed 14 November 2013
Wong-Kalu, Hinaleimoana K.K.	Chair, O‘ahu Island Burial Council; Director of Culture, Halau Lokahi Public Charter School	CSH mailed letter and figures 30 October 2013

Section 7 Interviews

Kama‘āina and kūpuna with knowledge of the proposed project and study area participated in semi-structured interviews for this CIA. CSH attempted to contact 23 individuals; two responded and three participated in formal interviews. CSH initiated the interviews with questions from broad categories such as wahi pana and mo‘olelo, agriculture and gathering practices, freshwater and marine resources, trails, cultural and historic properties, and burials. Participants' biographical backgrounds, comments, and concerns about the proposed development and study area and environs are presented below.

7.1 Acknowledgements

The authors and researchers of this report extend our deep appreciation to everyone who took time to speak and share their mana‘o with CSH whether in interviews or brief consultations. We request that if these interviews are used in future documents, the words of contributors be reproduced accurately and not in any way altered, and that if large excerpts from interviews are used, report preparers obtain the express written consent of the interviewee/s.

7.2 Mr. Glen Kila and Mr. Christopher Oliveira

CSH met with and interviewed Mr. Glen Kila and Mr. Christopher Oliveira on 7 November 2014, at the Kahe Valley Photovoltaic project area following a site visit to inspect archaeological features throughout the property. They shared with CSH their mana‘o (knowledge) regarding the project area.

Mr. Kila and Mr. Oliveira are kupuka‘āina, lineal descendants and cultural practitioners from the Wai‘ānae Coast whose great-grandmothers were sisters. Mr. Kila grew up in Wai‘ānae and spent about ten years learning from his kupuna, Aunty Lei Fernandez, at Ko‘olina where he had his formal Hawaiian education. Mr. Kila attributes his cultural knowledge to his family, who taught him much of what he knows. His haumana (student), Mr. Oliveira, grew up in Nānākuli but also spent time in Waipahu, ‘Ewa Beach, Wai‘ānae, Maili, and on Hawai‘i Island. They describe themselves as kupuka‘āina—lineal descendants of the aboriginal families of Wai‘ānae, from the first settlers. Together, they run the Marae Ha‘a Koa cultural learning center that their kūpuna had established in Wai‘ānae centuries ago. They continue the legacy of teaching children about the land and values of the Wai‘ānae moku (district) passed down through generations of Wai‘ānae families.

According to Mr. Kila, the project area is part of an area called Kahe but the general area is also referred to as Ko‘olina, within the ahupua‘a of Honouliuli. He explained that Honouliuli is one of the largest ahupua‘a in O‘ahu but Honouliuli is generally understood to refer to the part of the ahupua‘a in the vicinity of Pearl Harbor. Mr. Oliveira explained, "'Hono' means bay. 'Uliuli' means the deep, dark, depth color. So when you consider Honouliuli, that's in 'Ewa." The men explained that the project area was traditionally part of the moku of Wai‘ānae when O‘ahu only had three moku before the political boundaries of O‘ahu were changed in 1909. Prior to that time, Wai‘ānae Moku was composed of Wai‘ānae Makai and Wai‘ānae Uka and the project area was part of the former which included the coastal area of Nānākuli, Wai‘ānae, Lualualei,

Makaha, all the way to Ka‘ena Point. Wai‘ānae Uka included portions of Wai‘ānae, Wahiawā, and Honouliuli. As such, the project area has historical ties to Wai‘ānae.

Mr. Oliveira added that the project area is also known as Keana‘ō‘io, the caves of the ‘ō‘io fish, a fish he said the coastal area fronting the project area is known for. Upon closer examination of the USGS map depicting the project area, he noticed the map labeled the area near the project area as Keone‘ō‘io, “the sands of the ‘ō‘io.” Mr. Oliveira speculated it is possible Keone‘ō‘io refers to the larger coastal area in the vicinity of the project area and that Keana‘ō‘io refers more specifically to the area immediately near the project area. Mr. Kila concurred and elaborated on the importance of fishing to the area:

> I would think so too. ‘Ō‘io (*Albula vulpes*) is a sand fish. This place has ‘ō‘io. Fishing was seasonal. If a certain fish was in season, families would come down to the coast and fish then go back to the places that had water like Wai‘anae, Makaha, and Wahiawā.

Mr. Oliveira also offered an alternative meaning of the wahi pana of Keana‘ō‘io that had been passed on to him. “According to kupuna uncle Alika Silva, his uncle Adrian told him this place was called ‘i‘o‘i‘o which means friction. If you look it up in the dictionary, ‘i‘o‘i‘o means ‘clitoris, the entrance to the female womb.’”

Having lived near the Project area for most of his life with accumulated knowledge of the Wai‘ānae lands from generations of family, Mr. Kila shared his thoughts of the project lands. He explained that the project area was not an area of permanent settlement due to lack of resources such as water and good soil for cultivation. Instead, it was a place where people passed through to and from ‘Ewa, or to the fishing and surfing along the coastal areas of the property. He explained,

> Basically this place over here talks about mostly fishing and surfing. Other than that, our families would talk about this place being desolate. Due to the lack of water over here, most of the habitation was temporary. Very few people visited here because of lack of water. There were some small families here who fished but that’s more from Kalaeloa. We were told that during the rainy season, there would be menehune falls flowing from Kahe Valley so water does flow but very, very limited. This area might just be a shelter area from the heat. The place lacked resources, there were plenty of fish, good surfing but lacked water and soil for planting taro or sweet potato. I have not seen a mala, or signs of gardening at Kahe but there were a few rock walls along the hillsides. Mo‘o or lizard goddesses were usually associated with water sources such as the mo‘o of Ko‘iahi where the spring is located or the mo‘o of Kikoo, the goddess of the springs in Wai‘ānae.

Mr. Kila told of many mo‘o stories up in the valley where probably most of the water was but down below, such as the project area, he did not recall any mo‘o stories. “We do have stories of Waimānalo, where you ‘carry the water,’ or ‘water flowing’ from underground springs but that’s down by Ko‘olina,” he said, which is south of the Project area.

Mr. Kila pointed out that petroglyphs also indicate places of previous settlement, which would suggest the existence of water sources to support population. The men pointed to the map to

indicate that petroglyphs are found north of the project area, and also south in Ko‘olina by the highway overpass. Mr. Kila explained,

> There was an ancient petroglyph by Kahe Point that's over 1000 years old. Right by Pili o Kahe down by Black Rocks. The petroglyph was a stick figure that indicated its age. So I know that they had water in the area.

"They were marking all these places where they could stay for a little while, get resources, and then travel," said Mr. Oliveira. No petroglyphs have been found in the project area.

Thus, Mr. Kila and Mr. Oliveira were puzzled by the size of the gulch area that they had visited earlier on the project property, just mauka of the bridge along Farrington Highway. The gulch was large for an area that lacked water so they wondered whether the gulch was man-made or altered. They had examined a rock wall along the sides of the gulch which archaeologists identified as possible cattle walls (Figure 14). "Though some families talk about ranching and that some cattle were raised here," said Mr. Kila, he was skeptical.

> They describe it as cattle walls but if I can walk over it, the cow can just lift its leg up and it's on the other side. But those are the kind of interpretations that makes us laugh. If there were only five cowboys here, why would they put a wall that's only 30 feet long to keep the cattle out? The cattle could walk around or lift its leg over.

Mr. Oliveira added that he had seen cattle walls dug into the ground in other places. "They're rocked and ramped like a corral and is like a cattle enclosure but you can actually see that it's sunk into the ground," he said. Mr. Kila also spoke of his experience with cattle walls in Hana where "cattle walls have rocks sticking out because cattle like to rub and scratch their backs against the wall or on the trees. If their backs were itchy, they'd rub their rump along side of the wall and that would knock rocks off."

Mr. Kila and Mr. Oliveira explained that an ancient trail passed through in the immediate vicinity of the project area, along the coast where the current Farrington Highway is located. "The traveling was just done here, by the ocean side," said Mr. Kila.

> They wouldn't go on the sides of the hill or mountains because it was too hot and steep. From the Wahiawā side, there is Pohakea Pass. The Kapolei route or Wai‘anae trail came through here by the ocean.

In referencing travel, the men also referred to the project area as "the entrance to the female womb" which metaphorically refers to the project area as a place enroute to the places of settlement of Nānākuli, Lualualei, Makaha, and Wai‘anae. The place name "Kahe," said Mr. Kila, refers to the female womb. Petroglyphs also marked boundaries, or places where people could drink water and refresh themselves before moving on.

Known for surfing, "this was a land mostly for fishing and recreational surfing by the ali‘is," said Mr. Kila. He continued,

> The ali‘is came here because they had beautiful winter swells and they lived at Lanikuhonua by Ko‘olina because there was water at Waimānalo from an underground stream. King Kakuihewa of O‘ahu made Kahe one of his favorite places to reside. His father, Ka‘ihikapu also loved this place.

Figure 14. Rock wall along side of gulch (CSH 2014)

> The sacred spots for this area was dedicated to surfing. That’s the reason why I was interested in looking to see if there were any shrine structures dedicated to surfing here. Most places have some kind of shrine or ahu dedicated to some god but this place have already been developed with a train track and a roadway.

Mr. Kila shared his thoughts on a structure visited earlier in the project area, thought to be a fishing shrine. Due to the location of the structure further inland from the ocean and its structural composition, neither man thought the structure was a shrine. Mr. Kila explained,

> If it was a fishing shrine, it has to have fish or be close to a fishing resource. There are two types of fishing ko‘a. One is called a kū‘ula which is found next to the ocean made from basalt rocks and the other hina made from sandstone or coral. The hina ko‘a attracted fish like the kū‘ula. At Kahe in a secured place is a kū‘ula and hina stone still worshiped by our family for fishing.
>
> Then there are the kane ko‘a fishing shrines found next to waterways and taro patches to increase the ‘o‘opu, a freshwater fish that goes upstream. The stones and shrines were once common in Wai‘ānae. Now there are only two shrines known to our family, one at Kiko‘o in Kamaile and the other in Makaha Valley near Kaneaki heiau. Simple kane ko‘a shrines were also erected for birds at Ka‘ena Point to attract birds for their feathers or for food, like the ‘ua‘ua

> *(Pterodroma phaeopygia sandwichensis)*. Only one such ko‘a was recorded at Nenele‘a, Keawa‘ula.
>
> So, in visiting the Kahe fishing shrine, I asked myself if it was a kane ko‘a? My mana‘o is that it is not because there’s no spring in the area that has flowing water and it is too far up from the ocean to be for salt water fish. Therefore the structure doesn’t fit the characteristics of a fishing ko‘a in our Wai‘ānae tradition. I believe it might be either a burial or some kind of shelter for fishermen. We would like to have the area preserved and protected because it does have cultural value as a sheltered area used by our kūpuna.

Mr. Oliveira added, “it’s completely speculation but I think there is a burial under that collapsed structure. There is something inside.”

“Down by the ocean are Hawaiian burials. They are ancient burials and there is a fishing shrine,” said Mr. Kila referring to an area outside the Project area. The men discussed cave burials which is common to the Wai‘ānae region and many are inaccessible. He remembered going up once to where his family was buried and finding kapa. He described the place as almost impossible to get to but there were certain ways that they were taught to climb. Mr. Kila shared that iwi were found in a cave along the Pili o Kahe ridge (Figure 15) on the northern boundary of the project area. Mr. Kila remembered visiting the cave years ago and described the iwi as having been isolated and found on the surface of the ground. He explained that the iwi did not seem like a burial but more like bones that had fallen down from a higher area. He recommended the cave for preservation.

The men also pointed out that Honoluliuli and the lands of ‘Ewa were an important place for the ali‘i historically. Mr. Kila explained,

> When it’s kau, the dry season, the families migrated up the valleys and into Waianae Uka. When it was ho‘oilo, the wet season, they came down the valleys to the coast to grow sweet potato and fish. I was taught by my kumu that the ali‘is would give birth in Wai‘ānae Uka/Wahiawā and bring their children to Wai‘ānae Kai to be raised because the weather was warm and there was lots of foods.

Mr. Oliveira added,

> When Kamehameha came, he tried to get Ke‘opulani to give birth at Kukaniloko, the royal birthing place of the sacred ali‘i’s. None of his children were born there but he wanted them to be born there because the real kings were born there. He wasn’t bloodline. He was a usurpian. He also killed a lot of his own people for white man’s values. His line only lasted a few generations and then it died. Not like how the Hawaiian ali‘i ruled for generations and generations continuously. We believe it’s because he never respected the traditions of the people wherever he’d conquered.

In addition to Hawaiian ali‘i and royalty, numerous gods are associated with the general area where the project is located such as the two gods, Kāne and Kanaloa. Mr. Kila recounted these mo‘olelo:

Figure 15. Pili o Kahe Ridge where iwi were found in a cave (CSH 2014)

> When the two major gods Kāne and Kanaloa came to O‘ahu, they landed in Kona, in Honolulu area, and marked this place with a boulder. They threw the boulder across Honolulu and it hit Pili-o-Kahe. Kahe supposed to be the sluicegate or female part of the body, the womb of Haumea, the mother earth.
>
> Kahe Point, where Pili-o-Kahe is located, is a landmark that draws the boundary between Nānākuli and Kahe, where Nānākuli is located north of Pili-o-Kahe and Kahe is to the south.

Though Kāne is the god of the sun, “he had much to do with freshwater so we pray to Kāne for freshwater,” said Mr. Kila. He explained that to mark the rainy seasons and know when it would rain, they would look at natural elements. Seeing red clouds in the east or the little Hawaiian mo‘o running around during the day indicated rain was on its way. Mr. Oliveira shared a scientific interpretation of the mo‘olelo of Kāne:

> If you look at Kāne as a scientific metaphor, it’s beautiful. Kāne had one twin brother, Kanaloa who traveled around the island digging up springs. Well what is Kāne? He’s the sun. Hawaiians say that water came from vapor because they know that the sun heat up the water in the ocean, turns it into clouds, which is also the kino lau [many forms taken by a supernatural body] of Kāne, and then it rains and you get freshwater filling up aquifers and springs. So, Kāne is the sun and the sun creates fresh water. It‘s evaporation. Hawaiians knew that. You can see it. If

> you go up to the top of the Ko‘olaus and wait until the sun comes up, you see steam coming on the side of the mountain. So all that ohu [mist, fog, vapor] that come up, Hawaiian realize, it’s Kāne. It’s a big cycle for water.

The setting of the sun in the west where the project area directly faces, is also associated with the spirit world and night marchers. Mr. Oliveira shared his knowledge:

> Wai‘ānae refers to Kāne who is the sun and we are in the land of the sun in Wai‘ānae. Hina is the moon. Wai‘ānae is a reference to the sun because Kāne creates water with Kanaloa—evaporation, rain and then the springs pop up. Then ‘anae (mullet) is the highest offerings to Kāne. So the name Wai‘ānae doesn’t just refer to mullet water. When we end up here in Ka‘ō‘io, it’s not just about the ‘ō‘io fish. The night marchers story is about the sun coming over, setting, and after the sun sets over here, the moon starts to travel. After the moon, every planet is following in this its path. So when they say the spirits are following the ancestor chiefs into Po, they aren’t talking about the ghost stories, ‘oh, I see night marchers here,’ in O‘ahu, I’m positive, it is about the planets following the sun because we were navigating people. If you take your cellphone with the navigating app on it, you go to the end of the mo‘olelo, which goes to Mount Lahilahi which is where they leap into Po. You’ll see the sunset, you’ll see the moon set, Venus, you’ll see all them traveling in this one path and setting over there. Mount Lahilahi is a place in Makaha. It’s a leina ka ‘uhane, a jumping off point.

Mr. Kila recalled that a village from the Pearl Harbor area, part of Honouliuli, was where the navigators like Kaha‘i came from. Kaha‘i was a famous Tahitian/Hawaiian navigator who brought the first ulu from Tahiti. He was the grandson of Mo‘ikeha who was from Tahiti. Mr. Kila stated,

> All our Polynesians traveled to Raiatea, Tonga, Samoa, Cook Islands. They all went to Raiatea, Taputapuatea, in Tahiti for southern navigation. For northern navigation, they came to Wai‘ānae to Kane‘ilio temple, marae before going east or back south to where they came from. This Wai‘ānae coast was important for navigation because there must be some special current that brings canoes here.

Mr. Oliveira added that the whole Wai‘ānae mountain range acts as a ruler. “You can see the stars pop up on this side as the season moves on,” he said. You look at the points of the mountain and each point has a name. “We’re lucky over here, we have such a wide deep sweeping valley, that you have a really nice vista.” Mr. Kila also carried on the discussion on navigation and indicated that from the heiau Kane‘ilio the seasons can be marked as the sun rises over the mountain peaks which differs from other islands like Kona, where the ocean is used to mark the seasons. He stated,

> At Keauhou in Kona, they have a big heiau called Hapaiali‘i and you can stand in the middle and mark the solstice and equinox by the sun setting. But here we have the mountains, Ka‘ala, Makali‘i, etc. During that time of Makali‘i, it first rises from the mountain peaks to our heiaus.

Another mo‘olelo associated with the Project area is the story of Hi‘iaka and Lohiau, thought to have taken place above Pili-o-Kahe ridge. Mr. Oliveira recounted the story:

> Above that ridge, that’s where Hi‘iaka went up and chant to Pele about why she’s burning down the forest. If you look at the chants, Wai‘ānae starts in Ka‘ena, comes this way with Lohiau, then goes up there and then Pele finds out he’s fooling around with the goddesses of Makua and with Hi‘iaka. Pele got mad and started burning down the forest in Big Island. What we know is that behind the mo‘olelo, if she’s speaking to Pele, then there’s a meaning behind it, yah? The mauna is Mauna Kapu. We believe because you can see the Big Island from over there. If you climb up this ridge, Pili-o-Kahe ridge, you just follow the ridge all the way up to the highest point before it starts dropping back down and that’s Mauna Kapu.

Mr. Oliveira also explained that the birth place of Maui Akalana is also right across the other side of Pili-o-Kahe ridge at Ulehawa which is outside the Project area but in the vicinity.

Native plants were also identified throughout the project area. These included the native cotton plant, ma‘o, ‘uhaloa (Figure 16), and ‘ilima (Figure 17). Mr. Kila stated that the Hawaiian cotton, ma‘o, is important because there used to be acres of Hawaiian cotton in the area. “The cotton that we have today, is a hybrid of the American cotton and the Hawaiian cotton because the American cotton were dying from disease so they interbred and this is a hapa-haole cotton over here,” said Mr. Kila. Since the project area is a habitat for the ma‘o, they recommended that the plants be preserved. Mr. Kila recommended the following:

> We would like to recommend: 1. that the ma‘o be incorporated into the landscaping of the project and that part of the ma‘o be cultivated and left as is because it’s part of our history. We’d like to see a lot of the ma‘o retained, naio, ‘uhaloa, ‘a‘ali‘i, maybe iliahi, the coastal one. Those kind of plants should be incorporated including the coconut trees.

Regarding other cultural resources on the property, military remnants currently exist onsite and Mr. Kila recommended that structures that were house sites or the names associated with them be preserved. He acknowledged those structures are important to the history of the 1920s and 1930s. A World War II historic site up along the hillside of the project area, as well as a pill box existing in the flats are recommended for preservation.

Also, Mr. Kila reported that in the 1920s to 1930s during plantation times, a railroad station used to be on the ocean side of the coast before Nānākuli. Ewa and Waipahu plantation workers would get off there and go swimming along the sandy beaches so a railroad used to pass through along the coastal area in front the project area.

In sharing their knowledge on the cultural resources and practices of the area, Mr. Kila and Mr. Oliveira also emphasized and discussed the important Hawaiian value of Ka‘ananiau which is central to managing natural resources and their environment. Mr. Oliveira explained that the term means “managing the beauty of time.” He explained,

> ‘Ka‘a’ means time. ‘Ka‘a’ also means rolling or seasons. So Ka‘ananiau means the rolling beauty of time or the changing seasons and it’s our role to manage our resources. As is common in Hawaiian culture, there is always a male and female side to everything. ‘Ka‘a’ would be the male side and ‘rolling changing cycles’ is the female. We are Ka‘ananiau. We mark the beauty of time. We perceive time.

Figure 16. ‘Uhaloa (*Waltheria indica var. americana*) (CSH 2013)

Figure 17. ‘Ilima (all species of *Sida*, especially *S. fallax*) (CSH 2013)

> Our mo‘olelo is Ka‘ananiau because it’s passing along information through generations of time.

Mr. Kila also added,

> We believe in Ka‘ananiau and that means ‘managing the beauty of time’ so for us, the mountains was Ka‘ananiau. It marks time. It’s eternal. It’s a time that all the ancestors viewed the mountains like Mount Ka‘ala. Never changed for 2000 years so it marks time. A tree marks time. The time that you plant it, it grows up and has fruit and feeds the children and grandchildren. The ocean. The springs. When the water comes down, that’s Ka‘ananiau. Even the tides. That’s why we call it Ka‘ananiau. Managing the beauty of time. It’s all about time and managing ourselves.

They emphasized that the value of Ka‘ananiau is essential for Hawaiians to have been able to live in their environment and especially in the dry lands of Wai‘ānae. They both believe the proposed project is positive and an appropriate technology for the place because it utilizes the sun, a resource that is an important part of the culture of the place and that is environmentally cleaner and cheaper. Mr. Kila explained,

> Building a solar system is very appropriate for this ‘āina because of the sun, because we worship the sun. Kāne was the sun god so utilizing this land for solar energy, that’s utilizing our akua. That’s very appropriate and better than oil. We get the cleaner technology, why don’t we use that? Our ‘oli [chants] talk about the sun and the heat of the sun. ‘‘Oi ka niho o ka la i ku manomano.’ Which means ‘the teeth of the sun grinds the sacred lands of Kumanomano.’ And then you have Heleakala, which means, ‘the snaring of the sun or the transit of the sun.’ So again, there’s a lot of mo‘olelo about the sun. This place is hot, then put solar engery here because it respects our mo‘olelo of the sun and managing the beauty of time. It’s appropriate because it‘s environmentally positive for our commuity and it’s cleaner, cheaper energy. It will teach everyone here that the sun is our life’s force.

7.2.1 Recommendations

Though some recommendations are mentioned in the interview summary above, the following section provides all recommendations by Mr. Kila and Mr. Oliveira regarding the proposed project:

- Mr. Kila recommends preserving the cave with iwi located along Pili-o-Kahe ridge on the northern boundary of the project area.
- Mr. Kila recommends preserving the site on the property thought to possibly be a fishing shrine.
- Concerning the rock wall with basalt on the property, Mr. Kila and Mr. Oliveira suggest that if the rocks are removed, they be donated to their community center, Marae Ha‘a Koa. They expressed that instead of the rocks being thrown away, and removed, that they could be used by the community center to build replicate

cultural structures, a process that helps perpetuate the culture, as children learn how to build those structures.

- Regarding the military remnants on the property, Mr. Kila recommends that structures that were house sites or the names associated with them be preserved. He acknowledged those structures are important to the history of the 1920s and 1930s. A World War II historic site up along the hillside of the project area, as well as a pill box existing in the flats are recommended for preservation.
- The Hawaiian cotton, ma‘o, is important because there used to be acres of Hawaiian cotton in the area. Since the project area is a habitat for the ma‘o, they recommend the plants be preserved. They recommend the ma‘o be incorporated into the landscaping of the project and that part of the ma‘o be cultivated and left as is. Other native plants like naio, ‘uhaloa, ‘a‘ali‘i, iliahi, ‘ilima, and coconut trees were also recommended to be included in the landscaping.
- Mr. Oliveira explained that he would like to see technology hybridized with nature to make the development look beautiful instead of an eyesore. He recommends a garden of the native plants of the project area be created within the solar panels so the facility can serve multiple purposes, not only in providing clean energy, but also in preserving the native plants of the area. He believes that hybridizing technology with nature could also serve as an educational classroom to the people of the area. He emphasized the importance of beautifying the proposed development and using plants to achieve that purpose.
- Mr. Kila recommends cultural monitoring particularly for the sites within the property, such as the possible fishing shrine, to prevent any desecration of cultural resources. “We want to be sure that the cultural and historic sites are protected, preserved and perpetuated,” he said.

7.3 Mr. Eric Enos

CSH met with Mr. Eric Enos at Ka‘ala Farms in Wai‘ānae on 8 November 2013 where he shared his mana‘o about the project area. Mr. Enos has spent his whole life in Makaha since his parents moved there from Kalihi when he was a child. He has family connections to Kalaieloa, south of the project area, on his mother’s side and his great-grand uncle was a fisherman and caretaker of the place now known as Barber’s Point Lighthouse. “His house was where the luau grounds right now is located and we used to go there and fish when we were small. This was before the Campbell Industrial Park was built,” said Mr. Enos. The other side of his family is from Kaua‘i and some are from Ka‘ū, on Hawai‘i Island.

Currently, Mr. Enos is the executive director of Ka‘ala Farms, a cultural learning center dedicated to perpetuating Native Hawaiian culture and connecting communities to the ‘āina. He is an educator and a long-time activist involved since the 1970s in the struggle for land rights for Native Hawaiians. Mr. Enos recalled and shared his experiences from earlier years:

> We were involved in a lot of the cultural issues of Hawaiians uprooted from the land and their culture. I got involved way back with the Kalama Valley land struggles, Kamehameha Schools, to Chinatown, then with the Hawaiian Renaissance, Kaho‘olawe, then Hilo Airport and sovereignty issues that go way back to when nobody knew what the word sovereignty meant. So we [Ka‘ala

> Farms] have a long tradition and then we were the ones in court for the Kalaeloa Deep Draft Harbor. We petitioned with Legal Aid and challenged the Deep-Draft Harbor. It was Snug Harbor before they dug it out to create the new harbor. We went to court, first with Legal Aid then with Native Hawaiian Legal Corporation. Our concern was the potential impact of development on the fishing grounds because the Kalaeloa area is probably one of the richest fishing grounds on O‘ahu. Pu‘uloa, or Pearl Harbor, was a fishery prior to being a military base. People don’t realize it but if you look at that whole area in front of Kalaeloa, there’s a huge coral system out there—a flat fringing reef with huge coral heads.

Mr. Enos described being involved in court cases against major development projects along the coast that threatened the ability of Native Hawaiians to practice their traditional subsistence livelihoods dependent on fishing and gathering. He shared the following:

> We also went to court regarding the Ko‘olina West Beach Resort and our concern was the potential loss of traditional limu and fishing grounds and the impact on gathering food. That’s what sustained families—the gathering of limu, salt, and fish. At the time, people were still practicing those traditions and that place was where the families would go. This was about the 1970s, around the time of the Renaissance. Everything was happening. Kaho‘olawe was happening. We saw that being able to feed yourself and eating healthy food, was how we were going to survive. We saw these projects as providing jobs but they’re short-term jobs. Construction jobs.

When the construction job is over, Mr. Enos explained, “Now you no more place for fish. Your land will get so valuable, you’re not going to afford it. You’re gonna get pushed, pushed, pushed, and on O‘ahu, everyone got pushed to Wai‘ānae.” Mr. Enos recalled that prior to urbanization, the way to Hawai‘i Kai including Pearl City, was all farmlands. Today, Wai‘ānae and the North Shore are the areas furthest from the impacts of urbanization. With the loss of natural resources, Mr. Enos is concerned about the loss of traditional food.

> That’s why we got into the water rights in Ka‘ala so we were in the courts. We said, keep your urban areas this way, but at the same time, we need to preserve our culture. We need to preserve our ahupua‘a. We need to preserve our water and ocean resources.

Mr. Enos pointed out that Wai‘ānae lands were very important because of salt and limu. “If you look at the spice trade, spices made European nations,” he said. “Our spices were ‘inamona, limu, and salt and then we had deep sea fisheries.” He explained that it was not Waikīkī that had the most combination of these resources but rather, it was Kā‘ena. He referenced the mo‘olelo of Maui pulling up the islands and explained that the story was not just about pulling islands out of the ocean but acknowledging the deep sea, where the ahi and aku come from, valuable resources for the livelihood of the people.

Mr. Enos also talked of the historical significance of Līhu‘e, the area now known as Scholfield, as the birthing place of the ali‘i of O‘ahu.

> If you keep going straight on this road, that would have brought you to Līhu‘e which is now known as Schofield. Līhu‘e was the base for O‘ahu, not Waikīkī.

> Līhu‘e is where the Kūkaniloko was, the birthing stones of the O‘ahu chiefs. When the wars came and the mixing of dynasties happened, the Maui chiefs took control. People think this goes back 200 years but it goes back a lot longer. The site of Līhu‘e was strategic because Pu‘uloa, if you look down from Schofield, you see Pu‘uloa [in Honouliuli]. That was rich lands and had many salt fishponds. All that was wai [water], wai, wai, wai. Waiao, Waimalu. They were all watered lands. Rich. But at Līhu‘e, you get Wai‘alua and that’s why it’s Kamehameha lands now because that’s where Princess Ruth gave the lands to Pauahi. So if you go to North Shore now, Kamehameha Schools owns all that land. That’s where the ali‘i lands were.

From Līhu‘e, ali‘i could command salt, the big fish, and also the ‘ōpelu and akule fish when they would come in. “This place had a lot of value because you have water and sun, you have limu and salt, and you have the fisheries,” said Mr. Enos. Accordingly, Wai‘ānae got its place name from the ‘anae or mullet that would travel out of Pu‘uloa and follow the current around the island. “The ‘anae used to be plentiful at one time and they would come out of Pu‘uloa hatchery and travel around and the ‘anae grew huge. But you don’t see it now because it’s lost,” Mr. Enos reminisced.

Having walked and studied the maps of the project area previously, Mr. Enos explained that what was important about that area was the shoreline and the fisheries along the coast. “That area would be just fishing and it would have had fishing ko‘a along the shoreline path.” He continued to explain that mauka lands were accessed only from Waimānalo, the area in Ko‘olina, south of the project area. “When you go past Waimānalo to the springs there, that’s when you went up mauka and had access to the uplands.” Mr. Enos explained,

> The rich uplands were up here up at Palehua, further south [of the project area] from both sides. If you go up above Nānākuli, that’s where you have Mauna Kapu. That’s where all the communication towers are. That’s important, Mauna Kapu and Palehua. That goes right to Līhu‘e but Mauna Kapu, it’s the unrestricted point on the kapae ‘āina of the islands that gives you Kaua‘i and all the peaks of the other islands if you look this way. So if you look this way, you can see Kaua‘i on a good day and the other way, you can see all the way to Hawai‘i Island. Right there is where Hi‘iaka rested in her journeys. Right where she stopped, that’s Mauna Kapu. So when she stopped at Pohakea Pass, that’s where she saw Pele and her girls burning so that place is significant. That’s right in Lualualei, Pu‘ukaua. Palehua is part of the Kahe area and connects to here [project area].

“There are native plants too [in the project area],” said Mr. Enos. “One of the place names of the area is Ma‘o because that’s the habitat of the ma‘o [Figure 18], the rocks. After a fire and then it rains, you’ll see ma‘o growing all along the whole rock side of that area,” he continued.

Mr. Enos elaborated in more detail his knowledge of trails in and around the project area such as the Pohakea Pass that he had referenced earlier, a trail that is part of the historic trail system in O‘ahu.

> The trails came through the coast. Everything is coastal. The inland trails are only in Lualualei, Kolekole and the other one, the military call it ‘gun site.’ Pohakea

Figure 18. Ma‘o (CSH 2013)

> Pass. Hi‘iaka rested at Pohakea and climbed up Mauna Kapu. That was all Honouliuli area and that’s where the Honouliuli Preserve was under the Nature Conservancy. In the Wai‘ānaes, that’s where you got all your maile. All in there was where they had the native forests and there are still remnants of it. Nowhere else. The only other place would be at Ka‘ala and Pahole, down the coast. So Honouliuli, then after that you hit Ka‘ala then you go up to Pahole above Makua and then you drop down into Kā‘ena. That walking path would have gone all the way from here, along the Wai‘ānaes. It’s a rich trail, then you have the upper valley trails that cross over all these lands but I’ve never seen anything in this place [the project area] other than fishing ko‘a.

Regarding fishing ko‘a, Mr. Enos explained that these structures were also shrines made of coral. Ko‘a were built to align with the mountain peaks and acted as transects for indicating fishing grounds. Many ko‘a were associated with the ‘ōpelu and akule fisheries. Mr. Enos described ‘ōpelu fishing in more detail:

> We revived the hoop-net fisheries from Miloli‘i from Uncle Eddie Ka‘ananā and Uncle Walter Paulo. We were trying to revive the Kona fishing canoe and in the process, we started to feed the ko‘a. The other one to feed the ko‘a was Domingo. Now, it’s Barney Gomes, the son of Domingo who feeds the ko‘a the traditional way. ‘Ōpelu ko‘a is like in Miloli‘i. When the ‘ōpelu comes in to spawn, it’s like salmon. You go in there, you feed them, and then you harvest them. They spawn, just like how the salmon comes upstream. They go to spawn but then after that

> they die. ‘Ōpelu season goes into the end of summer and goes into a few months then after that, they’re hard to find. This is the kind of ‘ōpelu that’s pelagic—deep sea. They go out to deep sea and then they come back in so there are these rhythms and cycles. The mana ‘ōpelu taro comes from ‘ōpelu fishing. It’s a variety of taro that was fed to the fish so it’s a form of animal husbandry.

Mr. Enos turned to his thoughts on the proposed project and explained that he had walked the project area property and had seen the proposed project plans. He explained that the project is proposed for the flat area of the property. He agrees with the vision of the project in introducing clean energy to the Wai‘ānae area. However, he cautioned that although alternative energy is good, gaining access to alternative energy should not mean spending more energy. He pointed out that some people may be concerned about the reflection of the solar panels especially with the road nearby but that overall, the project is rather non-invasive. He discussed some of his thoughts on several issues surrounding development and energy use:

> There’s people concerned about reflection but it’s pretty much non-invasive. We had fought the windmills and you can see in Wai‘ānae, we preserved our mountains. It’s important to keep development down. Now of course, Hale‘iwa has them but then that’s their decision. Windmills are good. Alternative energy is good and the PV panels are good. We gotta do something. We had this discussion on the second power plant. Our concern was that we cannot find more alternative energy to spend more energy. To me, that’s the problem. We have to find more alternative energy, at the same time, we have to reduce our energy needs. Hawaiian Electric is supporting some of our small projects around the ideas of community give back and to us, that’s a good way of holding the energy companies responsible by helping support education programs all around the areas of conservation and the kind of work that we’re doing in the community. It’s one way to deal with the problem—supporting alternative efforts like Ka‘ala and getting people educated on alternative lifestyles is a great thing. One of our greatest concerns is that when you create more energy, then people want more energy. We live in a world that tells us, one flatscreen in every room, the car gets bigger, more tires, higher, bigger. So that’s part of our Ka‘ala Farm’s Grow Local efforts. All our cultural events surround sustainability, like Ma‘o and other places.

Mr. Enos also explained the type of community-oriented work that they do at Ka‘ala Farms:

> We have this development plan for Ka‘ala as a community farm. We’re organizing families to come back on the land. The left hand side of this plan is meant to be all lo‘i. On the right side, we’re going to be training families to live off the land. We would also like to restore the ancient corridors so we are talking with the Navy. We have this watershed, an ancient trail connects right there and it goes over into Lualualei where it has the Puhawai water system with all abandoned lo‘i. The historic trails went from here and you keep going, you get Mauna Kapu which has archaeological and cultural sites. There is water and lo‘i there, too, then you hit Pohakea Pass, then you get right on top to Palehua. In the Wai‘ānaes, we have a corridor that drops into Makaha. We’re working with the golf course owners right now to open up the golf course so that before you put

water on the golf course, it needs to go into lo‘i first. Kaneaki Heiau is there and there’s a spring over there. Everybody has to eat so first we have to take care of our people. First take care so we’re going to start opening this place up to the families and teach them and HECO’s helping us.

Section 8 Cultural Landscape

Discussions of specific aspects of traditional Hawaiian culture as they may relate to the project area are presented below. This section integrates information from Sections 3–6 in order to examine cultural resources and practices identified within or in proximity to the project area in the broader context of the encompassing Honouliuli and Wai‘ānae landscape. Excerpts from interview sessions from past and present cultural studies are incorporated throughout this section where applicable.

8.1 Hawaiian Habitation and Agriculture

Various Hawaiian mo‘olelo and early historical accounts suggest ‘Ewa was once widely inhabited in pre-Contact times, including the residences of Hawaiian ali‘i. This would be attributable for the most part to the abundant marine and estuarine resources available at the coast, along which several sites interpreted as permanent habitations and fishing shrines have been located. However, most of the early settlement and habitation in Honouliuli occurred around the lochs of Pearl Harbor or Pu‘uloa, further away from the project area.

Community consultations indicate the project area was not a place of permanent settlement due to the lack of water and fertile soil for cultivation. Instead, it was a place people passed through on their way to fishing and surfing along the coast. Habitation occurred near water sources such as south of the project area at Waimānalo in Ko‘olina and further north of the project area. Consultations also mention a handful of ranchers living in the area nearby at one point as evidenced by possible cattle walls within the project area. The project area remains an uninhabited area shelted by Pili-o-Kahe ridge and the existing HECO structure.

8.2 Wahi Pana and Mo‘olelo

Wahi pana and mo‘olelo provide a unique insight into the cultural and natural landscape of the past. The prevalence of mo‘olelo about Kāne, the sun god, to the lands of Wai‘ānae is interesting particularly when compared with the uses of the proposed project. Community consultations reveal that the use of the sun for clean energy is in line with the significance of Kāne to the project area; therefore, it is appropriate.

Also of interest is the mo‘olelo of Hi‘iaka as she climbed up to Mauna Kapu which is outside of but near the project area. Though consultations indicate the people of Wai‘ānae have fought hard to protect their mountain range from development, communication antennaes exist at Mauna Kapu because it is a high point and an ideal location for inter-island communication. In the mo‘olelo of Hi‘iaka, she climbs this peak and is able to see all the way to Hawai‘i Island.

Though many mo‘olelo take place in Honouliuli, the majority of them are set in the area of Pu‘uloa and speak of the sharks of Pearl Harbor.

8.3 Marine and Freshwater Resources

Native Hawaiians historically fished the reefs, farmed fishponds, and utilized the freshwater springs in the ahupua‘a of Honouliuli. However, there is a lack of freshwater resouces within the

project area. Community consultations indicate the coastal area fronting the project area was known for fishing, particularly for ‘ō‘io, mullet, and deep sea fish.

8.4 Salt Gathering

According to community consultations, the areas along the Wai‘ānae coast were known for salt gathering. It is unclear whether the coastal area fronting the project area is still utilized for salt gathering.

8.5 Ala Hele

Trails were and continue to be valuable resources of Native Hawaiian culture and life ways. In the past, trails were well-used for travel within ahupua‘a between mauka and makai and laterally between ahupua‘a. An historical trail system existed in O‘ahu that extended from Honolulu to Wai‘ānae and passed through Honouliuli. Community consultations suggest a coastal lateral trail of this trail system most likely ran through what is now known as Farrington Highway that runs adjacent to but outside of the project property. Mr. Enos related that Pohakea Pass, which was part of the historial trail system, travels through the mauka areas of Wai‘ānae and still exists.

8.6 Burials

Community consultations reveal that iwi were found in a cave on the northern boundary of the project property. However, Mr. Kila stated that the positioning of the iwi led him to believe the iwi were not part of a burial but that possibly the iwi had fallen down from higher ground as the cave is located in a steep area of the Pili-o-Kahe ridge. While burials in caves are common to the Wai‘ānae region, the proposed development is intended for the flat areas of the property where caves are unlikely. However, Mr. Kila and Mr. Oliveira believe a structure on the property thought to be a possible fishing shrine may contain burials beneath it.

8.7 Native Plants

Native Hawaiians utilized native plants for lā‘au lapa‘au or traditional medicine. Community consultations indicate the project area is a habitat for the native ma‘o, as well as other native plants used for traditional medicine, such as ‘uhaloa and ‘ilima.

Section 9 Summary and Recommendations

CSH undertook this CIA at the request of Hawaiian Electric Company, Inc. The research broadly included the entire ahupua‘a of Honouliuli, including the 50-acre project area.

9.1 Results of Background Research

Background research for this study yielded the following results, presented in approximate chronological order:

1. The project area is located along the western coast of Honouliuli Ahupua‘a, the largest and Western-most ahupua‘a in ‘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. Numerous wahi pana, ‘ōlelo no‘eau, ‘oli, and mo‘olelo come from Honouliuli which suggests the ahupua‘a’s historical significance, abundance of natural resources, and the presence of a viable Native Hawaiian population. Many mo‘olelo took place along the plains of Honouliuli, such as the story of the demi-god Kamapua‘a and his grandmother; Pele’s sister, Hi‘iaka, on the plains of Kaupe‘a and Keahumoa; the wondering ghosts of Kaupe‘a, Pu‘uokapolei, and Kanēhili; the demi-god Maui and his stolen wife; the pōhaku of Pukaua; the hero Pikoi and his arrow-shooting skills; the warrior Palila and his supernatural war club; and the hero Nāmakaokapao‘o. Mo‘olelo and ‘ōlelo no‘eau associated with the natural resources of Honouliuli include the many shark stories of Pu‘uloa and the guardian shark Ka‘ahupāhau; the pipi and ‘ānae-holo of Pu‘uloa; the kāī-koi kalo of ‘Ewa; the fishponds of Pu‘uloa involving the gods Kane and Kū, Kaihuopala‘ai, and Ihuopala‘ai; and the planting of the first breadfruit from Kahiki. Mo‘olelo also tell of the ōlohe people who were humans with dog tails who dwelled in caves in Honouliuli.
3. Early historical accounts and the presence of permanent habitation sites, fishing shrines, and subsistence-related features along the coast also suggest ‘Ewa was once widely inhabited and home to many ali‘i during the pre-Contact period. Successful coastal settlement was likely supported by a plethora of marine resources, particularly the loches of Pearl Harbor; irrigated lowlands suitable for wetland taro, banana, and sugarcane cultivation seen nowhere else in O‘ahu (Meyen 1981:63); and forest resources along the slopes of the Wai‘ānae Range, likely utilized as a subsistence alternative in times of famine (Handy 1940:211; Handy and Handy 1972:469-470). Accounts by missionaries in 1823-24 suggest the lands further from the coast or the plains of ‘Ewa were largely uncultivated and habitation was scarce (Ellis 1963:7).
4. Ten historic properties were found within the project area of which four are recommended for preservation including SIHP #s 50-80-12-6647, -7137, -7139, and -

7140. These sites were associated with Native Hawaiian habitation and agricultural sites and WW II military activity.

5. Honouliuli was the most populous ahupua‘a on O‘ahu at Contact with the majority of the population centered around Pearl Harbor. The inland area of ‘Ewa was abandoned by the mid-nineteenth century likely due to population decline from disease and consolidation of the remaining people in the towns of Honouliuli, Waipahu, and Waiawa. Today, Honouliuli is among the most rapidly growing ahupua‘a in O‘ahu.
6. A heiau was once located on Pu‘uokapolei, a hill in Honouliuli thought to have been named after “beloved Kapo,” the sister of the volcano goddess, Pele, but had been destroyed by the time of McAllister’s (1933:108) survey of O‘ahu Island in the early 1930s. Pu‘uokapolei was a place for astronomical observations and it may have been regarded as the gate of the setting sun, just as Kumukahi in Puna is regarded as the gate of the rising sun (Fornander 1919:292).
7. ‘Ewa was known for the many limestone caves formed in the uplifted coral called the “Ewa Karst” (Mylroie and Carew 1995). Some of these caves, called “ka-lua-ōlohe” were inhabited by the “ōlohe,” a type of people that looked like 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, lived in Līhu‘e in upland Honouliuli, and he was an “ōlohe.”
8. Several historic trails traversed ‘Ewa, including a lateral trail that connected Honolulu to the Wai‘ānae District and is likely located in the vicinity of the project area. This trail is described by ‘Ī‘ī (1959:96) as dipping down “toward the coast towards . . . Pu‘uokapolei [and] . . . crossed into Wai‘ānae at the coast near Pili o Kahe.
9. The boundaries of Honouliuli were often contested with the people of Wai‘ānae. However, the boundaries of these two districts are said to be marked by a stone known as Pili o Kahe which translates literally as “clinging to flow” and refers to the female or Wai‘ānae side of the hill (Told to E.S. by Simeon Nawaa, 22 March 1954 in Sterling and Summers 1978:1).
10. Many battles took place in ‘Ewa, including Honouliuli, dating back to at least the twelfth century. Many ali‘i came from ‘Ewa and chiefs from its upland areas like Līhu‘e were called lō ali‘i because they lived there continually and guarded their kapu. The lō ali‘i were regarded as being like gods, unseen, resembling men (Kamakau 1991a:40). The supremacy of the ‘Ewa chiefs ended with the Battle of Nu‘uanu won by Kamehameha I.
11. In 1795, Honouliuli Ahupua‘a was given by Kamehameha I to Kalanimōkū, an early supporter (Kame‘eleihiwa 1992:58, 112). The ahupua‘a was inherited by Kalanimōkū’s sister, Wahinepi‘o. During the Māhele of 1848, 96 land claims were made and 72 claims were awarded to commoners. Claims ranged in size from 0.1 to 5.5 acres and almost all of them were adjacent to Honouliuli Gulch and contained fishponds and irrigated taro fields (Tuggle and Tomonari-Tuggle 1997:34). In 1855, the Land Commission awarded all 43,250 acres of unclaimed land in Honouliuli to Miriam Ke‘ahikuni Kekau‘ōnohi, a granddaughter of Kamehameha I, and the heir of Kalanimōkū (Indices of Awards 1929;

Kame‘eleihiwa 1992). The property passed through a series of heirs until 1877 when James Campbell purchased most of Honouliuli Ahupua‘a, except the ‘ili of Pu‘uloa, for a total of $95,000.

12. James Campbell started the Honouliuli Ranch, which was used almost exclusively for cattle. Cattle ranching continued into modern times and Honouliuli Ranch was considered the “fattening” area for other ranches (Frierson 1972:15). Though Honouliuli Ranch was not in operation until the 1870s, a longhorn cattle ranch reportedly existed in nearby Wai‘ānae by at least 1840 (Frierson 1972:10). The grazing of ranching animals as well as the logging of the sandalwood forests disturbed the ecosystem of the ‘Ewa plains, allowing exotic vegetation to thrive which further changed the landscape of the district.
13. Rice cultivation occurred in Honouliuli around the 1880s and in 1885, 200 acres of rice replaced much of the former taro lands in the lowland areas surrounding Pearl Harbor (Coulter and Chun 1937:21). The ancient taro lo‘i and ‘auwai (irrigation ditches) were modified and expanded to support rice cultivation which was dominated by the Chinese. By the early twentieth century, rice farming declined and was succeeded by sugar. Sisal, a plant used to make fibers for rope and other material, was also experimented with between 1898 and the 1920s mainly on the coastal plain of Honouliuli in Kānehili (Frierson 1972:16).
14. Sugar cane became a dominant industry in the 1800s and in 1879, the first artesian well was drilled in ‘Ewa allowing great irrigation possibilities (Ellis 1995:22). Three sugar companies were established in the district including the Ewa Plantation Company (EPC), which was located in Honouliuli (Nedbalek 1984:13). The EPC started in 1890 and by the 1930s, it encompassed much of the eastern half of Honouliuli Ahupua‘a. EPC was once termed the “richest sugar plantation in the world” (*Paradise of the Pacific,* December 1902:19-22 in Kelly 1985:171). The Oahu Sugar Company took over the EPC in 1970 and continued operations until 1995 (Dorrance and Morgan 2000:45, 50). Plantation villages to house a growing immigrant labor force developed in Honouliuli but by the 1930s and 1940s, World War II (WWII), took many of the plantations’ workers.
15. Railroads built by OR&L extended from Honolulu to Pearl City in 1890 and to Wai‘ānae in 1895, eventually running across the center of the ‘Ewa plains (Kuykendall 1967:III, 100). To attract business to the new railroad system, much land in Honouliuli was subleased to the sugar plantations. The U.S. military also used the sugar cane rail system to “haul large quantities of ammunition” and in 1947, the U.S. Navy took over a section of the OR&L track for their own use (Condé and Best 1973:315; Treiber 2005:25-26). After WWII, 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.
16. Though Pearl Harbor is located east of the project area, U.S. military development on Pearl Harbor and the events of WWII significantly changed the history of Honouliuli and Hawai‘i at large beginning in 1876 with the Reciprocity Treaty. Since then, the U.S. military acquired much of coastal ‘Ewa for its naval and air force bases, and developed the surrounding areas of ‘Ewa with infrastructure to support its operation. By 1943, the military attracted over 24,000 people who worked at Pearl Harbor and naval housing areas had grown large enough to be considered separate cities. Barracks and temporary

housing for workers were built for miles between Pearl Harbor and the outskirts of Honolulu (Downes 1953).

17. Following the bombing of Pearl Harbor on 7 December 1941, the strategic vantage point of Kahe Point was chosen as a potential site to house one of the two 14-inch gun turrets that could be recovered from the sunken battleship USS *Arizona.*

9.2 Results of Community Consultations

Community consultations for this study yielded the following results, presented in approximate chronological order:

1. According to Mr. Kila and Mr. Oliveira, the project area was traditionally part of Wai‘ānae Moku (district) when O‘ahu originally had three moku before political boundaries changed in 1909. During that time, Wai‘ānae Moku was composed of Wai‘ānae Makai and Wai‘ānae Uka. The project area was part of Wai‘ānae Makai which included the coastal area of Nānākuli, Wai‘ānae, Lualualei, Makaha, all the way to Ka‘ena Point. Wai‘ānae Uka included portions of Wai‘ānae, Wahiawā, and parts of existing Honouliuli. Thus, the project area has historical ties to Wai‘ānae.
2. Mr. Kila described the project area as part of Kahe but the general area is also known as Ko‘olina, in the ahupua‘a of Honouliuli. He explaind that Honouliuli is one of the largest ahupua‘a in O‘ahu but Honouliuli is generally understood to refer to the part of the ahupua‘a in the vicinity of Pearl Harbor. The coastal area fronting the project area is also known as Keana‘ō‘io, the caves of the ‘ō‘io fish which Mr. Oliveira said is common to the area. The place name Keone‘ō‘io, the sand of the ‘ō‘io, appears on a USGS map of the area which he speculated refers to the larger coastal area in the vicinity of the project area and that Keana‘ō‘io refers more specifically to the area immediately near the project area.
3. Mr. Enos pointed out that Wai‘ānae lands were very important because they had access to deep sea fisheries combined with an abundance of spices such as salt, limu, and ‘inamona. He referenced the mo‘olelo of Maui pulling up the islands and explained that the story was not just about pulling islands out of the ocean but acknowledging the deep sea, where the ahi and aku come from, valuable resources for the livelihood of the people.
4. Mr. Kila explained that the project area was not a place of permanent settlement due to lack of water and fertile soil for cultivation. Instead, it was a place where people passed through to and from ‘Ewa, or to the fishing and surfing for which the coastal area of the project property is most known for.
5. Mr. Kila and Mr. Oliveira explained that petroglyphs also indicate places of previous settlement, usually near water sources where people could drink water and refresh themselves before traveling. Petroglyphs exist north and south but not within the project area. According to Mr. Kila, stick figure petroglyphs that date back to over 1,000 years old are found by Kahe Point near Pili-o-Kahe by Black Rocks. Thus, given the lack of water, Mr. Kila and Mr. Oliveira are puzzled by the existence of a large gulch area on the project property, just mauka of the bridge along Farrington Highway.

6. Attracted to the good surf and fishing along the coast, Mr. Kila stated that ali‘i like King Kakuihewa and Ka‘ihikapu loved and frequented the area. They lived at Lanikuhonua by Ko‘olina because of water at Waimānalo, south of the project area. Mr. Enos added that the area in nearby Līhu‘e, now known as Scholfield, at the birthing stones of Kūkaniloko, was the birthing place of the O‘ahu ali‘i. From Līhu‘e, the ali‘i could look down to the rich lands of Pu‘uloa in Honouliuli and command the limu, salt, and large fish from that area.
7. According to Mr. Kila, there are two types of fishing ko‘a: 1) k ū‘ula and 2) kane ko‘a. Ku‘ula are usually located near the ocean and made of lava rock or coral while kane ko‘a are usually near waterways for fish like ‘o‘opu, in lo‘i or for birds. Therefore, he believes that a structure on the property, identified by archaeologists as a possible fishing shrine, is unlikely because of its location further inland from the ocean and its structural composition that is uncharacteristic of fishing ko‘a. Instead, Mr. Kila and Mr. Oliveira speculated that the structure may have burials beneath it. Mr. Enos explained that ko‘a were built to align with the mountain peaks and acted as transects for indicating fishing grounds particularly for ‘ōpelu and akule.
8. Mr. Kila and Mr. Oliveira discussed that cave burials are common to the Wai‘ānae region and that Native Hawaiian burials are most likely found along the coast. Mr. Kila recalled iwi found in a cave, SIHP # -7139, along the Pili-o-Kahe ridge on the northern boundary of the project area. The iwi did not seem like a burial but more like bones that had fallen from higher ground.
9. Though family members speak of some previous cattle ranching in the area, Mr. Kila and Mr. Oliveira were skeptical that a rock wall along the gulch within the project area was for cattle, as indicated by archaeologists.
10. Numerous mo‘olelo are associated with the general area of Kahe, including Kāne and Kanaloa, Hi‘iaka at Mouna Kapu, Pili-o-Kahe landmark that marks the boundary between Kahe and Nānākuli, and the birth place of Maui Akalana across from Pili-o-Kahe. Though located far from the project area, the first breadfruit is said to have been brought by the Tahitian/Hawaiian navigator Kaha‘i, the grandson of Mo‘ikeha, and it was planted in a village near Pearl Harbor in Honouliuli Ahupua‘a.
11. The predominance of Kāne, the god of the sun, in the western part of O‘ahu speaks to the significance of the sun to these areas, explained Mr. Kila and Mr. Oliveira. In addition, the setting of the sun in the west where the project area directly faces, is also associated with the spirit world and night marchers. Therefore, Mr. Kila and Mr. Oliveira feel the proposed project is in line with the cultural significance of Kāne and the sun to the region.
12. The three participants pointed out that native plants such as, ma‘o, ‘ilima, and ‘uhaloa grow throughout the project area. Mr. Kila stated that the Hawaiian cotton, ma‘o, is important because there used to be acres of Hawaiian cotton in the area and the other plants are used in lā‘au lapa‘au.
13. Military remnants, such as a World War II historic site up along the hillside of the project area as well as a pill box in the flat area of the property currently exist on the

project property. Mr. Kila acknowledged the importance of these structures to the history of the 1920s and 1930s.

14. Mr. Kila recounted that from the 1920s to the 1930s during plantation times, a railroad station used to be located on the ocean side of the coast before Nānākuli. Plantation workers would get off there and go swimming at the sandy beaches nearby so a railroad used to pass through along the coastal area fronting the project area.
15. According to all three participants, historic trails came through the coast, most likely where the current Farrington Highway runs adjacent to the project area. Mr. Enos pointed out that inland trails are only in Lualualei, Kolekole, and the famous Pohakea Pass where Hi‘iaka rested at Pohakea and climbed up Mauna Kapu.
16. In sharing their knowledge of the cultural resources and practices of the area, Mr. Kila and Mr. Oliveira also emphasized and discussed the important Hawaiian value of Ka‘ananiau which means “managing the beauty of time.” Ka‘ananiau is central to managing natural resources particularly of a place like the project area with limited resources.

9.3 Recommendations

The following cultural impacts and recommendations are based on a synthesis of all information gathered during preparation of the CIA. Recommendations are dichotomized to differentiate between community recommendations provided by participants of this study for the proposed project and CSH recommendations formulated to consider the restrictions of existing rules and regulations on land use and access. The findings indicate several historical features, a cave with iwi, and native plants exist on the project property. To help mitigate the potential adverse impacts of the proposed project on Native Hawaiian cultural beliefs, practices, and resources, recommendations should be faithfully considered and appropriate measures to address each concern, should be developed.

1. **Burials**

   Community Recommendations: Community participants acknowledge that a cave along the northern boundary of the project property contained iwi. Mr. Kila recommends preserving the cave. Mr. Kila and Mr. Oliveira also speculated that the structure on the property thought to be a fishing shrine may contain burials underneath it. They recommend this structure be preserved.

   CSH Recommendations: CSH recommends the cave and also the possible fishing structure be preserved. In Hawai‘i State burials are protected through HRS §13-300, HRS §6E, and State of Hawai‘i Constitution Article 12 Section 7. These state, 1) The treatment of burial sites and human remains is under the jurisdiction of the SHPD and OIBC; therefore, should burial sites be discovered, CSH recommends that all work immediately cease and the above agencies be notified; 2) Requests to preserve or relocate human remains must be submitted to the OIBC for Native Hawaiian human remains and to the SHPD for non-Native Hawaiian human remains in the form of a Burial Treatment Plan; therefore, should such requests be necessary, CSH recommends a Burial Treatment Plan be developed pursuant to the guidelines established in HRS

§13-300; 3) In developing this plan, CSH recommends identifying and consulting with cultural and lineal descendants of the ahupua‘a where human remains are found, as required by law. Thus, recommendations provided by community participants regarding burials as stated above, should be considered in the preparation of a Burial Treatment Plan; 4) Furthermore, CSH recommends archaeological monitoring and consultations with recognized descendants of corresponding ahupua‘a during ground-disturbing phases of development.

2. Historic Properties

Community Recommendations: Mr. Kila recommends military remnants on the property that were house sites and the names associated with them be preserved. He acknowledged that those structures are important to the history of the 1920s and 1930s. Regarding the rock wall with basalt on the property, Mr. Kila and Mr. Oliveira suggested that if the rocks are removed, they be donated to the Marae Ha‘a Koa community center, where children can learn how to build replicate cultural strucutres.

CSH Short-Term Recommendations: CSH recommends that 1) historic property boundaries to be located by a licensed land surveyor and indicated on all construction plans; 2) the establishment of a 6.1-m (20-ft) preserve buffer for each historic property as indicated in the preservation plan; 3) the addition of preserve buffers on all construction plans; 4) installation of a continuous barrier of orange web fencing or similar highly visible material around the preserve buffer for SIHP #s -6647 and -7140; 5) passive preservation of SIHP #s -7137 and -7139; and 6) a preconstruction meeting between project personnel and monitoring archaeologist(s).

CSH Long-Term Recommendations: CSH recommends the 1) establishment of a 6.1 m (20-ft) preserve buffer for each historic property as indicated in the preservation plan; 2) that physical buffers to be installed around SIHP #s -6647 and -7140 Feature A and B using permanent fencing and/or boulder barriers to be determined in consultation with community members and installed with the supervision of an archaeologist; 3) preservation in place of the iwi at SIHP # -7139 to include reburial of the iwi within the underlying previously excavated and backfilled test unit to be conducted in consultation with community members; and 4) passive preservation for SIHP #s -7137 and -7139.

3. Native Plants

Community Recommendations: Participants emphasized that the project area is a habitat for native plants such as ma‘o, ‘ilima, and ‘uhaloa. Mr. Kila and Mr. Oliveira recommend the plants be preserved. Mr. Oliveira believes the facility serves multiple purposes in addition to providing clean energy, such as preserving the native plants of the area, educating the public about them, and beautifying the area. He recommends ma‘o be incorporated into the landscaping of the project and that part of the ma‘o currently growing on the property be left as is or as a garden amongst the solar panels. Other native plants like naio, ‘uhaloa, ‘a‘ali‘i, iliahi, ‘ilima, and coconut trees were also recommended to be included in the landscaping.

CSH Recommendations: Native plant populations within the project area, particularly of ma‘o, should be inventoried and protected as they are important cultural and natural

resources in Hawai‘i and beyond, due to their endemic nature and their uses in traditional medicine.

4. Cultural Monitoring

Community Recommendations: Mr. Kila recommends cultural monitoring particularly for the historic sites within the property, such as the possible fishing shrine, to prevent any desecration of cultural resources. “We do not want to stop the project because the project should go on but to make sure it’s pono,” he said.

CSH Recommendations: Developing and maintaining positive relationships with the Kahe and Ko‘olina communities are important in ensuring that proper cultural protocols are respected and unanticipated adverse cultural impacts are minimized. To achieve this process, CSH recommends recognized descendants and Native Hawaiian organizations be consulted as the project design progresses.

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n.d. Photograph of Waikele rice fields below the Oahu Sugar Company Mill. Original at Hawai‘i State Archives, Honolulu.

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Appendix A: Authorization Release Form

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 89 mmagat@culturalsurveys.com afaanunu@culturalsurveys.com

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AUTHORIZATION AND RELEASE FORM

Cultural Surveys Hawai‘i (CSH) appreciates the generosity of the *kūpuna* and *kama‘āina* who are sharing their knowledge of cultural and historic properties, and experiences of past and present cultural practices in the Ahupua‘a of Honouliuli for the Cultural Impact Assessment CSH is preparing for the proposed Kahe Utility Scale Photovoltaic Project at the request of the Hawaiian Electric Company, Inc. (HECO).

We understand our responsibility in respecting the wishes and concerns of the interviewees participating in our study. Here are the procedures we promise to follow:

1. The interview will not be tape-recorded without your knowledge and explicit permission.
2. You will have the opportunity to review the written transcript or notes of our interview with you. At that time you may make any additions, deletions or corrections you wish.
3. You will be given a copy of the interview transcript or notes for your records.
4. You will be given a copy of this release form for your records.
5. You will be given any photographs taken of you during the interview.

For your protection, we need your written confirmation that:

1. You consent to the use of the complete transcript and/or interview quotes for reports on cultural sites and practices, historic documentation, and/or academic purposes.
2. You agree that the interview shall be made available to the public.
3. If a photograph is taken during the interview, you consent to the photograph being included in any report/s or publication/s generated by this cultural study.

I, _____, agree to the procedures outlined above and, by my
(Please print your name here)
signature, give my consent and release for this interview and/or photograph to be used as specified.

_____
(Signature)

_____
(Date)

Appendix B: Community Outreach Letter

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 89 afaanunu@culturalsurveys.com, mmagat@culturalsurveys.com www.culturalsurveys.com

October 25, 2013

Aloha e,

At the request of the Hawaiian Electric Company, Inc. (HECO), Cultural Surveys Hawai'i, Inc. (CSH) is preparing a cultural impact assessment (CIA) for the Kahe Utility Scale Photovoltaic Project, located in the Honouliuli Ahupua'a, 'Ewa District, O'ahu Island, TMK: [1] 9-2-003:027 por. 4. See accompanying USGS and aerial maps.

The proposed Project includes the construction/installation of a Photovoltaic array/system (solar panels that generate electricity) on approximately 50 acres of the 454 acres of Kahe valley owned by HECO. HECO will minimize earth-moving and retain as much of the existing vegetation as possible. Only the land on which such things as fire breaks, access roads, inverter and transformer pads, and other essential facilities would be cleared. Most of the land beneath the PV panels themselves would be left undisturbed. It is anticipated that approximately 8,000 linear feet of access road will be constructed throughout the project area. All site preparation will incorporate a 100-foot setback from Farrington Highway. The Project expects no changes to storm water runoff to the ocean by controlling any potential increases in storm water runoff utilizing runoff diversions, swales, and retention basins.

Approximately 50,000 solar modules will be mounted to less than 5,000 small diameter steel posts that will be pile driven to a depth of approximately 8 feet. Depending on conditions at a particular post location, the contractor may install a concrete poured footing, or an additional driven post as necessary. The solar panels will be set at a 20 degree fixed tilt from horizontal and will be oriented facing south. The height of the solar module racking units will be approximately 6 feet above the ground at the highest point.

We are seeking your *kōkua* and guidance regarding the following aspects of our study:

- **General history and present and past land use of the Project area.**
- **Knowledge of cultural sites which may be impacted by future decommissioning of the Project area, for example, historic, archaeological, and burial sites.**
- **Knowledge of traditional gathering practices in the Project area, both past and ongoing.**
- **Cultural associations of the Project area, such as legends and traditional uses.**
- **Referrals of *kūpuna* or elders 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.**

We invite you to contact us, Angela Fa‘anunu, at (808)-227-8855 (e-mail: afaanunu@culturalsurveys.com), or Margaret Magat, at (808)-990-6340 (e-mail: mmagat@culturalsurveys.com) if you have any information you would like to share.

Mahalo nui loa,
Angela Fa‘anunu and Margaret Magat
Cultural Researchers
Cultural Surveys Hawaii Inc.
Archaeological and Cultural Impact Studies
P.O. Box 1114
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D. PUC APPLICATION, EXHIBIT 4 "30-YEAR LEVELIZED COST CALCULATION METHODOLOGY"

EXHIBIT 4

30-Year Levelized Cost Calculation Methodology

The purpose of this exhibit is to present how the 30-year levelized cost was calculated for the Kahe Utility-Scale Photovoltaic Project ("PV Project") proposed by the Hawaiian Electric Company, Inc.("Hawaiian Electric" or the "Company") using traditional regulatory accounting treatment. It also includes a comparison to a proxy 20-year energy-only Power Purchase Agreement ("PPA"), as explained below. Additionally, this exhibit provides a narrative description of the significant assumptions used in the calculations.

Revenue Requirements

The calculations used in this exhibit are based on the revenue requirements for the proposed project. A simplified definition of a revenue requirement is that it is a calculated value which represents the estimated revenues needed from ratepayers which would allow the Company to recover its capital investment and expenses, honor its debt obligations, pay its revenue and income tax liabilities and pay its preferred shareholders while providing a fair return to its common shareholders for their investment. Generally, the structure and major components included in the revenue requirement calculation and model are consistent and similar, in many respects, from project to project and across all Companies[1] as the calculation needs to capture the impact from the above listed items. However, each calculation and model is modified for each project to specifically capture any factors or assumptions related to that particular project (e.g. renewable tax credits for a renewable energy project).

[1] The "Companies" collectively refers to Hawaiian Electric, Hawai'i Electric Light Company, Inc. and Maui Electric Company, Limited.

30-Year Levelized Cost Analysis

The levelized cost for the PV Project was determined by dividing the accumulated present value of the 30-year revenue requirements by the discounted amount of energy estimated to be produced over the 30-year period, and then adjusting the result to remove the revenue taxes imbedded in the revenue requirement calculations. The formula is as follows:

$$\frac{\text{(Accumulated Present Value of Revenue Requirements)}}{\text{(Discounted Total Energy Output) * (Revenue Adjustment Factor)}}$$

Page 13 of this Exhibit 4 shows the resultant levelized cost of energy for the proposed PV Project is 16.1 cents per kilowatt-hour ("¢/kWh"). Pages 14 and 17 through 23 show the detailed analysis.

The analysis for the PV Project includes the estimated initial capital cost of the project, annual operations and maintenance costs for the life of the project, and inverter replacement cost at year 15.

Comparison of the 30-Year PV Project to a 20-Year PPA

The levelized cost of the PV Project (16.1 ¢/kWh) is similar to the five as-available renewable projects ("waiver recently submitted to the Commission in the Application For Approval of Application for Waivers from the Framework for Competitive Bidding, filed on June 18, 2013, in Docket No. 2013-0156 ("Application for Waivers"). The total average levelized energy price for the five as-available renewable projects was 15.934 ¢/kWh, based on the assumptions included in the Application for Waivers.

However, a direct comparison to the levelized cost of the waiver projects presents challenges because it does not take into account that the PV Project will continue to provide low-cost energy for ten (10) years after the waiver projects' 20-year PPAs terminate. For illustration

purposes, the Company developed a comparison scenario that assumes a proxy 20-year photovoltaic energy PPA followed by 10 years of equivalent energy supplied from firm generation. The firm energy for the last 10 years of the analysis period is assumed to be equal to the energy produced by the Kahe PV Project over that same time period. This enables the two scenarios to be evaluated over the same 30-year period of time. In this analysis, the PPA fixed energy price is a calculated value. It is the value that results in the same approximate 30-year levelized cost of energy for the comparison scenario as that for the Kahe PV Project based on the other assumptions used in the analysisThe resultant cost of the 20-year PPA in this analysis was 14.5 ¢/kWh. The proxy project in this analysis was assumed to have the same technical qualities as the proposed PV Project and is assumed to produce energy at the same rate at the proposed PV Project.

Page 15 of this Exhibit 4 is a summary of the revenue requirement calculations showing the levelized cost comparison analysis results. Page 16 of this Exhibit 4 shows the summary and calculations of the revenue requirements for the proxy PPA system followed by 10 years of firm generation energy production. For both the PV Project and the proxy PPA system, the annual revenue requirements for each year were converted to present values using a discount rate of 8.076%.

Project Assumptions

The project and proxy PPA assumptions supporting the revenue requirement calculations are shown in Table 1 and described below.

TABLE 1 – PROJECT ASSUMPTIONS

Kahe Utility-Scale PV Assumptions	
System Life (except for inverters)	30 years
Initial Capital Cost	$42,400,000
First Year Capacity Factor	19%
Annual Output Degradation	0.5%
Annual Maintenance	$300,000
Maintenance Escalation Factor	2%
Inverter Life	15 years
Inverter Replacement Cost	$4,691,000
Federal Tax Credit	Yes - 30%
State Tax Credit	No

Proxy Power Purchase Agreement	
Contract Life	20 years
O&M Revenue Requirement Factor	9.751%
First Year Capacity Factor	19%
Annual Output Degradation	0.5%
Federal Tax Credit	Yes
State Tax Credit	No

1. System Life & Inverter Life

With the exception of the PV panels and the inverters, the equipment and material to be used in the PV Project (e.g., wires, steel structures, transformers, switchgear) are similar to those commonly used by electric utilities and have proven track records of lasting 30 years or more.

The expected lifetime for PV panels is somewhat speculative, because very few panels have been installed long enough to develop solid data. However, there are many reasons to believe that the PV panels used in this project will last and continue to produce power for 30 years. Most PV panel manufacturers warrant that their panels will continue to produce at least 80% of their original output after 25 years of operation. Although the warranty does not extend beyond 25 years, there is no reason to believe the rate of output degradation will change after 25 years. For example, after 20 years of operation at the LEE-TISO testing centre for PV components at

the University of Applied Sciences of Southern Switzerland, PV panels used at the centre showed signs of yellowing and peeling lamination, but were still providing 89% of their original output. Likewise, the Centre for Alternative Technology in England has experienced similar results after 13 years of operation.[2]

The inverters are expected to be the components with the shortest life span. Theoretically, a perfectly maintained inverter should last 30 years. However, the dust/dirt accumulation of an outdoor-installed inverter, coupled with the high heat generation of the equipment make it difficult to keep them perfectly maintained. Therefore, the financial analysis assumes that all the inverters used for the PV Project will need to be replaced at the 15 year mark.

2. First Year Capacity Factor

The capacity factor of a PV system is dependent upon many factors, such as solar insolence at the system location, equipment efficiencies, how dirty the panels get, panel orientation, wiring losses, and temperature losses. To evaluate all these factors, PV engineers use computer software to calculate the expected output. SolarCity used the "PVsyst" software to evaluate the expected output for the proposed PV Project. The output information received from SolarCity shows an expected first year output of 24,978 MWh, which equates to a 19% capacity factor. The output information is attached hereto as Exhibit 5. Based on this information, the initial capacity factor of 19% has been used in the financial analysis for the PV Project.

3. Annual Output Degradation

For crystalline modules like the ones proposed for this PV Project, the panels will likely suffer some degradation in the amount of energy they can produce. This degradation can be caused by several factors including irreversible light-induced degradation, discoloration or haze

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[2] The information about LEE-TISO and the Centre for Alternative Technology (CAT) was obtained from the CAT webpage (http://info.cat.org.uk/questions/pv/life-expectancy-solar-PV-panels).

of the encapsulant or glass, lamination defects, cell contact breakdown, and wiring degradation. The amount of this degradation typically ranges between 0.3% and 1.0% per year. For crystalline modules, a generic degradation rate of 0.5% per year is often considered applicable. This is consistent with the results of the National Renewable Energy Laboratory report "Photovoltaic Degradation Rates – An Analytical Review" published in June 2012[3]. Therefore, the financial analysis for this project uses an annual degradation value of 0.5%.

4. <u>Annual Maintenance</u>

Periodic maintenance of a PV system will include tests and inspections for inverters, panels and transformers, cleaning and washing for inverters and arrays, and warranty services. Although Hawaiian Electric has not yet determined who will provide maintenance services for the PV Project, a bid price was obtained from SolarCity for its cost of providing maintenance services. The SolarCity bid for the first year of maintenance is $[redacted].

In addition to the PV system maintenance, the PV Project will also require site maintenance activities such as ground cover control, road upkeep, fence repairs, and lighting maintenance. For this portion, the financial analysis assumed a total of $104,000 for the first year.

The total estimated amount for the above mentioned maintenance is $300,000. Each subsequent year will require the same level of maintenance at an equivalent cost of $300,000, assumed to escalate at 2% per year.

5. <u>Inverter Replacement Cost</u>

The financial analysis assumes replacement of all 12 inverters at year 15 for a total of $6.25M. This number was derived by estimating the cost to purchase and install the 12 inverters in 2013, and then escalating the total cost at 3% per year for 15 years.

The SolarCity bid included inverter spare pricing at $[redacted] per inverter. With a total of 12

[3] A copy of this report can be obtained at http://www.nrel.gov/docs/fy12osti/51664.pdf

inverters planned for the PV Project, the total equipment replacement cost in 2013 dollars would be $[redacted]. The labor cost to install replacement inverters (in 2013 dollars) is estimated at approximately $[redacted]. Therefore, the total cost in 2013 dollars (equipment plus labor) for replacement of the inverters is $3.5M. Escalating this cost for 15 years at 2% per year results in a total cost for replacement of $4.69M.

6. Federal Tax Credit

The current 35% Federal investment tax credit, scheduled to lapse at the end of 2016, is assumed in the financial analysis to be available to Hawaiian Electric. The full value of this tax credit will be passed on to Hawaiian Electric's customers.

7. State Tax Credit

Due to the uncertainty of whether Hawai'i state tax credits will be available at the time the PV Project goes into service, no Hawai'i state tax credits were assumed in the financial analysis. However, to the extent that Hawai'i state tax credits are available to Hawaiian Electric, their full value will be passed on to customers.

Financial Assumptions

The financial assumptions supporting the revenue requirement calculations are described below.

The following describe in more detail the individual components contained within the revenue requirement calculation for the proposed PV Project.

1. General Assumptions

Generally, certain simplifying assumptions are made in all revenue requirement calculations. While an attempt is made to accurately model the revenue requirement calculation to match the project, it is not always possible to accurately capture the realities surrounding any particular

project. The revenue requirement calculation is based on the most recently available project estimates and assumptions.

Revenue requirement calculations are generally modeled to provide annual revenue requirements over the estimated service life of the project or capital investment and utilize the annual average rate base. Use of an average rate base, which is the average of the beginning of year and ending of year balance, is consistent with the methodology employed in rate cases and generally used in most revenue requirement calculations. The use of an annual average rate base helps account for variations in the timing of events happening within a year and helps simplify the mechanics of the calculation.

2. Accounting, Tax and Ratemaking Treatment

The revenue requirements calculation will generally model the expected accounting, tax and ratemaking treatment expected for the project or capital investment. This is based on the current tax and accounting rules and the expected ratemaking treatment determined for the project or capital investment at that time.

3. Capital Structure and Financing Costs

The capital structure used in the PV Project revenue requirement calculation assumes financing of 3% short-term debt, 39% long-term taxable debt, 1% preferred stock and the remaining 57% common stock. The costs to finance are assumed as 4% for short-term debt, 7% for long-term taxable debt, 6.5% for preferred stock and 11% for common stock. This results in a weighted average cost of capital of 9.185% and an after-tax weighted average cost of capital of 8.076%. The Companies generally utilize this capital structure for long-term planning purposes. It is based on the Companies' forecast of the incremental capital costs on average over 10+ years.

4. Income Taxes

The Companies assumed a federal tax rate of 35% (32.89% effective) and a state tax rate of 6.4% (6.02% effective). The total effective tax rate assumed is 38.91%.

5. Revenue Taxes

The Companies are subject to the following revenue taxes: 1) Public Service Company Tax of 5.885%; 2) Franchise Tax of 0.5%; and 3) Public Utility Fee of 2.5%. This results in a composite revenue tax rate of 8.885%.

6. Capital Investment and Return on Investment –

The capital investments in the PV Project are assumed to be placed in rate base in the year they are deemed "used or useful". The return on investment is based on the average net capital investment in rate base and the assumed capital structure and costs of financing as previously discussed.

7. Book Depreciation

Depreciation allows for the return of the capital investment in rate base. Depreciation begins in the year after the capital investment is assumed to be placed in service. This is consistent with the current methodology followed by the Companies for book accounting purposes. For the revenue requirement calculation book depreciation is calculated on a straight-line basis based on the capital investment and the estimated service life of the capital investment. The estimated service life assumed in the revenue requirement calculation may differ from the actual book depreciation rates used.

8. Tax Depreciation

For tax purposes, depreciation begins in the year the capital investment is assumed to be placed in service. This is consistent with the current tax treatment of capital investments. Tax

depreciation is calculated based on the capital investment and the tax depreciation rates applicable to that particular capital investment. Accelerated tax depreciation is available for capital investments that are not financed with tax exempt revenue bonds. The revenue requirement model adjusts the tax depreciation calculation to take into account the proposed capital structure and any assumed tax exempt revenue bond financing. There is no tax exempt revenue bond financing in the capital structure so accelerated tax depreciation is available for this project.

9. Project Expenses

Project expenses are recognized and recorded in the year they're incurred. This is consistent with the current methodology followed by the Companies for book accounting purposes.

10. Deferred Income Taxes

A deferred tax asset or liability represents the increase or decrease in taxes payable or refundable in future years as a result of temporary differences in the current year. In the revenue requirement calculation the primary temporary difference which drives the deferred taxes is the difference in the book and tax treatment of depreciation and the difference in the book and tax treatment of the State Investment Tax Credit and the Federal Investment Tax Credit. In each year the differences in the annual book depreciation and tax depreciation are determined and the effective income tax rate is applied to determine the deferred income tax.

11. State Investment Tax Credit

A 4% State Investment Tax Credit is available for capital investments. For book accounting purposes, this credit is deferred with future recognition based on straight line annual amortization of the deferred balance at the book depreciation rate of the capital investment. In effect, the recognition of the credit is deferred in order to match the use of the capital investment which is

based on the straight line book depreciation. For tax purposes, this credit is taken in the year in which the capital investment is made and the utility asset is placed in service. This results in a temporary difference and a related deferred income tax asset.

12. Federal Renewable Energy Tax Credit

A 30% Federal Investment Tax Credit is available for capital investments made in eligible renewable energy projects. This project is considered eligible for this tax credit and the related impacts are reflected in the revenue requirement calculation. The credit is deferred with future recognition based on a straight line annual amortization of the deferred balance at the book depreciation rate of the capital investment. In effect, the recognition of the tax credit is deferred in order to match the use of the capital investment which is based on the straight line book depreciation.

13. Rebalancing Costs on PPA Payments

Hawaiian Electric assumed the payments it would make under a fixed price PPA are for energy purchases only. While there would be no recorded liability for the long-term payments, credit rating agencies would reflect these obligations as imputed debt in the ratios used to evaluate the Company's risk profile. Standard & Poor's ("S&P"), on May 7, 2007, published an article titled "Standard & Poor's Methodology For Imputing Debt For U.S. Utilities' Power Purchase Agreements." In this article, S&P described that for PPAs with energy purchases only, they consider "an implied capacity price that funds the recovery of the supplier's capital investment to be subsumed within the all-in energy price." S&P determines an implied capacity payment for the PPA in order to calculate imputed debt.[4]

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[4] "The pricing for some PPA contracts is stated as a single, all-in energy price. Standard & Poor's considers an implied capacity price that funds the recovery of the supplier's capital investment to be subsumed within the all-in energy price. Consequently, the Company used a proxy capacity charge, stated in $/kW, to calculate an implied

Hawaiian Electric prepared estimates of the imputed debt and rebalancing costs based on S&P's methodology as described. This rebalancing cost was included in the total revenue requirement and is consistent with the Companies treatment of all its PPAs.

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capacity payment associated with the PPA. The $/kW figure is multiplied by the number of kilowatts under contract. In cases of resources such as wind power that exhibit very low capacity factors, the Company will adjust the kilowatts under contract to reflect the anticipated capacity factor that the resource is expected to achieve.

The Company derives the proxy cost of capacity using empirical data evidencing the cost of developing new peaking capacity. The Company will reflect regional differences in our analysis. The cost of new capacity is translated into a $/kW figure using a weighted average cost of capital and a proxy capital recovery period. This number will be updated from time to time to reflect prevailing costs for the development and financing of the marginal unit, a combustion turbine."

30-Year Levelized Cost of Energy ("LCOE")
Kahe Utility-Scale PV Project

	Kahe Utility Scale PV Project (PV Project) 30-Year Life
Accumulated Present Value of Revenue Requirements (APVRR) over 30-Year Life of Project [A]	$47,150,249
Discounted Energy Produced by PV System (kWh) [B]	266,293,349
Revenue Tax Adjustment Factor [C]	1.09751
30-Year LCOE (¢/kWh) [A*100/(B*C)]	16.133

Assumptions:

System Size (kW)	15,000
Capacity Factor	19%
Annual Output Degradation	0.5%
Initial Capital Cost for PV Project ($/Watt)	2.827
Inverter Replacemenet Cost in Year 15 for PV Project	$4,691,390
First Year O&M for PV Project ($/kW)	20
O&M Esclation Factor	2.0%

Note: See page 14 of Exhibit 4 for calculations of [A] and [B]

Calculation of 30-Year Levelized Cost of Energy ("LCOE") for the Kahe Utility-Scale PV Project

Price per Watt	$2.83	A
Discount Rate	8.076%	B
Revenue Tax Factor	9.751%	C

Size (kw)	15,000	D
Capacity Factor	19%	E
Annual Degradation	0.5%	F

				Entire System Except Inverters			Inverters - First Set	Inverters - Second Set	Project Totals		
System Year	Present Value Factor	KWH	Discounted KWH	O&M Revenue Requirements	Capital Revenue Requirements	Total Revenue Requirements	Capital Revenue Requirements	Capital Revenue Requirements	Total Revenue Requirements	Present Value of Revenue Requirements	Accumulated Present Value of Revenue Requirements (APVRR)
G	H	J	K	L	M	N	O	P	Q	R	S
	=1/(1+B)^G	= (D*8760*E)*(1-(G-1)*F))	= H*J			= L+M			=N+O+P	=H*Q	
1	0.9253	24,966,000	23,100,411	$329,254	$2,644,155	$2,973,409	$153,313	$0	$3,126,722	$2,893,077.09	$2,893,077.09
2	0.8561	24,841,170	21,267,357	$335,839	$5,757,554	$6,093,393	$382,102	$0	$6,475,495	$5,543,887.99	$8,436,965.08
3	0.7922	24,716,340	19,579,264	$342,556	$5,135,906	$5,478,462	$338,025	$0	$5,816,487	$4,607,580.95	$13,044,546.03
4	0.7330	24,591,510	18,024,704	$349,407	$4,711,197	$5,060,604	$305,367	$0	$5,365,971	$3,933,066.33	$16,977,612.36
5	0.6782	24,466,680	16,593,146	$356,395	$4,360,340	$4,716,735	$276,991	$0	$4,993,726	$3,386,713.01	$20,364,325.37
6	0.6275	24,341,850	15,274,887	$363,523	$4,064,872	$4,428,395	$251,826	$0	$4,680,221	$2,936,910.99	$23,301,236.37
7	0.5806	24,217,020	14,060,989	$370,794	$3,880,182	$4,250,976	$233,085	$0	$4,484,061	$2,603,554.50	$25,904,790.87
8	0.5372	24,092,190	12,943,215	$378,210	$3,750,881	$4,129,091	$217,555	$0	$4,346,646	$2,335,178.97	$28,239,969.84
9	0.4971	23,967,360	11,913,979	$385,774	$3,621,580	$4,007,354	$202,025	$0	$4,209,379	$2,092,447.96	$30,332,417.80
10	0.4599	23,842,530	10,966,290	$393,489	$3,492,280	$3,885,769	$186,496	$0	$4,072,265	$1,873,024.27	$32,205,442.07
11	0.4256	23,717,700	10,093,707	$401,359	$3,362,979	$3,764,338	$170,966	$0	$3,935,304	$1,674,774.72	$33,880,216.80
12	0.3938	23,592,870	9,290,298	$409,386	$3,233,678	$3,643,064	$155,436	$0	$3,798,500	$1,495,756.78	$35,375,973.57
13	0.3644	23,468,040	8,550,596	$417,574	$3,104,377	$3,521,951	$139,906	$0	$3,661,857	$1,334,200.09	$36,710,173.67
14	0.3371	23,343,210	7,869,568	$425,925	$2,975,077	$3,401,002	$124,377	$0	$3,525,379	$1,188,491.65	$37,898,665.32
15	0.3119	23,218,380	7,242,575	$434,444	$2,845,775	$3,280,219	$108,847	$0	$3,389,066	$1,057,160.89	$38,955,826.21
16	0.2886	23,093,550	6,665,343	$443,133	$2,716,474	$3,159,607	$0	$305,536	$3,465,143	$1,000,121.95	$39,955,948.16
17	0.2671	22,968,720	6,133,937	$451,996	$2,587,173	$3,039,169	$0	$907,505	$3,946,674	$1,053,983.45	$41,009,931.60
18	0.2471	22,843,890	5,644,732	$461,035	$2,457,873	$2,918,908	$0	$811,190	$3,730,098	$921,708.33	$41,931,639.94
19	0.2286	22,719,060	5,194,388	$470,256	$2,328,572	$2,798,828	$0	$741,995	$3,540,823	$809,558.48	$42,741,198.42
20	0.2116	22,594,230	4,779,828	$479,661	$2,199,271	$2,678,932	$0	$682,971	$3,361,903	$711,213.39	$43,452,411.81
21	0.1957	22,469,400	4,398,220	$489,254	$2,069,971	$2,559,225	$0	$631,574	$3,190,799	$624,575.48	$44,076,987.29
22	0.1811	22,344,570	4,046,954	$499,040	$1,940,669	$2,439,709	$0	$595,432	$3,035,141	$549,711.84	$44,626,699.14
23	0.1676	22,219,740	3,723,625	$509,020	$1,811,369	$2,320,389	$0	$566,919	$2,887,308	$483,860.39	$45,110,559.53
24	0.1551	22,094,910	3,426,020	$519,201	$1,682,067	$2,201,268	$0	$538,405	$2,739,673	$424,811.66	$45,535,371.19
25	0.1435	21,970,080	3,152,101	$529,585	$1,552,766	$2,082,351	$0	$509,891	$2,592,242	$371,915.24	$45,907,286.43
26	0.1328	21,845,250	2,899,988	$540,176	$1,423,466	$1,963,642	$0	$481,377	$2,445,019	$324,579.74	$46,231,866.17
27	0.1228	21,720,420	2,667,953	$550,980	$1,294,165	$1,845,145	$0	$452,863	$2,298,008	$282,267.87	$46,514,134.04
28	0.1137	21,595,590	2,454,402	$562,000	$1,164,864	$1,726,864	$0	$424,350	$2,151,214	$244,491.78	$46,758,625.82
29	0.1052	21,470,760	2,257,869	$573,240	$1,035,563	$1,608,803	$0	$395,836	$2,004,639	$210,808.23	$46,969,434.05
30	0.0973	21,345,930	2,077,003	$584,704	$906,263	$1,490,967	$0	$367,322	$1,858,289	$180,815.38	$47,150,249.43
	Total	**694,678,950**	**266,293,349** T			**$97,468,569**	**$3,246,317**	**$8,413,166**	**$109,128,052**	**$47,150,249** U	

Note: See pages 18 through 23 of Exhibit 4 for details of revenue requirement calculations

APVRR/kWh V = U/T **$0.1771**

Comparison of 30-Year Levelized Cost of Energy ("LCOE")
Kahe PV Project (30-Year Life)
&
20-Year Proxy Power Purchase Agreement ("PPA") @ 14.5¢/kWh + 10 Years of Energy Supplied by Firm Generation

Time Span	Kahe Utility Scale PV Project (PV Project) 30 Years	Proxy 20-Year PPA + 10 Years of Firm Generation 30 Years
Accululated Present Value of Revenue Requirements (APVRR) [A]	$47,150,249	$47,151,240
Discounted Energy Produced (kWh) [B]	266,293,349	266,293,349
Revenue Tax Adjustment Factor [C]	1.09751	1.09751
30-Year LCOE (¢/kWh) [A*100/(B*C)]	16.133	16.133

Assumptions:

System Size (kW)	15,000
Capacity Factor	19%
Annual Output Degradation	0.5%
Initial Capital Cost for PV Project ($/Watt)	2.8266
Inverter Replacemenet Cost in Year 15 for PV Project	$4,691,390
First Year O&M for PV Project ($/kW)	20
O&M Esclation Factor	2.0%
20-Year PPA Fixed Energy Cost (¢/kWh)	
Note 1	**14.540**

Note 1 - The PPA fixed energy cost is a calculated value. This is the value that results in the same approximate 30-year LCOE as the Kahe PV Project based on the other assumptions used in the analysis

Note 2 - This analysis assumes that after the 20-year PPA expires, firm generation is used to produce the energy for the next 10 years. The firm energy for those 10 years in the analysis are assumed to be equal to the energy produced by the Kahe PV Project over that same time period.

Note 3: See page 14 of Exhibit 4 for calculations of [A] and [B] for the Kahe PV Project

Note 4: See page 16 of Exhibit 4 for calculations of [A] and [B] for the 20-Year PPA + 10 years of firm generation

Calculation of Comparison 30-Year Levelized Cost of Energy ("LCOE")
20-Year Photovoltaic System Power Purchase Agreement + 10 Years of Energy Supplied by Firm Generation

PPA Payment Rate ($/kWh)	$0.1454	A
Discount Rate	8.076%	B
Revenue Tax Factor	9.751%	C

Size (kw)	15,000	E
Capacity Factor	19%	F
Annual Degradation	0.5%	G

Year	System Year	Present Value Factor	KWH	Discounted kWh
	H	J	K	L
		=1/(1+B)^H	= (E*8760*F)*(1-(H-1)*G))	=H*J
2016	1	0.9253	24,966,000	23,100,411
2017	2	0.8561	24,841,170	21,267,357
2018	3	0.7922	24,716,340	19,579,264
2019	4	0.7330	24,591,510	18,024,704
2020	5	0.6782	24,466,680	16,593,146
2021	6	0.6275	24,341,850	15,274,887
2022	7	0.5806	24,217,020	14,060,989
2023	8	0.5372	24,092,190	12,943,215
2024	9	0.4971	23,967,360	11,913,979
2025	10	0.4599	23,842,530	10,966,290
2026	11	0.4256	23,717,700	10,093,707
2027	12	0.3938	23,592,870	9,290,298
2028	13	0.3644	23,468,040	8,550,596
2029	14	0.3371	23,343,210	7,869,568
2030	15	0.3119	23,218,380	7,242,575
2031	16	0.2886	23,093,550	6,665,343
2032	17	0.2671	22,968,720	6,133,937
2033	18	0.2471	22,843,890	5,644,732
2034	19	0.2286	22,719,060	5,194,388
2035	20	0.2116	22,594,230	4,779,828
2036	21	0.1957	22,469,400	4,398,220
2037	22	0.1811	22,344,570	4,046,954
2038	23	0.1676	22,219,740	3,723,625
2039	24	0.1551	22,094,910	3,426,020
2040	25	0.1435	21,970,080	3,152,101
2041	26	0.1328	21,845,250	2,899,988
2042	27	0.1228	21,720,420	2,667,953
2043	28	0.1137	21,595,590	2,454,402
2044	29	0.1052	21,470,760	2,257,869
2045	30	0.0973	21,345,930	2,077,003
		Totals	**475,602,300**	**266,293,349**
				U

PPA Payment	Rebalancing Costs	Total Revenue Requirement for PPA	Firm Generation Cost ($/kWh) Note 1	Firm Generation Cost ($)	Revenue Requirement for Firm Generation	Total Revenue Requirement	Present Value of Revenue Requirements	Accumulated Present Value of Revenue Requirements (APVRR)
M	N	O	D	P	Q	R	S	T
= A *K		= (M +N) * (1+C)		= D*K	= P*(1+C)	= O+Q	= R*J	
$3,630,056	$112,224	$4,107,190				$4,107,190	$3,800,280	$3,800,280
$3,611,906	$109,038	$4,083,773				$4,083,773	$3,496,255	$7,296,535
$3,593,756	$105,661	$4,060,147				$4,060,147	$3,216,281	$10,512,816
$3,575,606	$102,082	$4,036,299				$4,036,299	$2,958,464	$13,471,279
$3,557,455	$98,288	$4,012,215				$4,012,215	$2,721,058	$16,192,338
$3,539,305	$94,266	$3,987,880				$3,987,880	$2,502,457	$18,694,794
$3,521,155	$90,003	$3,963,282				$3,963,282	$2,301,177	$20,995,972
$3,503,004	$85,484	$3,938,402				$3,938,402	$2,115,855	$23,111,827
$3,484,854	$83,159	$3,915,930				$3,915,930	$1,946,577	$25,058,404
$3,466,704	$83,159	$3,896,010				$3,896,010	$1,791,956	$26,850,360
$3,448,554	$83,159	$3,876,090				$3,876,090	$1,649,575	$28,499,935
$3,430,403	$83,159	$3,856,170				$3,856,170	$1,518,466	$30,018,401
$3,412,253	$83,159	$3,836,250				$3,836,250	$1,397,740	$31,416,141
$3,394,103	$83,159	$3,816,330				$3,816,330	$1,286,578	$32,702,719
$3,375,952	$83,159	$3,796,409				$3,796,409	$1,184,225	$33,886,944
$3,357,802	$83,159	$3,776,489				$3,776,489	$1,089,984	$34,976,927
$3,339,652	$83,159	$3,756,569				$3,756,569	$1,003,215	$35,980,142
$3,321,502	$83,159	$3,736,649				$3,736,649	$923,327	$36,903,469
$3,303,351	$83,159	$3,716,729				$3,716,729	$849,777	$37,753,246
$3,285,201	$83,159	$3,696,809				$3,696,809	$782,063	$38,535,309
			$0.234	$5,249,651	$5,761,544	$5,761,544	$1,127,780	$39,663,089
			$0.238	$5,324,896	$5,844,126	$5,844,126	$1,058,463	$40,721,552
			$0.243	$5,401,051	$5,927,707	$5,927,707	$993,376	$41,714,929
			$0.248	$5,478,122	$6,012,293	$6,012,293	$932,262	$42,647,190
			$0.253	$5,556,115	$6,097,892	$6,097,892	$874,879	$43,522,070
			$0.258	$5,635,037	$6,184,510	$6,184,510	$821,002	$44,343,072
			$0.263	$5,714,894	$6,272,153	$6,272,153	$770,418	$45,113,490
			$0.268	$5,795,691	$6,360,829	$6,360,829	$722,927	$45,836,417
			$0.274	$5,877,433	$6,450,542	$6,450,542	$678,340	$46,514,757
			$0.279	$5,960,128	$6,541,300	$6,541,300	$636,482	$47,151,240
$69,152,574	**$1,794,954**	**$77,865,622**		**$55,993,018**	**$61,452,897**	**$139,318,519**	**$47,151,240**	
							V	

APVRR/kWh	**$0.1771**
W	
=V/U	
LCOE	**$0.1613**
X	
=W/(1+C)	

Note 1: See page 17 of Exhibit 4 for calculation of firm generation cost

Estimated Firm Generation Costs for Years 2036 through 2045

Year	LNG Fuel Cost ($/Mbtu) Note 1 IRP Reference Forecast	Future Years Forecast Note 2	Estimated Heat Rate (Btu/kWh) Note 3	Cost of Generation ($/kWh)
2012	N/A			
2013	N/A			
2014	N/A			
2015	N/A			
2016	N/A			
2017	N/A			
2018	16.38			
2019	16.38			
2020	16.38			
2021	16.82			
2022	17.40			
2023	17.87			
2024	18.29			
2025	18.65			
2026	19.21			
2027	19.73			
2028	19.96			
2029	20.11			
2030	25.64			
2031	26.28			
2032	26.97			
2033	27.52			
2034		28.07		
2035		28.63		
2036		29.20	8,000	0.2336
2037		29.79	8,000	0.2383
2038		30.38	8,000	0.2431
2039		30.99	8,000	0.2479
2040		31.61	8,000	0.2529
2041		32.24	8,000	0.2580
2042		32.89	8,000	0.2631
2043		33.55	8,000	0.2684
2044		34.22	8,000	0.2737
2045		34.90	8,000	0.2792

"LNG" - Liquefied Natural Gas

Note 1 - For purposes of this analysis, it is assumed that LNG will available for firm generation in years 2034 thru 2045.

Note 2 - The IRP fuel forecast ends in 2033. Future year LNG prices for this evaluation are assumed to escalate at 2% per year

Note 3 - The For purposes of this analysis, a simplified assumption of heat rate consistent with combined-cycle generation is used for years 2034 and beyond

Kahe Utility-Scale PV Project
Project Assumptions

USER INPUT

Cost of Capital Assumptions:	Weight	Rate	Weighted Average	After-Tax Weighted Avg.
ST Debt	3.00%	4.00%	0.120%	0.073%
LT Debt (Taxable)	39.00%	7.00%	2.730%	1.668%
Hybrids	0.00%	6.50%	0.000%	0.000%
Preferred Stock	1.00%	6.50%	0.065%	0.065%
Common Stock	57.00%	11.00%	6.270%	6.270%
			9.185%	8.076%

Tax Assumptions:		
Federal	35.00%	32.89%
State	6.40%	6.02%
		38.91%

Public Service Company Tax	5.885%	(on gross receipts)
PUC Fee	0.500%	(on gross receipts)
Franchise Tax	2.500%	(on electricity sales)
Revenue Tax Rate	8.885%	

Tax Assumptions

State Investment Tax Credit (ITC)	4.000%	
State Renewable Energy Technologies Income Tax Credit (RETITC)	30.000%	
Number of Systems	0	
(limited to $500,000 per System)	-	
Federal Tax Credit	30.000%	

Depreciation

Expected Useful Life (less than 30)	30
MACRS Tax Life ("Tax Life")	5
Tax Class Life ("Class Life")	12

Capital Cost	$ 40,078,835	
Price per Watt	$ 2.83	Input on Summary

O&M Expenses

O&M per kw in Year 1	$ 20.00	
O&M Start Year (after warranty)	1	

PV System Output

System Size (kw)	15,000	Input on Summary
Capacity Factor	19%	
Hours per Year	1,664	
Annual production in Year 1 (kwh)	24,966,000	
Annual Degradation in PV output	0.50%	
Annual Escalation Rate for O&M Expense	2.00%	

Kahe Utility-Scale PV Project
Complete System Except Inverters

System Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total
PV System Assumptions																																
O&M Rate ($/kwh)	$ 20.0000	20.0000	20.4000	20.8080	21.2242	21.6486	22.0816	22.5232	22.9737	23.4332	23.9019	24.3799	24.8675	25.3648	25.8721	26.3896	26.9174	27.4557	28.0048	28.5649	29.1362	29.7189	30.3133	30.9196	31.5380	32.1687	32.8121	33.4684	34.1377	34.8205	35.5169	
Escalation Factor	2.00%	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61	1.64	1.67	1.71	1.74	1.78	
PV System Output	24,966,000	24,966,000	24,841,170	24,716,340	24,591,510	24,466,680	24,341,850	24,217,020	24,092,190	23,967,360	23,842,530	23,717,700	23,592,870	23,468,040	23,343,210	23,218,380	23,093,550	22,968,720	22,843,890	22,719,060	22,594,230	22,469,400	22,344,570	22,219,740	22,094,910	21,970,080	21,845,250	21,720,420	21,595,590	21,470,760	21,345,930	694,678,950
Annual Output Reduction Factor	0.50%	1.00	0.995	0.990	0.985	0.980	0.975	0.970	0.965	0.960	0.955	0.950	0.945	0.940	0.935	0.930	0.925	0.920	0.915	0.910	0.905	0.900	0.895	0.890	0.885	0.880	0.875	0.870	0.865	0.860	0.855	
O&M Expense (based on $/kw)	15000	300,000	306,000	312,120	318,362	324,730	331,224	337,849	344,606	351,498	358,528	365,698	373,012	380,473	388,082	395,844	403,761	411,836	420,072	428,474	437,043	445,784	454,700	463,794	473,070	482,531	492,182	502,025	512,066	522,307	532,753	12,170,424
Capital Cost		40,078,835																														
Tax Basis	6,011,825	34,067,010																														
Book Depreciation																																
Book Depreciation Rates		0.000%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	100.0%
Depreciation Expense		-	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	40,078,835
Accumulated Depreciation		-	1,382,029	2,764,058	4,146,086	5,528,115	6,910,144	8,292,173	9,674,202	11,056,230	12,438,259	13,820,288	15,202,317	16,584,346	17,966,374	19,348,403	20,730,432	22,112,461	23,494,489	24,876,518	26,258,547	27,640,576	29,022,605	30,404,633	31,786,662	33,168,691	34,550,720	35,932,749	37,314,777	38,696,806	40,078,835	
Book Depreciation - Tax Basis																																
Book Depreciation Rates		0.000%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	3.448%	100.0%
Depreciation Expense		-	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	1,174,724	34,067,010
Accumulated Depreciation		-	1,174,724	2,349,449	3,524,173	4,698,898	5,873,622	7,048,347	8,223,071	9,397,796	10,572,520	11,747,245	12,921,969	14,096,694	15,271,418	16,446,143	17,620,867	18,795,592	19,970,316	21,145,041	22,319,765	23,494,489	24,669,214	25,843,938	27,018,663	28,193,387	29,368,112	30,542,836	31,717,561	32,892,285	34,067,010	
Tax Depreciation																																
Tax Depreciation Rates (Straight Line)		4.170%	8.330%	8.330%	8.330%	8.330%	8.330%	8.340%	8.330%	8.340%	8.330%	8.340%	8.330%	4.170%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%
Revenue Bond Financed Tax Basis (S/L)	0.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax Depreciation Rates (MACRS)		20.000%	32.000%	19.200%	11.520%	11.520%	5.760%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%
NonRB Financed Tax Basis (MACRS)	100.00%	6,813,402	10,901,443	6,540,866	3,924,520	3,924,520	1,962,260	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34,067,010
Tax Depreciation		6,813,402	10,901,443	6,540,866	3,924,520	3,924,520	1,962,260	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34,067,010
Accumulated Tax Depreciation		6,813,402	17,714,845	24,255,711	28,180,230	32,104,750	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	
Federal Tax Basis Adjustment For Energy Tax Credit																																
50% of Amortization of Federal Tax Credit		-	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	207,304	
Federal Tax Rate		35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	
Federal Tax Incr (Decr)		-	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	72,557	
Gross Up of Federal Tax Incr (Decr)		-	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	
State Investment Tax Credit (ITC)																																
Book																																
State ITC Amortization Rate		0.00%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	100.0%
Amortization of State ITC		-	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	1,603,153
Accumulated Amortization		-	55,281	110,562	165,843	221,125	276,406	331,687	386,968	442,249	497,530	552,812	608,093	663,374	718,655	773,936	829,217	884,498	939,780	995,061	1,050,342	1,105,623	1,160,904	1,216,185	1,271,466	1,326,748	1,382,029	1,437,310	1,492,591	1,547,872	1,603,153	
Deferred ITC		1,603,153	1,547,872	1,492,591	1,437,310	1,382,029	1,326,748	1,271,466	1,216,185	1,160,904	1,105,623	1,050,342	995,061	939,780	884,498	829,217	773,936	718,655	663,374	608,093	552,812	497,530	442,249	386,968	331,687	276,406	221,125	165,843	110,562	55,281	0	
Tax		1,603,153																														1,603,153
State Renewable Energy Technologies Income Tax Credit (RETITC)																																
Book																																
RETITC Amortization Rate		0.00%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	100.0%
Amortization of RETITC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated Amortization		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Deferred RETITC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tax		-																														
Federal Tax Credit (FTC) - Not in Rate Base																																
Book																																
FTC Amortization Rate		0.00%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	100.0%
Amortization of FTC (Credit)		-	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	414,609	12,023,651
Accumulated Amortization		-	414,609	829,217	1,243,826	1,658,435	2,073,043	2,487,652	2,902,260	3,316,869	3,731,478	4,146,086	4,560,695	4,975,304	5,389,912	5,804,521	6,219,130	6,633,738	7,048,347	7,462,955	7,877,564	8,292,173	8,706,781	9,121,390	9,535,999	9,950,607	10,365,216	10,779,825	11,194,433	11,609,042	12,023,651	
Deferred FTC		12,023,651	11,609,042	11,194,433	10,779,825	10,365,216	9,950,607	9,535,999	9,121,390	8,706,781	8,292,173	7,877,564	7,462,955	7,048,347	6,633,738	6,219,130	5,804,521	5,389,912	4,975,304	4,560,695	4,146,086	3,731,478	3,316,869	2,902,260	2,487,652	2,073,043	1,658,435	1,243,826	829,217	414,609	0	
FTC Gross-Up - Include in Rate Base																																
Deferred Tax Asset (Debit)		7,658,140	7,394,067	7,129,993	6,865,919	6,601,845	6,337,771	6,073,698	5,809,624	5,545,550	5,281,476	5,017,402	4,753,329	4,489,255	4,225,181	3,961,107	3,697,033	3,432,960	3,168,886	2,904,812	2,640,738	2,376,664	2,112,590	1,848,517	1,584,443	1,320,369	1,056,295	792,221	528,148	264,074	0	
Reg. Liability Amortization Rate		0.00%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	3.45%	100.0%
Reg. Liability Amortization(Credit)		-	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	264,074	7,658,140
Reg. Liability Balance (Credit)		7,658,140	7,394,067	7,129,993	6,865,919	6,601,845	6,337,771	6,073,698	5,809,624	5,545,550	5,281,476	5,017,402	4,753,329	4,489,255	4,225,181	3,961,107	3,697,033	3,432,960	3,168,886	2,904,812	2,640,738	2,376,664	2,112,590	1,848,517	1,584,443	1,320,369	1,056,295	792,221	528,148	264,074	(0)	
Deferred Tax Calculation																																
Book Accumulated Depreciation		-	1,174,724	2,349,449	3,524,173	4,698,898	5,873,622	7,048,347	8,223,071	9,397,796	10,572,520	11,747,245	12,921,969	14,096,694	15,271,418	16,446,143	17,620,867	18,795,592	19,970,316	21,145,041	22,319,765	23,494,489	24,669,214	25,843,938	27,018,663	28,193,387	29,368,112	30,542,836	31,717,561	32,892,285	34,067,010	
Tax Accumulated Depreciation		6,813,402	17,714,845	24,255,711	28,180,230	32,104,750	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	34,067,010	
Book/Tax Acc Depr Difference		(6,813,402)	(16,540,121)	(21,906,262)	(24,656,057)	(27,405,852)	(28,193,387)	########	########	########	########	########	########	########	########	(17,620,867)	(16,446,143)	(15,271,418)	(14,096,694)	(12,921,969)	(11,747,245)	(10,572,520)	(9,397,796)	(8,223,071)	(7,048,347)	(5,873,622)	(4,698,898)	(3,524,173)	(2,349,449)	(1,174,724)	-	
Deferred ITC, RETITC		1,603,153	1,547,872	1,492,591	1,437,310	1,382,029	1,326,748	1,271,466	1,216,185	1,160,904	1,105,623	1,050,342	995,061	939,780	884,498	829,217	773,936	718,655	663,374	608,093	552,812	497,530	442,249	386,968	331,687	276,406	221,125	165,843	110,562	55,281	0	
Net Deferred Tax Asset (Liability)		(2,027,296)	(5,833,450)	(7,942,913)	(9,034,362)	(10,125,811)	(10,453,749)	########	(9,582,603)	(9,147,030)	(8,711,457)	(8,275,885)	(7,840,312)	(7,404,739)	(6,969,166)	(6,533,593)	(6,098,020)	(5,662,447)	(5,226,874)	(4,791,302)	(4,355,729)	(3,920,156)	(3,484,583)	(3,049,010)	(2,613,437)	(2,177,864)	(1,742,291)	(1,306,719)	(871,146)	(435,573)	0	
Deferred Tax Base		5,210,249	9,782,000	5,421,423	2,805,076	2,805,076	842,816	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(1,119,443)	(0)
Deferred Taxes - Federal		1,713,898	3,217,763	1,783,363	922,722	922,722	277,242	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	(368,238)	-
Deferred Taxes - State excluding credit		313,398	588,391	326,101	168,726	168,726	50,696	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(67,335)	(0)
Change in Deferred Taxes		2,027,296	3,806,154	2,109,463	1,091,449	1,091,449	327,938	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(435,573)	(0)
Accumulated Deferred Taxes		2,027,296	5,833,450	7,942,913	9,034,362	10,125,811	10,453,749	10,018,176	9,582,603	9,147,030	8,711,457	8,275,885	7,840,312	7,404,739	6,969,166	6,533,593	6,098,020	5,662,447	5,226,874	4,791,302	4,355,729	3,920,156	3,484,583	3,049,010	2,613,437	2,177,864	1,742,291	1,306,719	871,146	435,573	(0)	
	check	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Rate Base and Financing																																
Gross Plant	-	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	40,078,835	
Accumulated Depreciation		-	1,382,029	2,764,058	4,146,086	5,528,115	6,910,144	8,292,173	9,674,202	11,056,230	12,438,259	13,820,288	15,202,317	16,584,346	17,966,374	19,348,403	20,730,432	22,112,461	23,494,489	24,876,518	26,258,547	27,640,576	29,022,605	30,404,633	31,786,662	33,168,691	34,550,720	35,932,749	37,314,777	38,696,806	40,078,835	
Accumulated Deferred ITC, RETITC		1,603,153	1,547,872	1,492,591	1,437,310	1,382,029	1,326,748	1,271,466	1,216,185	1,160,904	1,105,623	1,050,342	995,061	939,780	884,498	829,217	773,936	718,655	663,374	608,093	552,812	497,530	442,249	386,968	331,687	276,406	221,125	165,843	110,562	55,281	0	
Accumulated Deferred Taxes (FTC)		7,658,140	7,394,067	7,129,993	6,865,919	6,601,845	6,337,771	6,073,698	5,809,624	5,545,550	5,281,476	5,017,402	4,753,329	4,489,255	4,225,181	3,961,107	3,697,033	3,432,960	3,168,886	2,904,812	2,640,738	2,376,664	2,112,590	1,848,517	1,584,443	1,320,369	1,056,295	792,221	528,148	264,074	0	
Regulatory Liability (FTC)		7,658,140	7,394,067	7,129,993	6,865,919	6,601,845	6,337,771	6,073,698	5,809,624	5,545,550	5,281,476	5,017,402	4,753,329	4,489,255	4,225,181	3,961,107	3,697,033	3,432,960	3,168,886	2,904,812	2,640,738	2,376,664	2,112,590	1,848,517	1,584,443	1,320,369	1,056,295	792,221	528,148	264,074	(0)	
Accumulated Deferred Taxes (Deprec)		2,027,296	5,833,450	7,942,913	9,034,362	10,125,811	10,453,749	10,018,176	9,582,603	9,147,030	8,711,457	8,275,885	7,840,312	7,404,739	6,969,166	6,533,593	6,098,020	5,662,447	5,226,874	4,791,302	4,355,729	3,920,156	3,484,583	3,049,010	2,613,437	2,177,864	1,742,291	1,306,719	871,146	435,573	(0)	
Ending Net Investment	-	36,448,386	31,315,484	27,879,273	25,461,077	23,042,880	21,388,194	20,497,020	19,605,845	18,714,670	17,823,495	16,932,321	16,041,146	15,149,971	14,258,796	13,367,622	12,476,447	11,585,272	10,694,097	9,802,922	8,911,748	8,020,573	7,129,398	6,238,223	5,347,049	4,455,874	3,564,699	2,673,524	1,782,350	891,175	0	
Average Net Investment		18,224,193	33,881,935	29,597,378	26,670,175	24,251,979	22,215,537	20,942,607	20,051,432	19,160,258	18,269,083	17,377,908	16,486,733	15,595,558	14,704,384	13,813,209	12,922,034	12,030,859	11,139,685	10,248,510	9,357,335	8,466,160	7,574,986	6,683,811	5,792,636	4,901,461	4,010,286	3,119,112	2,227,937	1,336,762	445,587	
Average Financing																																
Short Term Debt	3.00%	546,726	1,016,458	887,921	800,105	727,559	666,466	628,278	601,543	574,808	548,072	521,337	494,602	467,867	441,132	414,396	387,661	360,926	334,191	307,455	280,720	253,985	227,250	200,514	173,779	147,044	120,309	93,573	66,838	40,103	13,368	
Taxable Debt	39.00%	7,107,435	13,213,955	11,542,978	10,401,368	9,458,272	8,664,060	8,167,617	7,820,059	7,472,500	7,124,942	6,777,384	6,429,826	6,082,268	5,734,710	5,387,151	5,039,593	4,692,035	4,344,477	3,996,919	3,649,361	3,301,803	2,954,244	2,606,686	2,259,128	1,911,570	1,564,012	1,216,454	868,895	521,337	173,779	
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Preferred Stock	1.00%	182,242	338,819	295,974	266,702	242,520	222,155	209,426	200,514	191,603	182,691	173,779	164,867	155,956	147,044	138,132	129,220	120,309	111,397	102,485	93,573	84,662	75,750	66,838	57,926	49,015	40,103	31,191	22,279	13,368	4,456	
Common Equity	57.00%	10,387,790	19,312,703	16,870,506	15,202,000	13,823,628	12,662,856	11,937,286	11,429,316	10,921,347	10,413,377	9,905,408	9,397,438	8,889,468	8,381,499	7,873,529	7,365,559	6,857,590	6,349,620	5,841,651	5,333,681	4,825,711	4,317,742	3,809,772	3,301,803	2,793,833	2,285,863	1,777,894	1,269,924	761,954	253,985	
Total Financing		18,224,193	33,881,935	29,597,378	26,670,175	24,251,979	22,215,537	20,942,607	20,051,432	19,160,258	18,269,083	17,377,908	16,486,733	15,595,558	14,704,384	13,813,209	12,922,034	12,030,859	11,139,685	10,248,510	9,357,335	8,466,160	7,574,986	6,683,811	5,792,636	4,901,461	4,010,286	3,119,112	2,227,937	1,336,762	445,587	
Return on Investment																																
Short Term Debt	4.00%	21,869	40,658	35,517	32,004	29,102	26,659	25,131	24,062	22,992	21,923	20,853	19,784	18,715	17,645	16,576	15,506	14,437	13,368	12,298	11,229	10,159	9,090	8,021	6,951	5,882	4,812	3,743	2,674	1,604	535	493,799
Taxable Debt	7.00%	497,520	924,977	808,008	728,096	662,079	606,484	571,733	547,404	523,075	498,746	474,417	450,088	425,759	401,430	377,101	352,772	328,442	304,113	279,784	255,455	231,126	206,797	182,468	158,139	133,810	109,481	85,152	60,823	36,494	12,165	11,233,937
Hybrids	6.50%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Interest Expense		519,389	965,635	843,525	760,100	691,181	633,143	596,864	571,466	546,067	520,669	495,270	469,872	444,473	419,075	393,676	368,278	342,879	317,481	292,083	266,684	241,286	215,887	190,489	165,090	139,692	114,293	88,895	63,496	38,098	12,699	11,727,737
Preferred Dividends	6.50%	11,846	22,023	19,238	17,336	15,764	14,440	13,613	13,033	12,454	11,875	11,296	10,716	10,137	9,558	8,979	8,399	7,820	7,241	6,662	6,082	5,503	4,924	4,344	3,765	3,186	2,607	2,027	1,448	869	290	267,475
Net Income on Common	11.00%	1,142,657	2,124,397	1,855,756	1,672,220	1,520,599	1,392,914	1,313,101	1,257,225	1,201,348	1,145,471	1,089,595	1,033,718	977,842	921,965	866,088	810,212	754,335	698,458	642,582	586,705	530,828	474,952	419,075	363,198	307,322	251,445	195,568	139,692	83,815	27,938	25,801,021
Income Taxes																																
Income Before Pref Dividends		1,154,503	2,146,421	1,874,994	1,689,556	1,536,363	1,407,354	1,326,714	1,270,258	1,213,802	1,157,346	1,100,890	1,044,435	987,979	931,523	875,067	818,611	762,155	705,699	649,243	592,787	536,331	479,875	423,419	366,963	310,508	254,052	197,596	141,140	84,684	28,228	
Income Before Taxes (including tax credits)		1,889,832	3,513,525	3,069,221	2,765,673	2,514,908	2,303,731	2,171,729	2,079,315	1,986,901	1,894,487	1,802,073	1,709,659	1,617,245	1,524,831	1,432,417	1,340,003	1,247,589	1,155,175	1,062,761	970,347	877,933	785,519	693,105	600,691	508,277	415,863	323,449	231,035	138,621	46,207	
ITC, RETITC		-	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	55,281	1,603,153
Income Before Taxes (excluding tax credits)		1,889,832	3,458,244	3,013,940	2,710,391	2,459,627	2,248,450	2,116,448	2,024,034	1,931,620	1,839,206	1,746,792	1,654,378	1,561,964	1,469,550	1,377,136	1,284,722	1,192,308	1,099,894	1,007,480	915,066	822,652	730,238	637,824	545,410	452,996	360,582	268,168	175,754	83,340	(9,074)	
Federal Income Tax		621,655	1,155,765	1,009,612	909,761	827,272	757,806	714,385	683,985	653,586	623,187	592,787	562,388	531,988	501,589	471,190	440,790	410,391	379,992	349,592	319,193	288,794	258,394	227,995	197,596	167,196	136,797	106,398	75,998	45,599	15,200	14,036,882
State Income Tax		113,674	211,340	184,615	166,356	151,273	138,570	130,630	125,072	119,513	113,954	108,395	102,837	97,278	91,719	86,160	80,602	75,043	69,484	63,925	58,367	52,808	47,249	41,691	36,132	30,573	25,014	19,456	13,897	8,338	2,779	2,566,744
ITC, RETITC		-	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(1,603,153)
Total Taxes		735,329	1,311,824	1,138,946	1,020,836	923,264	841,095	789,734	753,776	717,818	681,859	645,901	609,943	573,985	538,027	502,069	466,111	430,153	394,195	358,237	322,279	286,321	250,363	214,404	178,446	142,488	106,530	70,572	34,614	(1,344)	(37,302)	

Kahe Utility-Scale PV Project
Complete System Except Inverters

System Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenue Requirement Calculation															
Revenue Requirement	2,973,409	6,093,393	5,478,462	5,060,604	4,716,735	4,428,395	4,250,976	4,129,091	4,007,354	3,885,769	3,764,338	3,643,064	3,521,951	3,401,002	3,280,219
Revenue Taxes	264,187	541,398	486,761	449,635	419,082	393,463	377,699	366,870	356,053	345,251	334,461	323,686	312,925	302,179	291,447
Income Before Depr, Int, Inc Tax	2,709,221	5,551,995	4,991,701	4,610,970	4,297,653	4,034,932	3,873,277	3,762,221	3,651,301	3,540,518	3,429,876	3,319,378	3,209,026	3,098,823	2,988,772
O&M Expense	300,000	306,000	312,120	318,362	324,730	331,224	337,849	344,606	351,498	358,528	365,698	373,012	380,473	388,082	395,844
Depreciation Expense	-	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029
Amortization Expense	-	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)
Fed Tax Basis Depr Adj	-	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769
Interest Expense	519,389	965,635	843,525	760,100	691,181	633,143	596,864	571,466	546,067	520,669	495,270	469,872	444,473	419,075	393,676
Income Before Income Taxes	1,889,832	3,458,244	3,013,940	2,710,391	2,459,627	2,248,450	2,116,448	2,024,034	1,931,520	1,839,206	1,746,792	1,654,378	1,561,964	1,469,550	1,377,136
Income Taxes - Federal	621,655	1,135,765	1,009,612	909,761	827,272	757,806	714,385	683,965	653,588	623,187	592,787	562,388	531,988	501,589	471,190
Income Taxes - State	113,674	211,340	184,615	166,358	151,273	138,570	130,630	125,072	119,513	113,954	108,395	102,837	97,278	91,718	86,160
ITC, RETITC	-	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)
Total Income Taxes	735,329	1,311,824	1,138,946	1,020,838	923,264	841,095	789,734	753,776	717,818	681,859	645,901	609,943	573,985	538,027	502,069
Preferred Dividends	11,846	22,023	19,238	17,336	15,764	14,440	13,613	13,033	12,454	11,875	11,296	10,716	10,137	9,558	8,979
Net Income for Common	1,142,657	2,124,397	1,855,756	1,672,220	1,520,599	1,392,914	1,313,101	1,257,225	1,201,348	1,145,471	1,089,595	1,033,718	977,842	921,965	866,088
check	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
ROE	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%
Book Income Statement															
Revenues	2,973,409	6,093,393	5,478,462	5,060,604	4,716,735	4,428,395	4,250,976	4,129,091	4,007,354	3,885,769	3,764,338	3,643,064	3,521,951	3,401,002	3,280,219
Revenue Taxes	264,187	541,398	486,761	449,635	419,082	393,463	377,699	366,870	356,053	345,251	334,461	323,686	312,925	302,179	291,447
Net Revenue	2,709,221	5,551,995	4,991,701	4,610,970	4,297,653	4,034,932	3,873,277	3,762,221	3,651,301	3,540,518	3,429,876	3,319,378	3,209,026	3,098,823	2,988,772
O&M Expense	300,000	306,000	312,120	318,362	324,730	331,224	337,849	344,606	351,498	358,528	365,698	373,012	380,473	388,082	395,844
Depreciation Expense	-	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029
Amortization Expense	-	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)
Fed Tax Basis Depr Adj	-	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769
Interest Expense	519,389	965,635	843,525	760,100	691,181	633,143	596,864	571,466	546,067	520,669	495,270	469,872	444,473	419,075	393,676
Income Before Taxes	1,889,832	3,458,244	3,013,940	2,710,391	2,459,627	2,248,450	2,116,448	2,024,034	1,931,520	1,839,206	1,746,792	1,654,378	1,561,964	1,469,550	1,377,136
Income Taxes	735,329	1,367,105	1,194,227	1,076,117	978,545	896,376	845,015	809,057	773,099	737,141	701,183	665,224	629,266	593,308	557,350
ITC, RETITC	-	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)
Total Taxes	735,329	1,311,824	1,138,946	1,020,836	923,264	841,095	789,734	753,776	717,818	681,859	645,901	609,943	573,985	538,027	502,069
Preferred Dividends	11,846	22,023	19,238	17,336	15,764	14,440	13,613	13,033	12,454	11,875	11,296	10,716	10,137	9,558	8,979
Net Income (Loss)	1,142,657	2,124,397	1,855,756	1,672,220	1,520,599	1,392,914	1,313,101	1,257,225	1,201,348	1,145,471	1,089,595	1,033,718	977,842	921,965	866,088
ROE (Return on Equity)	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%

System Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total
Revenue Requirement Calculation																
Revenue Requirement	3,159,607	3,039,169	2,918,908	2,798,828	2,679,932	2,559,225	2,439,709	2,320,399	2,201,268	2,082,351	1,963,642	1,845,145	1,726,864	1,608,803	1,490,967	97,468,568
Revenue Taxes	280,731	270,030	259,345	248,676	238,023	227,387	216,768	206,167	195,583	185,017	174,470	163,941	153,432	142,942	132,472	8,660,082
Income Before Depr, Int, Inc Tax	2,878,876	2,769,139	2,659,563	2,550,152	2,440,909	2,331,837	2,222,941	2,114,222	2,005,686	1,897,334	1,789,173	1,681,204	1,573,432	1,465,861	1,358,494	88,808,486
O&M Expense	403,761	411,836	420,072	428,474	437,043	445,784	454,700	463,794	473,070	482,531	492,182	502,025	512,066	522,307	532,753	12,170,424
Depreciation Expense	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	40,078,835
Amortization Expense	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(19,681,791)
Fed Tax Basis Depr Adj	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	3,444,313
Interest Expense	368,278	342,679	317,481	292,063	266,584	241,286	215,867	190,499	165,090	139,692	114,293	88,895	63,496	38,098	12,699	11,727,737
Income Before Taxes	1,284,722	1,192,308	1,099,894	1,007,480	915,066	822,652	730,238	637,824	545,410	452,996	360,582	268,168	175,754	83,340	(8,074)	24,831,490
Income Taxes	440,790	410,391	379,992	349,592	319,193	288,794	258,394	227,995	197,596	167,196	136,797	106,398	75,998	45,599	15,200	14,036,882
Income Taxes - State	80,602	75,043	69,484	63,925	58,367	52,808	47,249	41,691	36,132	30,573	25,014	19,456	13,897	8,338	2,779	2,566,744
ITC, RETITC	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(1,603,153)
Total Income Taxes	466,111	430,153	394,195	358,237	322,279	286,321	250,363	214,404	178,446	142,488	106,530	70,572	34,614	(1,344)	(37,302)	15,000,473
Preferred Dividends	7,820	7,241	6,662	6,082	5,503	4,924	4,344	3,765	3,186	2,607	2,027	1,448	869	290	267,475
Net Income for Common	810,212	754,335	698,458	642,582	586,705	530,828	474,952	419,075	363,198	307,322	251,445	195,568	139,692	83,815	27,938	9,563,543
check	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
ROE	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	
Book Income Statement																
Revenues	3,159,607	3,039,169	2,918,908	2,798,828	2,679,932	2,559,225	2,439,709	2,320,399	2,201,268	2,082,351	1,963,642	1,845,145	1,726,864	1,608,803	1,490,967	97,468,568
Revenue Taxes	280,731	270,030	259,345	248,676	238,023	227,387	216,768	206,167	195,583	185,017	174,470	163,941	153,432	142,942	132,472	8,660,082
Net Revenue	2,878,876	2,769,139	2,659,563	2,550,152	2,440,909	2,331,837	2,222,941	2,114,222	2,005,686	1,897,334	1,789,173	1,681,204	1,573,432	1,465,861	1,358,494	88,808,486
O&M Expense	403,761	411,836	420,072	428,474	437,043	445,784	454,700	463,794	473,070	482,531	492,182	502,025	512,066	522,307	532,753	12,170,424
Depreciation Expense	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	1,382,029	40,078,835
Amortization Expense	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(678,682)	(19,681,791)
Fed Tax Basis Depr Adj	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	118,769	3,444,313
Interest Expense	368,278	342,679	317,481	292,063	266,584	241,286	215,867	190,499	165,090	139,692	114,293	88,895	63,496	38,098	12,699	11,727,737
Income Before Taxes	1,284,722	1,192,308	1,099,894	1,007,480	915,066	822,652	730,238	637,824	545,410	452,996	360,582	268,168	175,754	83,340	(8,074)	24,831,490
Income Taxes	521,292	485,434	449,476	413,518	377,560	341,602	305,644	269,686	233,728	197,769	161,811	125,853	89,895	53,937	17,979	16,603,626
ITC, RETITC	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(55,281)	(1,603,153)
Total Taxes	466,111	430,153	394,195	358,237	322,279	286,321	250,363	214,404	178,446	142,488	106,530	70,572	34,614	(1,344)	(37,302)	15,000,473
Preferred Dividends	7,820	7,241	6,662	6,082	5,503	4,924	4,344	3,765	3,186	2,607	2,027	1,448	869	290	267,475	
Net Income (Loss)	810,212	754,335	698,458	642,582	586,705	530,828	474,952	419,075	363,198	307,322	251,445	195,568	139,692	83,815	27,938	9,563,543
ROE (Return on Equity)	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	

Kahe Utility-Scale PV Analysis
Project Assumptions

USER INPUT

Cost of Capital Assumptions:	Weight	Rate	Weighted Average	After-Tax Weighted Avg.
ST Debt	3.00%	4.00%	0.120%	0.073%
LT Debt (Taxable)	39.00%	7.00%	2.730%	1.668%
Hybrids	0.00%	6.50%	0.000%	0.000%
Preferred Stock	1.00%	6.50%	0.065%	0.065%
Common Stock	57.00%	11.00%	6.270%	6.270%
			9.185%	8.076%

Tax Assumptions:		
Federal	35.00%	32.89%
State	6.40%	6.02%
		38.91%

Public Service Company Tax	5.885%	(on gross receipts)
PUC Fee	0.500%	(on gross receipts)
Franchise Tax	2.500%	(on electricity sales)
Revenue Tax Rate	8.885%	

Tax Assumptions

State Investment Tax Credit (ITC)	4.000%
State Renewable Energy Technologies Income Tax Credit (RETITC)	30.000%
Number of Systems	0
(limited to $500,000 per System)	-
Federal Tax Credit	30.000%

Depreciation

Expected Useful Life (less than 30)	15
MACRS Tax Life ("Tax Life")	5
Tax Class Life ("Class Life")	12

Capital Cost $ 2,323,848

Kahe Utility-Scale PV Project

Inverters - First Set at 15 Year Life

System Year			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total	Average
PV System Assumptions																																		
Capital Cost			2,323,848																															
Tax Basis		348,577	1,975,271																															
Book Depreciation																																		
Book Depreciation Rates			0.000%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
Depreciation Expense			-	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,323,848	
Accumulated Depreciation			-	165,989	331,978	497,967	663,957	829,946	995,935	1,161,924	1,327,913	1,493,902	1,659,891	1,825,881	1,991,870	2,157,859	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848		
Book Depreciation - Tax Basis																																		
Book Depreciation Rates			0.000%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
Depreciation Expense			-	141,091	141,091	141,091	141,091	141,091	141,091	141,091	141,091	141,091	141,091	141,091	141,091	141,091	141,091	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,975,271	
Accumulated Depreciation			-	141,091	282,182	423,272	564,363	705,454	846,545	987,635	1,128,726	1,269,817	1,410,908	1,551,998	1,693,089	1,834,180	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271		
Tax Depreciation																																		
Tax Depreciation Rates (Straight Line)			4.170%	8.330%	8.330%	8.330%	8.330%	8.330%	8.340%	8.330%	8.340%	8.330%	8.340%	8.330%	4.170%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
Revenue Bond Financed Tax Basis (S/L)	0.00%		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tax Depreciation Rates (MACRS)			20.000%	32.000%	19.200%	11.520%	11.520%	5.760%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
NonRB Financed Tax Basis (MACRS)	100.00%		395,054	632,087	379,252	227,551	227,551	113,776	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,975,271	
Tax Depreciation			395,054	632,087	379,252	227,551	227,551	113,776	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,975,271	
Accumulated Tax Depreciation			395,054	1,027,141	1,406,393	1,633,944	1,861,495	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271		
Federal Tax Basis Adjustment For Energy Tax Credit																																		
50% of Amortization of Federal Tax Credit			-	24,898	24,898	24,898	24,898	24,898	24,898	24,898	24,898	24,898	24,898	24,898	24,898	24,898	24,898	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Federal Tax Rate			35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%		
Federal Tax Incr (Decr)			-	8,714	8,714	8,714	8,714	8,714	8,714	8,714	8,714	8,714	8,714	8,714	8,714	8,714	8,714	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Gross Up of Federal Tax Incr (Decr)			-	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
State Investment Tax Credit (ITC)																																		
Book																																		
State ITC Amortization Rate			0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Amortization of State ITC			-	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	92,954	
Accumulated Amortization			-	6,640	13,279	19,919	26,558	33,198	39,837	46,477	53,117	59,756	66,396	73,035	79,675	86,314	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954	92,954		
Deferred ITC			92,954	86,314	79,675	73,035	66,396	59,756	53,117	46,477	39,837	33,198	26,558	19,919	13,279	6,640	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Tax			92,954																														92,954	
State Renewable Energy Technologies Income Tax Credit (RETITC)																																		
Book																																		
RETITC Amortization Rate			0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Amortization of RETITC			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Accumulated Amortization			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Deferred RETITC			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Tax			-																															
Federal Tax Credit (FTC) - Not in Rate Base																																		
Book																																		
FTC Amortization Rate			0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Amortization of FTC (Credit)			-	49,797	49,797	49,797	49,797	49,797	49,797	49,797	49,797	49,797	49,797	49,797	49,797	49,797	49,797	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	697,154	
Accumulated Amortization			-	49,797	99,593	149,390	199,187	248,984	298,780	348,577	398,374	448,171	497,967	547,764	597,561	647,358	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154	697,154		
Deferred FTC			697,154	647,358	597,561	547,764	497,967	448,171	398,374	348,577	298,780	248,984	199,187	149,390	99,593	49,797	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
FTC Gross-Up - Include in Rate Base																																		
Deferred Tax Asset (Debit)			444,034	412,317	380,600	348,884	317,167	285,450	253,734	222,017	190,300	158,583	126,867	95,150	63,433	31,717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Reg. Liability Amortization Rate			0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Reg. Liability Amortization(Credit)			-	31,717	31,717	31,717	31,717	31,717	31,717	31,717	31,717	31,717	31,717	31,717	31,717	31,717	31,717	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	444,034	
Reg. Liability Balance (Credit)			444,034	412,317	380,600	348,884	317,167	285,450	253,734	222,017	190,300	158,583	126,867	95,150	63,433	31,717	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Deferred Tax Calculation																																		
Book Accumulated Depreciation			-	141,091	282,182	423,272	564,363	705,454	846,545	987,635	1,128,726	1,269,817	1,410,908	1,551,998	1,693,089	1,834,180	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271		
Tax Accumulated Depreciation			395,054	1,027,141	1,406,393	1,633,944	1,861,495	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271	1,975,271		
Book/Tax Acc Depr Difference			(395,054)	(886,050)	(1,124,211)	(1,210,672)	(1,297,132)	(1,269,817)	(1,128,726)	(987,635)	(846,545)	(705,454)	(564,363)	(423,272)	(282,182)	(141,091)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Deferred ITC, RETITC			92,954	86,314	79,675	73,035	66,396	59,756	53,117	46,477	39,837	33,198	26,558	19,919	13,279	6,640	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Net Deferred Tax Asset (Liability)			(117,547)	(311,175)	(406,427)	(442,652)	(478,877)	(470,832)	(418,517)	(366,203)	(313,888)	(261,573)	(209,259)	(156,944)	(104,629)	(52,315)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Deferred Tax Base			302,100	497,635	244,801	93,100	93,100	(20,676)	(134,451)	(134,451)	(134,451)	(134,451)	(134,451)	(134,451)	(134,451)	(134,451)	(134,451)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
Deferred Taxes - Federal			99,375	163,696	80,527	30,625	30,625	(6,801)	(44,227)	(44,227)	(44,227)	(44,227)	(44,227)	(44,227)	(44,227)	(44,227)	(44,227)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
Deferred Taxes - State excluding credit			18,171	29,933	14,725	5,600	5,600	(1,244)	(8,087)	(8,087)	(8,087)	(8,087)	(8,087)	(8,087)	(8,087)	(8,087)	(8,087)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		(0)
Change In Deferred Taxes			117,547	193,629	95,251	36,225	36,225	(8,045)	(52,315)	(52,315)	(52,315)	(52,315)	(52,315)	(52,315)	(52,315)	(52,315)	(52,315)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		0
Accumulated Deferred Taxes			117,547	311,175	406,427	442,652	478,877	470,832	418,517	366,203	313,888	261,573	209,259	156,944	104,629	52,315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
check			-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Rate Base and Financing																																		
Gross Plant	-		2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848		
Accumulated Depreciation			-	165,989	331,978	497,967	663,957	829,946	995,935	1,161,924	1,327,913	1,493,902	1,659,891	1,825,881	1,991,870	2,157,859	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848	2,323,848		
Accumulated Deferred ITC, RETITC			92,954	86,314	79,675	73,035	66,396	59,756	53,117	46,477	39,837	33,198	26,558	19,919	13,279	6,640	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Accumulated Deferred Taxes (FTC)			444,034	412,317	380,600	348,884	317,167	285,450	253,734	222,017	190,300	158,583	126,867	95,150	63,433	31,717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Regulatory Liability (FTC)			444,034	412,317	380,600	348,884	317,167	285,450	253,734	222,017	190,300	158,583	126,867	95,150	63,433	31,717	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Accumulated Deferred Taxes (Deprec)			117,547	311,175	406,427	442,652	478,877	470,832	418,517	366,203	313,888	261,573	209,259	156,944	104,629	52,315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Ending Net Investment	-		2,113,348	1,760,369	1,505,768	1,310,194	1,114,619	963,314	856,279	749,244	642,209	535,175	428,140	321,105	214,070	107,035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Average Net Investment			1,056,674	1,936,858	1,633,069	1,407,981	1,212,406	1,038,967	909,797	802,762	695,727	588,692	481,657	374,622	267,587	160,552	53,517	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Average Financing																																		
Short Term Debt	3.00%		31,700	58,106	48,992	42,239	36,372	31,169	27,294	24,083	20,872	17,661	14,450	11,239	8,028	4,817	1,606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Taxable Debt	39.00%		412,103	755,375	636,897	549,113	472,838	405,197	354,821	313,077	271,334	229,590	187,846	146,103	104,359	62,615	20,872	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Hybrids	0.00%		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Preferred Stock	1.00%		10,567	19,369	16,331	14,080	12,124	10,390	9,098	8,028	6,957	5,887	4,817	3,746	2,676	1,606	535	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Common Equity	57.00%		602,204	1,104,009	930,849	802,549	691,072	592,211	518,584	457,574	396,564	335,554	274,545	213,535	152,525	91,515	30,505	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Total Financing			1,056,674	1,936,858	1,633,069	1,407,981	1,212,406	1,038,967	909,797	802,762	695,727	588,692	481,657	374,622	267,587	160,552	53,517	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Return on Investment																																		
Short Term Debt	4.00%		1,268	2,324	1,960	1,690	1,455	1,247	1,092	963	835	706	578	450	321	193	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15,145	
Taxable Debt	7.00%		28,847	52,876	44,583	38,438	33,099	28,364	24,837	21,915	18,993	16,071	13,149	10,227	7,305	4,383	1,461	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	344,550	
Hybrids	6.50%		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total Interest Expense			30,115	55,200	46,542	40,127	34,554	29,611	25,929	22,879	19,828	16,778	13,727	10,677	7,626	4,576	1,525	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	359,695	
Preferred Dividends	6.50%		687	1,259	1,061	915	788	675	591	522	452	383	313	244	174	104	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,204	
Net Income on Common	11.00%		66,253	121,441	102,393	88,280	76,018	65,143	57,044	50,303	43,622	36,911	30,200	23,489	16,778	10,067	3,356	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	791,328	
Income Taxes																																		
Income Before Pref Dividends			66,940	122,700	103,455	89,196	76,806	65,819	57,636	50,855	44,074	37,294	30,513	23,732	16,952	10,171	3,390	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Income Before Taxes (including tax credits)			109,576	200,850	169,348	146,006	125,725	107,740	94,345	83,246	72,146	61,047	49,947	38,848	27,749	16,649	5,550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
ITC, RETITC			-	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	6,640	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	92,954	
Income Before Taxes (excluding tax credits)			109,576	194,211	162,708	139,367	119,086	101,100	87,706	76,606	65,507	54,407	43,308	32,208	21,109	10,010	(1,090)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Federal Income Tax			36,045	66,069	55,706	48,029	41,357	35,441	31,035	27,383	23,732	20,081	16,430	12,779	9,128	5,477	1,826	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	430,517	
State Income Tax			6,591	12,081	10,186	8,782	7,562	6,481	5,675	5,007	4,340	3,672	3,004	2,337	1,669	1,001	334	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79,723	

ITC, RETITC	-	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(92,954)
Total Taxes	42,636	71,511	59,253	50,171	42,280	35,282	30,070	25,751	21,432	17,114	12,795	8,476	4,157	(161)	(4,480)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Revenue Requirement Calculation																																
Revenue Requirement	153,313	382,102	338,025	305,367	276,991	251,826	233,085	217,555	202,025	186,496	170,966	155,436	139,906	124,377	108,847	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,246,316
Revenue Taxes	13,621.88	33,949.73	30,033.49	27,131.82	24,610.61	22,374.76	20,709.59	19,329.77	17,949.96	16,570.14	15,190.32	13,810.51	12,430.69	11,050.87	9,671.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	289,435
Income Before Depr, Int, Inc Tax	139,691	348,152	307,991	278,235	252,380	229,451	212,375	198,225	184,075	169,926	155,776	141,626	127,476	113,326	99,176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,957,881
Depreciation Expense	-	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,323,848
Amortization Expense	-	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1,141,188)
Fed Tax Basis Depr Adj	-	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	199,708
Interest Expense	30,115	55,200	46,542	40,127	34,554	29,611	25,929	22,879	19,828	16,778	13,727	10,677	7,626	4,576	1,525	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	359,695
Income Before Income Taxes	109,576	194,211	162,708	139,367	119,086	101,100	87,706	76,606	65,507	54,407	43,308	32,208	21,109	10,010	(1,090)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	274,338
Income Taxes - Federal	36,045	66,069	55,706	48,028	41,357	35,441	31,035	27,383	23,732	20,081	16,430	12,779	9,128	5,477	1,826	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	430,517
Income Taxes - State	6,591	12,081	10,186	8,782	7,562	6,481	5,675	5,007	4,340	3,672	3,004	2,337	1,669	1,001	334	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78,723
ITC, RETITC	-	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(92,954)
Total Income Taxes	42,636	71,511	59,253	50,171	42,280	35,282	30,070	25,751	21,432	17,114	12,795	8,476	4,157	(161)	(4,480)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	416,286
Preferred Dividends	687	1,259	1,061	915	788	675	591	522	452	383	313	244	174	104	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,204
Net Income for Common	66,253	121,441	102,393	88,280	76,018	65,143	57,044	50,333	43,622	36,911	30,200	23,489	16,778	10,067	3,356	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(150,152)
check	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ROE	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	
Book Income Statement																																
Revenues	153,313	382,102	338,025	305,367	276,991	251,826	233,085	217,555	202,025	186,496	170,966	155,436	139,906	124,377	108,847	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,246,316
Revenue Taxes	13,621.88	33,949.73	30,033.49	27,131.82	24,610.61	22,374.76	20,709.59	19,329.77	17,949.96	16,570.14	15,190.32	13,810.51	12,430.69	11,050.87	9,671.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	289,435
Net Revenue	139,691	348,152	307,991	278,235	252,380	229,451	212,375	198,225	184,075	169,926	155,776	141,626	127,476	113,326	99,176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,957,881
Depreciation Expense	-	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	165,989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,323,848
Amortization Expense	-	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	(81,513)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1,141,188)
Fed Tax Basis Depr Adj	-	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	14,265	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	199,708
Interest Expense	30,115	55,200	46,542	40,127	34,554	29,611	25,929	22,879	19,828	16,778	13,727	10,677	7,626	4,576	1,525	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	359,695
Income Before Taxes	109,576	194,211	162,708	139,367	119,086	101,100	87,706	76,606	65,507	54,407	43,308	32,208	21,109	10,010	(1,090)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	274,338
Income Taxes	42,636	78,150	65,893	56,811	48,919	41,921	36,709	32,391	28,072	23,753	19,434	15,116	10,797	6,478	2,159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	142,913
ITC, RETITC	-	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	(6,640)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(92,954)
Total Taxes	42,636	71,511	59,253	50,171	42,280	35,282	30,070	25,751	21,432	17,114	12,795	8,476	4,157	(161)	(4,480)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49,959
Preferred Dividends	687	1,259	1,061	915	788	675	591	522	452	383	313	244	174	104	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,204
Net Income (Loss)	66,253	121,441	102,393	88,280	76,018	65,143	57,044	50,333	43,622	36,911	30,200	23,489	16,778	10,067	3,356	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	216,176
ROE (Return on Equity)	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	

198,211

Kahe Utility-Scale PV Analysis
Project Assumptions

USER INPUT

Cost of Capital Assumptions:	Weight	Rate	Weighted Average	After-Tax Weighted Avg.
ST Debt	3.00%	4.00%	0.120%	0.073%
LT Debt (Taxable)	39.00%	7.00%	2.730%	1.668%
Hybrids	0.00%	6.50%	0.000%	0.000%
Preferred Stock	1.00%	6.50%	0.065%	0.065%
Common Stock	57.00%	11.00%	6.270%	6.270%
			9.185%	8.076%

Tax Assumptions:		
Federal	35.00%	32.89%
State	6.40%	6.02%
		38.91%

Public Service Company Tax	5.885%	(on gross receipts)
PUC Fee	0.500%	(on gross receipts)
Franchise Tax	2.500%	(on electricity sales)
Revenue Tax Rate	8.885%	

Tax Assumptions

State Investment Tax Credit (ITC)	4.000%
State Renewable Energy Technologies Income Tax Credit (RETITC)	30.000%
Number of Systems	0
(limited to $500,000 per System)	-
Federal Tax Credit	0.000%

Depreciation

Expected Useful Life (less than 30)	15
MACRS Tax Life ("Tax Life")	5
Tax Class Life ("Class Life")	12

Capital Cost	$ 4,691,390
Capital Escalation Rate	2.00%

Kahe Utility-Scale PV Project
Inverters - Second Set at 15 Year Life

System Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total	Average
PV System Assumptions																																	
Capital Cost		4,691,390																															
Tax Basis	-	4,691,390																															
Book Depreciation																																	
Book Depreciation Rates		0.000%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
Depreciation Expense		-	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,691,390	
Accumulated Depreciation		-	335,099	670,199	1,005,298	1,340,397	1,675,496	2,010,596	2,345,695	2,680,794	3,015,894	3,350,993	3,686,092	4,021,192	4,356,291	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390		
Book Depreciation - Tax Basis																																	
Book Depreciation Rates		0.000%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	7.143%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
Depreciation Expense		-	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,691,390	
Accumulated Depreciation		-	335,099	670,199	1,005,298	1,340,397	1,675,496	2,010,596	2,345,695	2,680,794	3,015,894	3,350,993	3,686,092	4,021,192	4,356,291	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390		
Tax Depreciation																																	
Tax Depreciation Rates (Straight Line)		4.170%	8.330%	8.330%	8.330%	8.330%	8.330%	8.340%	8.330%	8.340%	8.330%	8.340%	8.330%	4.170%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
Revenue Bond Financed Tax Basis (S/L)	0.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tax Depreciation Rates (MACRS)		20.000%	32.000%	19.200%	11.520%	11.520%	5.760%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	100.0%	
Nonrfill Financed Tax Basis (MACRS)	100.00%	938,278	1,501,245	900,747	540,448	540,448	270,224	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,691,390	
Tax Depreciation		938,278	1,501,245	900,747	540,448	540,448	270,224	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,691,390	
Accumulated Tax Depreciation		938,278	2,439,523	3,340,270	3,880,718	4,421,166	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390		
Federal Tax Basis Adjustment For Energy Tax Credit																																	
50% of Amortization of Federal Tax Credit		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Federal Tax Rate		35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%		
Federal Tax Incr (Decr)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Gross Up of Federal Tax Incr (Decr)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
State Investment Tax Credit (ITC)																																	
Book																																	
State ITC Amortization Rate		0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Amortization of State ITC		-	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	187,656	
Accumulated Amortization		-	13,404	26,808	40,212	53,616	67,020	80,424	93,828	107,232	120,636	134,040	147,444	160,848	174,252	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656	187,656		
Deferred ITC		187,656	174,252	160,848	147,444	134,040	120,636	107,232	93,828	80,424	67,020	53,616	40,212	26,808	13,404	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Tax		187,656																														187,656	
State Renewable Energy Technologies Income Tax Credit (RETITC)																																	
Book																																	
RETITC Amortization Rate		0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Amortization of RETITC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Accumulated Amortization		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Deferred RETITC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Tax		-																															
Federal Tax Credit (FTC) - Not in Rate Base																																	
Book																																	
FTC Amortization Rate		0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Amortization of FTC (Credit)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Accumulated Amortization		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Deferred FTC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
FTC Gross-Up - Include in Rate Base																																	
Deferred Tax Asset (Debit)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Reg. Liability Amortization Rate		0.00%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%	
Reg. Liability Amortization(Credit)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Reg. Liability Balance (Credit)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Deferred Tax Calculation																																	
Book Accumulated Depreciation		-	335,099	670,199	1,005,298	1,340,397	1,675,496	2,010,596	2,345,695	2,680,794	3,015,894	3,350,993	3,686,092	4,021,192	4,356,291	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390		
Tax Accumulated Depreciation		938,278	2,439,523	3,340,270	3,880,718	4,421,166	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390		
Book/Tax Acc Depr Difference		(938,278)	(2,104,424)	(2,670,071)	(2,875,420)	(3,080,769)	(3,015,894)	(2,680,794)	(2,345,695)	(2,010,596)	(1,675,496)	(1,340,397)	(1,005,298)	(670,199)	(335,099)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Deferred ITC, RETITC		187,656	174,252	160,848	147,444	134,040	120,636	107,232	93,828	80,424	67,020	53,616	40,212	26,808	13,404	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Net Deferred Tax Asset (Liability)		(292,065)	(751,026)	(976,333)	(1,061,449)	(1,146,566)	(1,126,538)	(1,001,367)	(876,196)	(751,026)	(625,855)	(500,684)	(375,513)	(250,342)	(125,171)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Deferred Tax Base		750,622	1,179,550	579,052	218,753	218,753	(51,471)	(321,695)	(321,695)	(321,695)	(321,695)	(321,695)	(321,695)	(321,695)	(321,695)	(321,695)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(0)	
Deferred Taxes - Federal		246,915	388,010	190,477	71,958	71,958	(16,931)	(105,821)	(105,821)	(105,821)	(105,821)	(105,821)	(105,821)	(105,821)	(105,821)	(105,821)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Deferred Taxes - State excluding credit		45,150	70,950	34,830	13,158	13,158	(3,096)	(19,350)	(19,350)	(19,350)	(19,350)	(19,350)	(19,350)	(19,350)	(19,350)	(19,350)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(0)	
Change in Deferred Taxes		292,065	458,960	225,308	85,116	85,116	(20,027)	(125,171)	(125,171)	(125,171)	(125,171)	(125,171)	(125,171)	(125,171)	(125,171)	(125,171)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
Accumulated Deferred Taxes		292,065	751,026	976,333	1,061,449	1,146,566	1,126,538	1,001,367	876,196	751,026	625,855	500,684	375,513	250,342	125,171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
check		-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Rate Base and Financing																																	
Gross Plant	-	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390		
Accumulated Depreciation		-	335,099	670,199	1,005,298	1,340,397	1,675,496	2,010,596	2,345,695	2,680,794	3,015,894	3,350,993	3,686,092	4,021,192	4,356,291	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390	4,691,390		
Accumulated Deferred ITC, RETITC		187,656	174,252	160,848	147,444	134,040	120,636	107,232	93,828	80,424	67,020	53,616	40,212	26,808	13,404	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Accumulated Deferred Taxes (FTC)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Regulatory Liability (FTC)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Accumulated Deferred Taxes (Deprec)		292,065	751,026	976,333	1,061,449	1,146,566	1,126,538	1,001,367	876,196	751,026	625,855	500,684	375,513	250,342	125,171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Ending Net Investment	-	4,211,669	3,431,014	2,884,011	2,477,199	2,070,388	1,768,720	1,572,195	1,375,671	1,179,146	982,622	786,098	589,573	393,049	196,524	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Average Net Investment		2,105,835	3,821,341	3,157,512	2,680,605	2,273,793	1,919,554	1,670,457	1,473,933	1,277,409	1,080,884	884,360	687,835	491,311	294,787	98,262	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Average Financing																																	
Short Term Debt	3.00%	63,175	114,640	94,725	80,418	68,214	57,587	50,114	44,218	38,322	32,427	26,531	20,635	14,739	8,844	2,948	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Taxable Debt	39.00%	821,275	1,490,323	1,231,430	1,045,436	886,779	748,626	651,478	574,834	498,189	421,545	344,900	268,256	191,611	114,967	38,322	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Hybrids	0.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Preferred Stock	1.00%	21,058	38,213	31,575	26,806	22,738	19,196	16,705	14,739	12,774	10,809	8,844	6,878	4,913	2,948	983	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Common Equity	57.00%	1,200,326	2,178,165	1,799,782	1,527,945	1,296,062	1,094,146	952,161	840,142	728,123	616,104	504,085	392,066	280,047	168,028	56,009	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Total Financing		2,105,835	3,821,341	3,157,512	2,680,605	2,273,793	1,919,554	1,670,457	1,473,933	1,277,409	1,080,884	884,360	687,835	491,311	294,787	98,262	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Return on Investment																																	
Short Term Debt	4.00%	2,527	4,586	3,789	3,217	2,729	2,303	2,005	1,769	1,533	1,297	1,061	825	590	354	118	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	28,701	
Taxable Debt	7.00%	57,489	104,323	86,200	73,181	62,075	52,404	45,603	40,238	34,873	29,508	24,143	18,778	13,413	8,048	2,683	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	652,958	
Hybrids	6.50%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total Interest Expense		60,016	108,908	89,989	76,397	64,803	54,707	47,608	42,007	36,406	30,805	25,204	19,603	14,002	8,401	2,800	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	681,660	
Preferred Dividends	6.50%	1,369	2,484	2,052	1,742	1,478	1,248	1,086	958	830	703	575	447	319	192	64	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	15,547	
Net Income on Common	11.00%	132,036	239,598	197,976	168,074	142,567	120,356	104,738	92,416	80,094	67,771	55,449	43,127	30,805	18,483	6,161	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	1,499,651	
Income Taxes																																	
Income Before Pref Dividends		133,405	242,082	200,029	169,816	144,045	121,604	105,823	93,374	80,924	68,474	56,024	43,574	31,125	18,675	6,225	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Income Before Taxes (including tax credits)		218,373	396,270	327,431	277,976	235,790	199,056	173,225	152,845	132,466	112,087	91,707	71,328	50,948	30,569	10,190	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
ITC, RETITC		13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	13,404	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	187,656	
Income Before Taxes (excluding tax credits)		218,373	382,866	314,027	264,572	222,386	185,652	159,821	139,442	119,062	98,683	78,303	57,924	37,545	17,165	(3,214)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)		
Federal Income Tax		71,833	130,352	107,708	91,440	77,563	65,479	56,982	50,278	43,574	36,871	30,167	23,463	16,759	10,056	3,352	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	815,876	

State Income Tax		13,135	23,836	19,695	16,720	14,183	11,973	10,420	9,194	7,968	6,742	5,516	4,290	3,065	1,839	613	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	149,189
ITC, RETITC		-	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(187,656)
Total Taxes		84,968	140,784	113,999	94,756	78,341	64,048	53,997	46,068	38,138	30,209	22,279	14,350	6,420	(1,510)	(9,439)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	
Revenue Requirement Calculation																																
Revenue Requirement		305,536	907,505	811,190	741,995	682,971	631,574	595,432	566,919	538,405	509,891	481,377	452,863	424,350	395,836	367,322	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	8,413,166
Revenue Taxes		27,146.90	80,631.81	72,074.21	65,926.26	60,681.94	56,115.34	52,904.17	50,370.72	47,837.27	45,303.82	42,770.37	40,236.92	37,703.47	35,170.02	32,636.57	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	747,510
Income Before Depr, Int, Inc Tax		278,389	826,873	739,116	676,069	622,289	575,459	542,528	516,548	490,568	464,587	438,607	412,627	386,646	360,666	334,685	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	7,665,656
Depreciation Expense		-	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,691,390
Amortization Expense		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fed Tax Basis Depr Adj		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		60,016	108,908	89,989	76,397	64,803	54,707	47,608	42,007	36,406	30,805	25,204	19,603	14,002	8,401	2,800	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	681,660
Income Before Income Taxes		218,373	382,866	314,027	264,572	222,386	185,652	159,821	139,442	119,062	98,683	78,303	57,924	37,545	17,165	(3,214)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	2,292,606
Income Taxes - Federal		71,833	130,352	107,708	91,440	77,563	65,479	56,982	50,278	43,574	36,871	30,167	23,463	16,759	10,056	3,352	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	815,876
Income Taxes - State		13,135	23,836	19,695	16,720	14,183	11,973	10,420	9,194	7,968	6,742	5,516	4,290	3,065	1,839	613	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	149,189
ITC, RETITC		-	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(187,656)
Total Income Taxes		84,968	140,784	113,999	94,756	78,341	64,048	53,997	46,068	38,138	30,209	22,279	14,350	6,420	(1,510)	(9,439)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	777,409
Preferred Dividends		1,369	2,484	2,052	1,742	1,478	1,248	1,086	958	830	703	575	447	319	192	64	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	15,547
Net Income for Common		132,036	239,598	197,976	168,074	142,567	120,356	104,738	92,416	80,094	67,771	55,449	43,127	30,805	18,483	6,161	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	1,499,651
	check	-	-	-	-	-	-	-	-	-	-	-	-	0	-	(0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	ROE	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	
Book Income Statement																																
Revenues		305,536	907,505	811,190	741,995	682,971	631,574	595,432	566,919	538,405	509,891	481,377	452,863	424,350	395,836	367,322	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	8,413,166	280,439
Revenue Taxes		27,146.90	80,631.81	72,074.21	65,926.26	60,681.94	56,115.34	52,904.17	50,370.72	47,837.27	45,303.82	42,770.37	40,236.92	37,703.47	35,170.02	32,636.57	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	747,509.78
Net Revenue		278,389	826,873	739,116	676,069	622,289	575,459	542,528	516,548	490,568	464,587	438,607	412,627	386,646	360,666	334,685	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	7,665,656
Depreciation Expense		-	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	335,099	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,691,390
Amortization Expense		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fed Tax Basis Depr Adj		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Expense		60,016	108,908	89,989	76,397	64,803	54,707	47,608	42,007	36,406	30,805	25,204	19,603	14,002	8,401	2,800	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	681,660
Income Before Taxes		218,373	382,866	314,027	264,572	222,386	185,652	159,821	139,442	119,062	98,683	78,303	57,924	37,545	17,165	(3,214)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	2,292,606
Income Taxes		84,968	154,188	127,403	108,160	91,745	77,452	67,401	59,472	51,542	43,613	35,683	27,754	19,824	11,894	3,965	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	965,064
ITC, RETITC		-	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	(13,404)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(187,656)
Total Taxes		84,968	140,784	113,999	94,756	78,341	64,048	53,997	46,068	38,138	30,209	22,279	14,350	6,420	(1,510)	(9,439)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	777,409
Preferred Dividends		1,369	2,484	2,052	1,742	1,478	1,248	1,086	958	830	703	575	447	319	192	64	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	15,547
Net Income (Loss)		132,036	239,598	197,976	168,074	142,567	120,356	104,738	92,416	80,094	67,771	55,449	43,127	30,805	18,483	6,161	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	1,499,651
ROE (Return on Equity)		**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	**11.00%**	

E. GLARE ANALYSIS

APPENDIX F - GLARE ANALYSIS

As part of their efforts to minimize adverse effects from the proposed Kahe Utility Scale PV project, Hawaiian Electric and its solar contractor, SolarCity, carefully evaluated ways in which it could mitigate the potential for glare from the project. The evaluation was conducted using the Solar Glare Hazard Analysis Tool computer software (SGHAT ver. 2) developed by the U.S. Department of Energy's Sandia National Laboratories. The software allows engineers to evaluate the potential for harmful glare from photovoltaic (PV) panels by calculating when and where solar glare off photovoltaic modules can occur throughout the year. This model is considered state-of-the-art and is required for use by the Federal Aviation Administration for all projects near airports.

The screening model identified the potential for solar glare to affect viewers in vehicles traveling northbound on Farrington Highway (i.e., towards Wai'anae). It indicated that the area of concern is limited to a short segment of roadway, and only in the early morning during certain months of the year. The model output for the locations that the SGHAT software identified as having some glare potential is reproduced in Figure A.1 below.

The SGHAT model considers <u>only</u> ground elevation; it <u>does not</u> take into account screening vegetation or buildings which can reduce or completely eliminate glare effects in locations where the model output indicates that this might be possible. In order to take those factors into account, SolarCity engineers used ground level photographs and preliminary engineering plans to prepare simulations of the appearance once the landscaping that has already been installed has grown in. Those simulations, reproduced in Figure A.2 below, depict views of the project site once the broad landscape strip that Hawaiian Electric has recently installed along the *mauka* side of Farrington Highway has fully grown in.

When viewed together, the figures make it apparent that glare from the proposed PV arrays has very limited potential to affect persons in vehicles once the landscaping has grown in. The exception is a stretch beginning about halfway along the parking lot that fronts the Kahe Generating Station administration building and ends a short distance north of the highway bridge across Kahe Stream. In that location, the existing trees and shrubbery in the Kahe parking lot thin out (as do the recent plantings in the highway landscaping strip) and the stream crossing creates an open view path. As a result, many of the PV modules on the northern side of the valley would be visible in a location where the SGHAT model indicates that glare is a possibility during the middle of the calendar year (March through October).

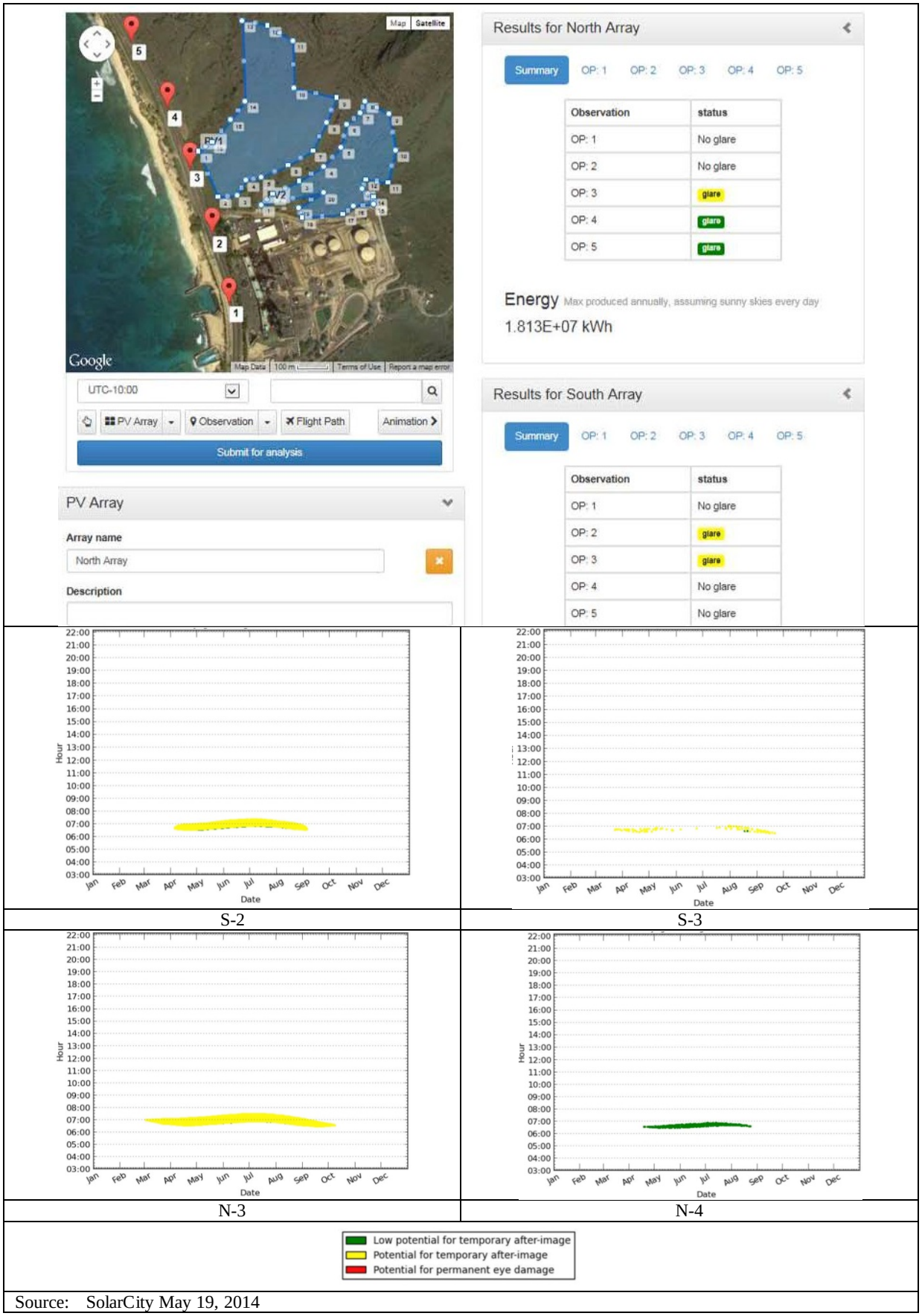
Based on the findings of the glare analysis, Hawaiian Electric has committed to consider widening the landscape strip and extending it inland for up to 500 feet inland along the northern side of Kahe Stream (i.e., along the southwestern corner of the PV site). Doing so would effectively close off the last corridor through which glare might reach the highway. It is presently conducting additional analyses designed to better-define the extent to which glare is, or is not, likely to be an issue for passing motorists, and it will finalize its plans based on the outcome of that work. The agreed-upon plan will form one of the bases for the plans on which the Conditional Use Permit needed for the project will be based.

In recognition of the fact that the plantings in the strip Hawaiian Electric has recently installed along the highway *makai* of the project site will take some time to grow in and achieve their full screening capability, Hawaiian Electric has committed to maintaining an artificial visual screen (such as construction dust screen) in place until the landscaping has become fully effective as a visual screen. This same commitment applies to any additional landscape screening that the results of the additional analysis described in the previous paragraph may indicate are appropriate.

Reference is:

Ho, Clifford K. and Cianan A. Sims. Solar Glare Hazard Analysis Tool (SGHAT) User's Manual v. 2.0. August 23, 2013. Sandia National Laboratories, U.S. Department of Energy.

Figure A.1. Solar Glare Hazard Analysis Tool Model Output



Source: SolarCity May 19, 2014

Figure A.2. Simulations of Appearance with Landscaping.